

7 Session 5: Energy Analysis Tools

Energy Assessment and Analysis Using REEP

Presenter: Mr. Donald Fournier, University of Illinois, Urbana

Assessing Energy & Water Opportunities Using REEP

the Renewables and Energy Efficiency Planning Program

Industry ESPC Workshop
Donald Fournier, UIUC-BRC
October 8, 2003

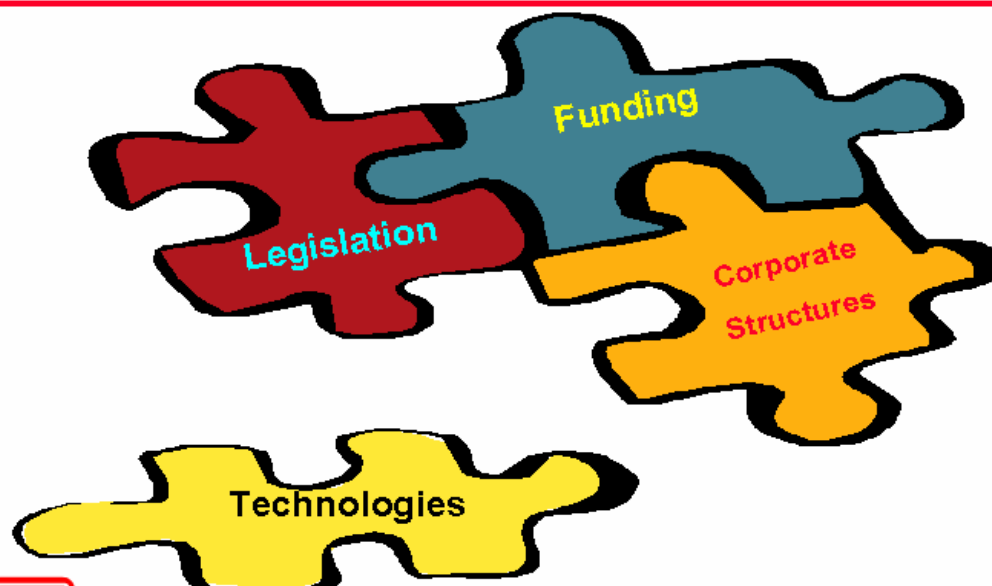


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Managing Energy, Water and Pollution is a Big Challenge



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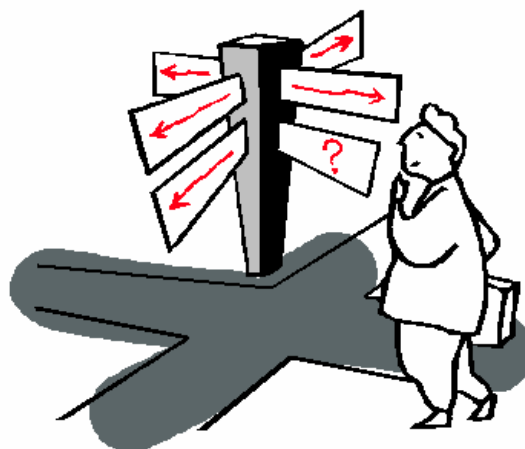
REEP provides Quick Answers to Tough Questions

Can I meet my
savings target?

Where should I
concentrate my
efforts?

What will a
project cost?

What if things
change?



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High Level Screening of Facilities Retrofits



REEP 5.2

Renewables and Energy Efficiency Planning

National/Installation level analysis of energy and water conservation in DoD



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Construction Engineering Research Laboratory



Lighting



Water



Broad Spectrum Technology Coverage

Envelope



Renewables



HVAC



Distribution Systems



Domestic Hot Water (DHW)



Misc.



DG/CHP



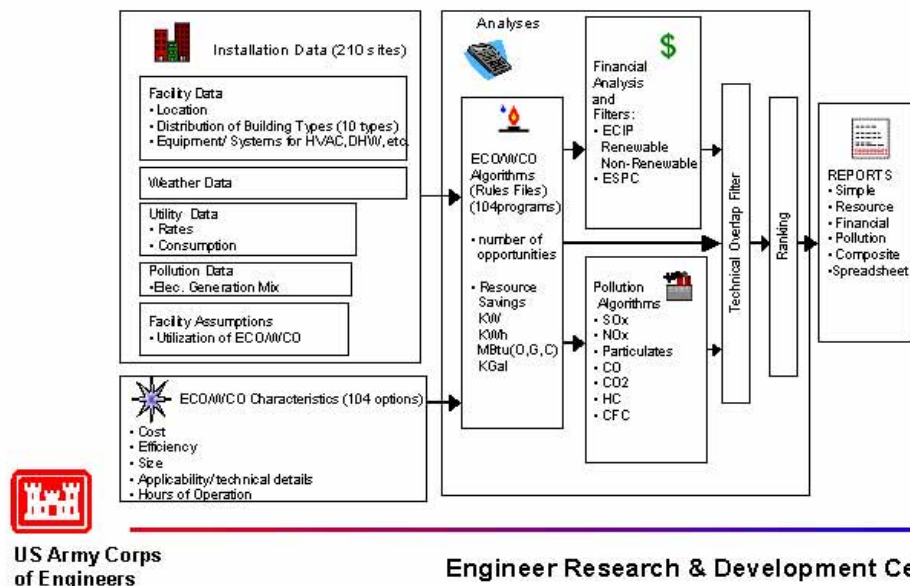
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REEP screens 104 projects at 210 DoD Installations

REEP Overview Schematic



Major Impact Analysis

-  Resources (energy and water savings potential)
 -  Financial Viability (life cycle costing)
 -  Pollution Abatement Potential (CO_2 , CO , SO_x , NO_x , PM, HC)
 -  Societal Costs
- Program can optimize on any of the above
 - Overlapping Technologies compete based on chosen criteria
 - Parametric analysis capabilities



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Potential Users

- Federal Budget Analysts
- ACSIM
- IMAs
- DoD Energy Managers
- DoD Energy Contractors



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Preloaded data from 210 Installations

- 77 Army
- 73 Air Force
- 54 Navy
- 6 Marine



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REEP Analysis

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ERDC-CERL
Energy Branch
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217-352-6511,x7522

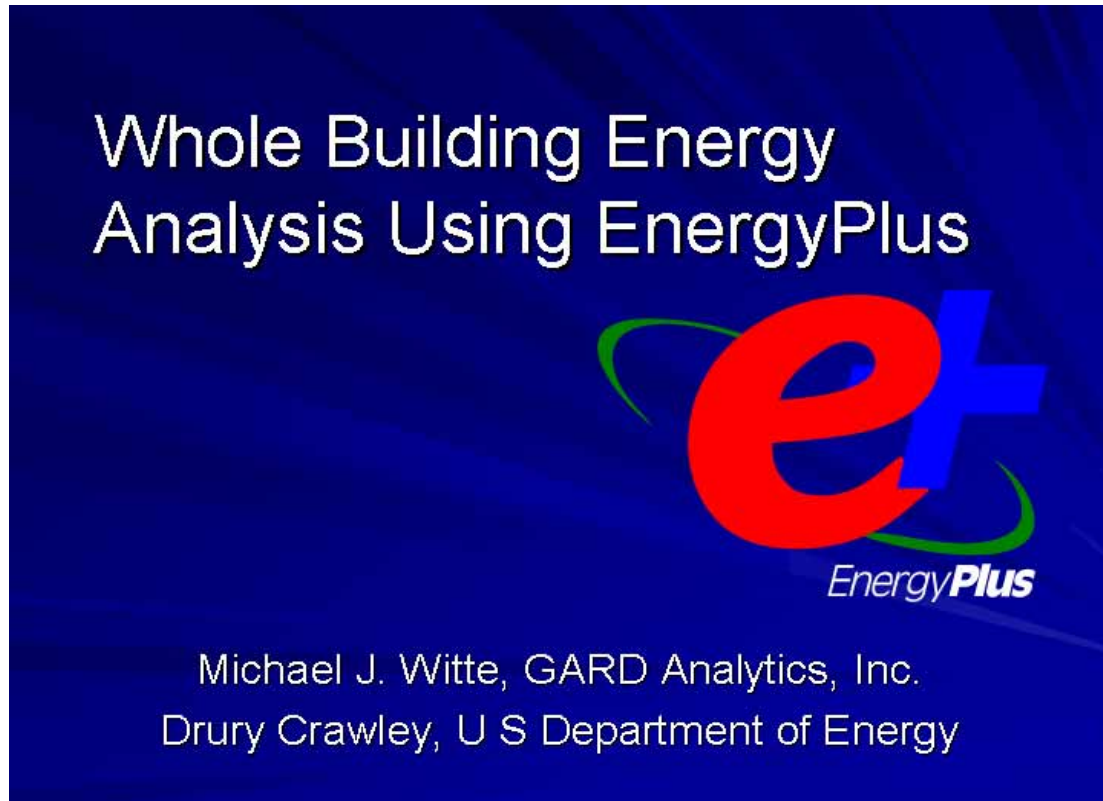


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Whole Building Energy Analysis Using EnergyPlus

Presenter: Dr. Michael Witte, GardAnalytics.



Building Simulation Process: Overview and Resources

What is building simulation?

Software which emulates the ***dynamic interaction*** of heat, light, mass (air and moisture) and sound ***within the building*** to predict its ***energy and environmental performance*** as it is exposed to climate, occupants, conditioning systems, and noise sources

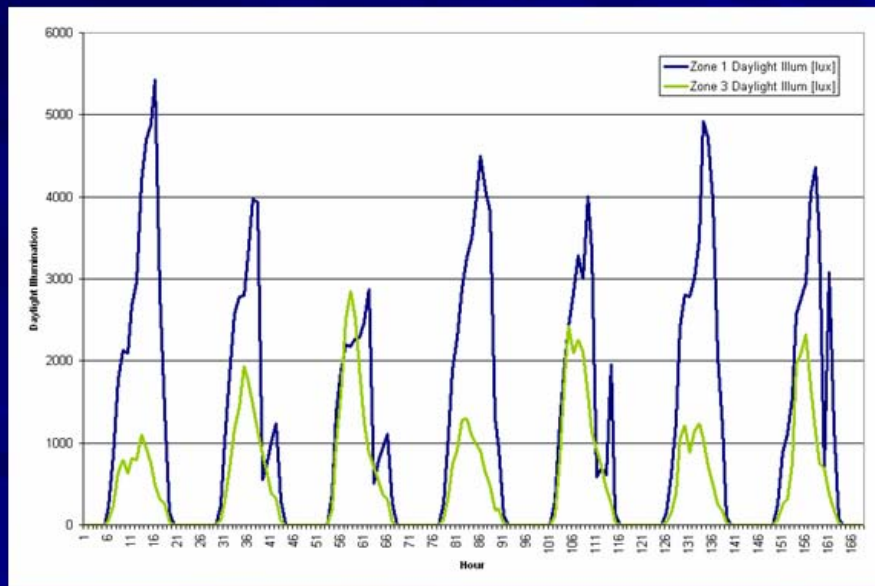
What kinds of programs are available

- Simplified programs for overall energy consumption assessment, peak temperature prediction, heating/cooling loads calculations
- Sophisticated programs, for hourly simulation of heat, light and air movement
- Complex specialist packages, for lighting, computational fluid dynamics (CFD), two- and three-dimensional conduction calculations
- Integrated design and analysis systems which combine a number of the above categories

What can building simulation programs do for me?

- Predict the dynamic response and performance of buildings
- Compare different design options—load calculations, energy performance, peak demand, and cost-benefit implications
- Simulate complex and 'green' technologies:
 - Naturally ventilated, passive and mixed-mode buildings
 - Daylighting
 - Overheating in unconditioned spaces
 - Advanced controls operation

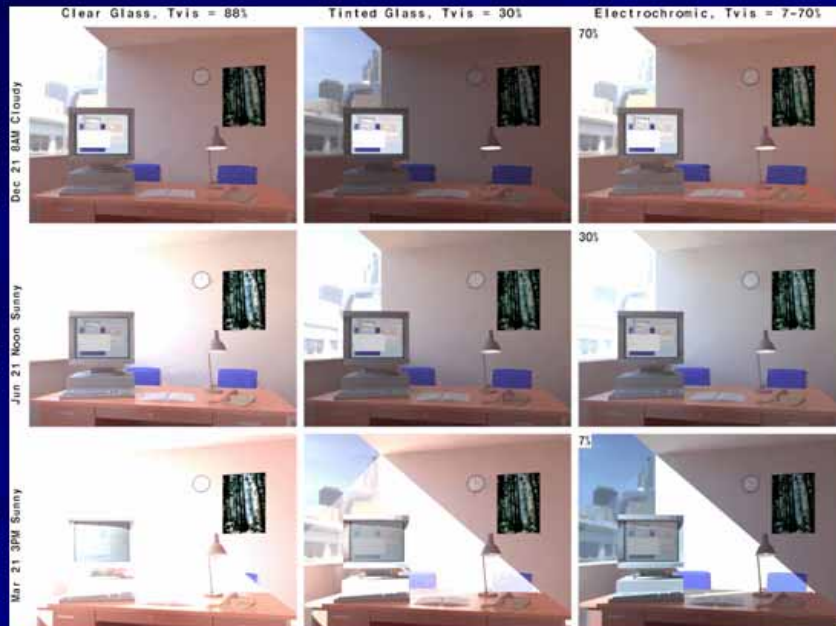
Exploring Daylighting through Glazing Options



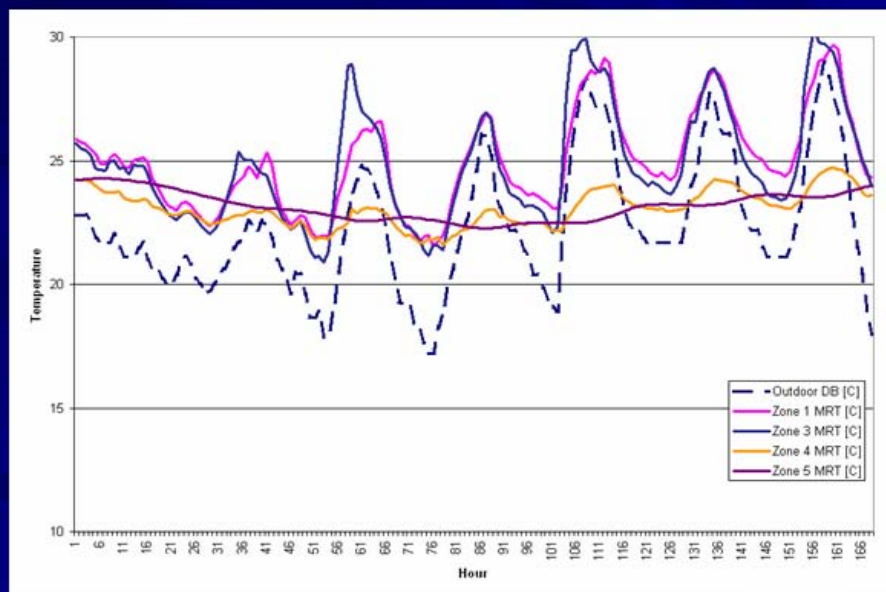
Change Glazing to Increase Daylight



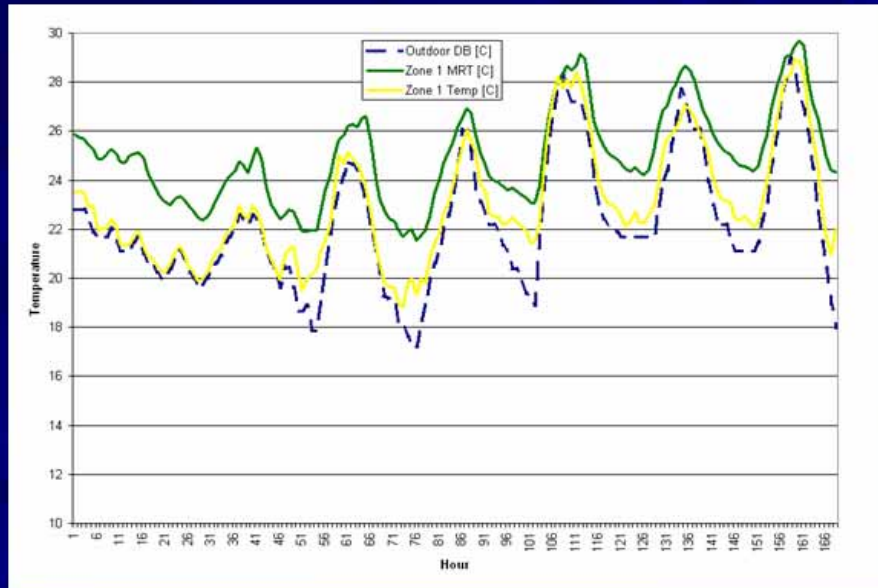
Glazing Studies of Glare



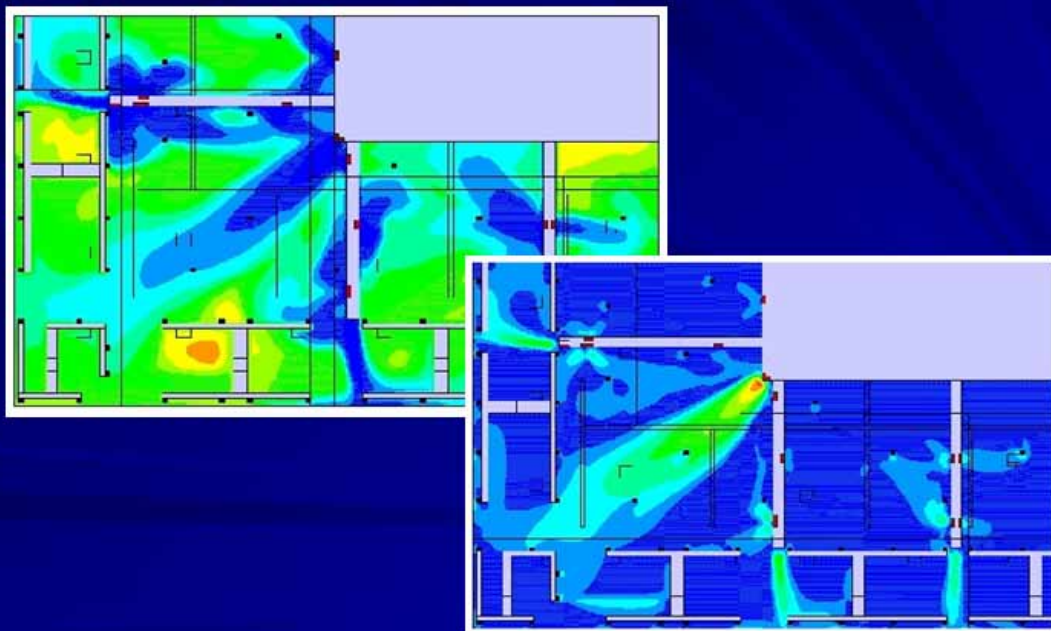
Thermal Comfort in Mixed-Mode Natural Ventilation



Overheating/Thermal Comfort

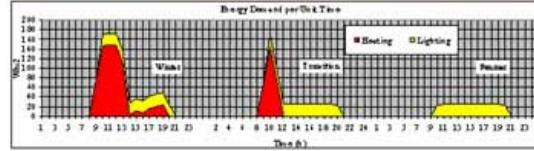


UFAD



Comparison of Alternatives

◆ Base Case

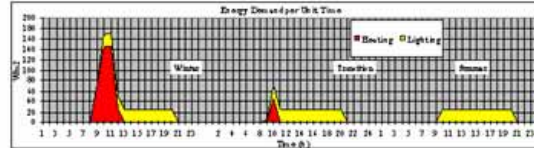


Annual Energy Performance

Heating:	118.29 kWh/m ² ·a
Cooling:	0.00 kWh/m ² ·a
Lighting:	100.10 kWh/m ² ·a
Fans:	0.00 kWh/m ² ·a
Small PL:	0.00 kWh/m ² ·a
DHW:	0.00 kWh/m ² ·a
Total:	218.39 kWh/m²·a

◆ As above +

◆ advanced glazing



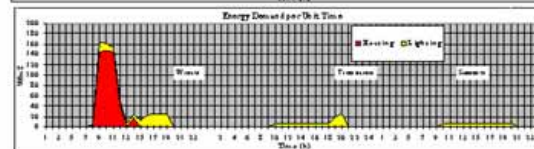
Annual Energy Performance

Heating:	49.07 kWh/m ² ·a
Cooling:	0.00 kWh/m ² ·a
Lighting:	100.10 kWh/m ² ·a
Fans:	0.00 kWh/m ² ·a
Small PL:	0.00 kWh/m ² ·a
DHW:	0.00 kWh/m ² ·a
Total:	149.17 kWh/m²·a

◆ As above +

◆ TIM wall +

◆ lighting control



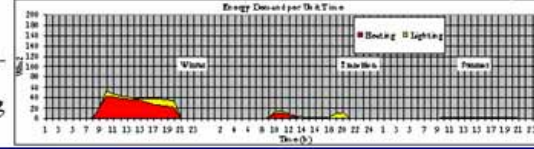
Annual Energy Performance

Heating:	64.52 kWh/m ² ·a
Cooling:	0.00 kWh/m ² ·a
Lighting:	41.59 kWh/m ² ·a
Fans:	0.00 kWh/m ² ·a
Small PL:	0.00 kWh/m ² ·a
DHW:	0.00 kWh/m ² ·a
Total:	106.12 kWh/m²·a

◆ As above +

◆ efficient lighting +

◆ responsive heating



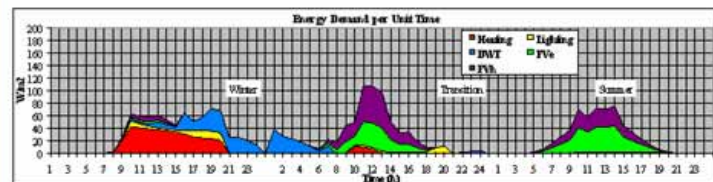
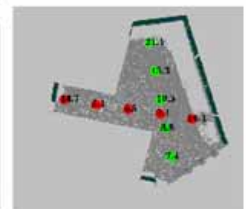
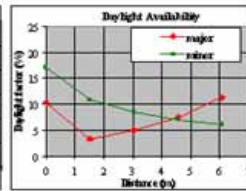
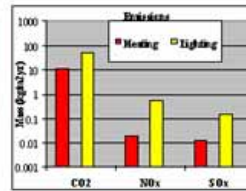
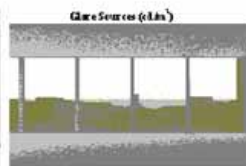
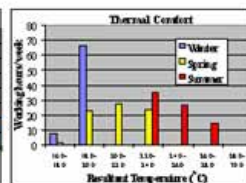
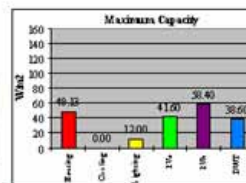
Annual Energy Performance

Heating:	48.99 kWh/m ² ·a
Cooling:	0.00 kWh/m ² ·a
Lighting:	19.96 kWh/m ² ·a
Fans:	0.00 kWh/m ² ·a
Small PL:	0.00 kWh/m ² ·a
DHW:	0.00 kWh/m ² ·a
Total:	68.96 kWh/m²·a

Integrated Performance



Viewing gallery with advanced glazing in all windows.
On/off lighting control, EE lighting.
TIM wall.
PV hybrid + ducted wind turbines



Annual Energy Performance

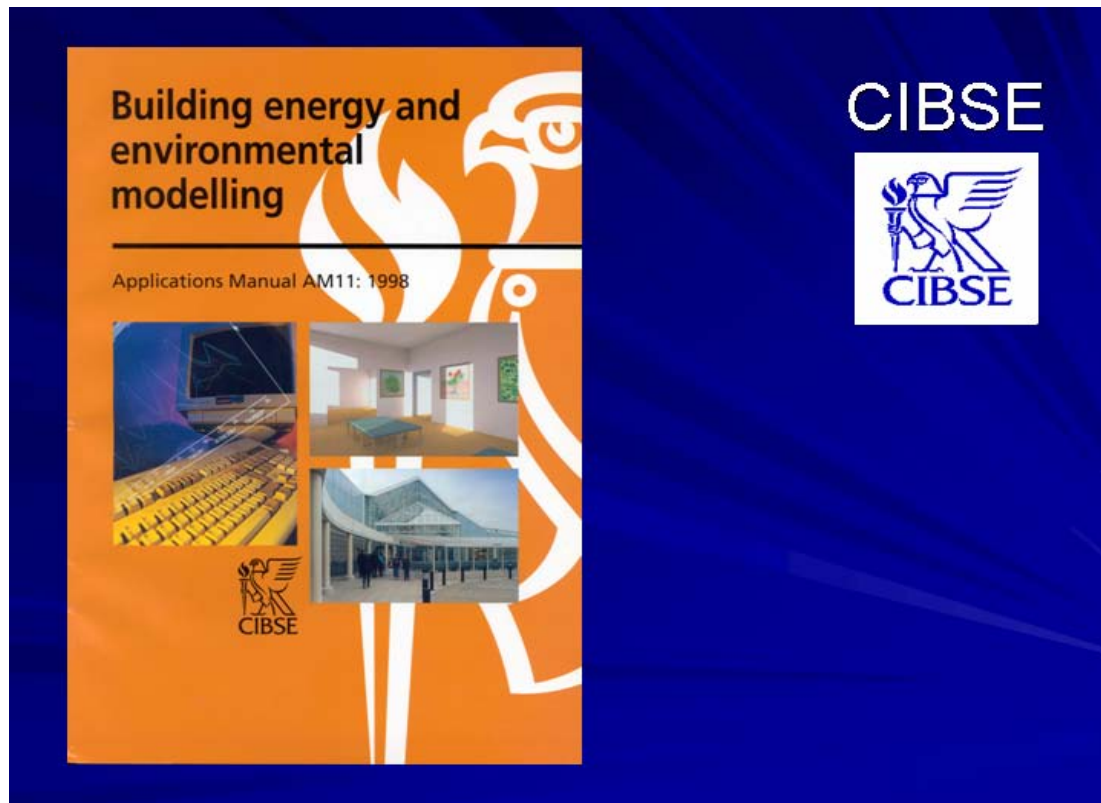
Heating:	48.99 kWh/m ² ·a
Cooling:	0.00 kWh/m ² ·a
Lighting:	19.96 kWh/m ² ·a
Fans:	0.00 kWh/m ² ·a
Total:	68.96 kWh/m²·a
DWT	25.03 kWh/m ² ·a
PV	33.79 kWh/m ² ·a
PVh	40.91 kWh/m ² ·a

What Sort of Computer Do I Need?

- Most building energy simulation programs are available for the PC—although some are also available for Mac, Linux and Unix platforms.
- Typical PC will run the typical energy program without trouble.
- Run a variety of component and whole building energy simulation programs on a laptop—1 GHz processor with 256 MB memory and a 30 GB hard drive.

Where Can I Learn More?

- *ASHRAE 2001 Handbook of Fundamentals*, Chapter 31
 - Complexity of input
 - Quality of the output
 - Availability of weather data
 - Auxiliary capabilities
 - Availability of good support to answer questions
 - AND the broader issue of Choosing an Analysis Method
- *Building Energy and Environmental Modelling*, CIBSE Applications Manual 11:1998
- *ANSI/ASHRAE Standard 140-2001 Standard Method of Test for the Evaluation of Building Energy Analysis Computer Programs* (has the program been tested and are the results readily available?)



Sources of Hourly, Daily, and Monthly Weather Data

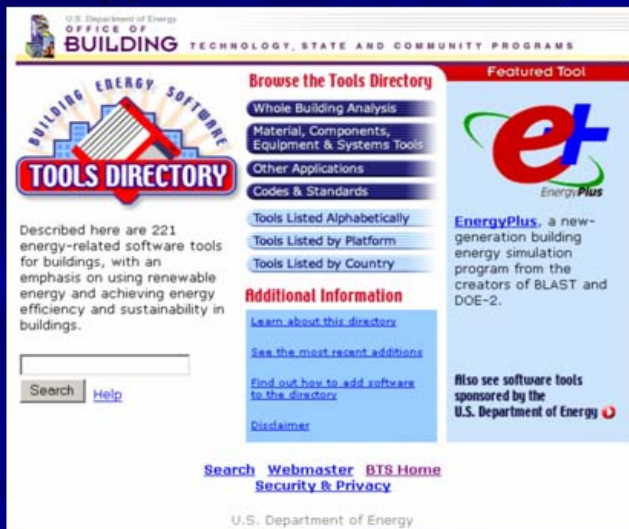
- TMY2 hourly data, typical weather years
239 US locations
- WYEC hourly data, typical weather years
72 US + 6 Canadian locations
- CWEC hourly data, typical weather years
55 Canadian locations
- IWECE hourly data, typical weather years
227 International locations

More Resources

- Technical Bulletin from TC 4.7 on *Estimating Building Energy Usage*
 - Available Energy Estimating Software Packages:
www.energytoolsdirectory.gov
 - ANSI/ASHRAE Standard 140-2001
 - Sources of Hourly, Daily, and Monthly Weather Data
 - Sources of Bin Weather Data
- Find TC 4.7 on the web:
www.mae.okstate.edu/tc47
or under Technical Committees on the ASHRAE web site.

Web Resources: Building Energy Tools Directory

Information on more than 240 energy-related software tools for buildings from around the world



www.energytoolsdirectory.gov

EnergyPlus

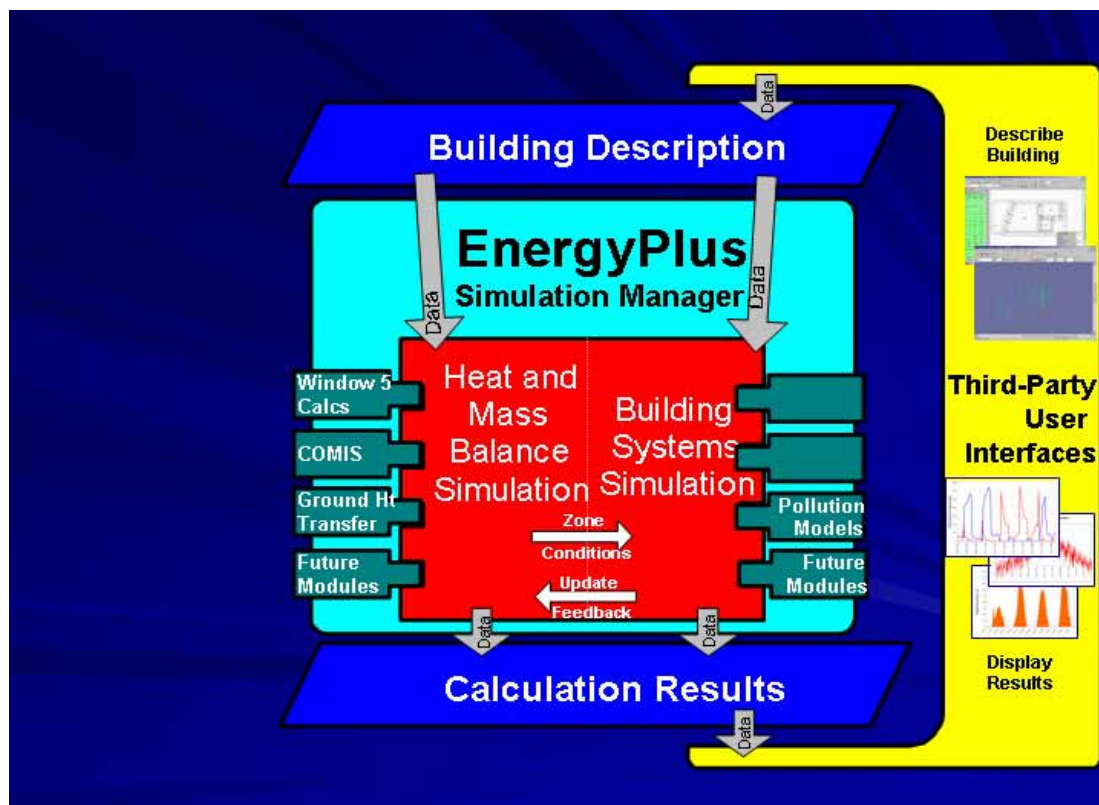


EnergyPlus, A New Building Energy Simulation Program

- Best features/capabilities of BLAST and DOE-2
- New capabilities
- All-new software (Fortran 90)
- Input, output, and weather simpler than either DOE-2 or BLAST
- Launch, input editing (Windows) utilities available
- Simulation 'engine'—no user-friendly interface
- 8 graphical interfaces under development
... first 2 betas available ... release of several in next few months

EnergyPlus Major Concepts

- Heat (and mass) balance
- Simultaneous loads/building simulation
- Multiple time steps [loads 15 min. default, building systems variable]
- Simple input/output
- Modular code for easy expansion
- Number of surfaces, zone and system unlimited—computer memory and hard drive
- Link to other software for other capabilities



EnergyPlus Features

Concepts from IBLAST	Concepts from DOE-2	New Features
• Integrated simultaneous loads/HVAC solution • Multiple time steps • Heat balance • Interior convection and mass • Combined heat and mass transfer • Thermal comfort • Radiant heating and cooling • Atmospheric pollution calculation • System and plant models	• Input functions • Anisotropic sky model • Advanced fenestration (blinds, switchable glazing) • WINDOW 4 library • Daylighting and glare • Atmospheric pollution calculation • System and plant models	• User-definable reporting • Ground heat transfer • WINDOW 5 calculations • Multizone airflow • HVAC loops (air, water) • User-configurable object-based HVAC components • Electrical system • Photovoltaic models • Links to CAD

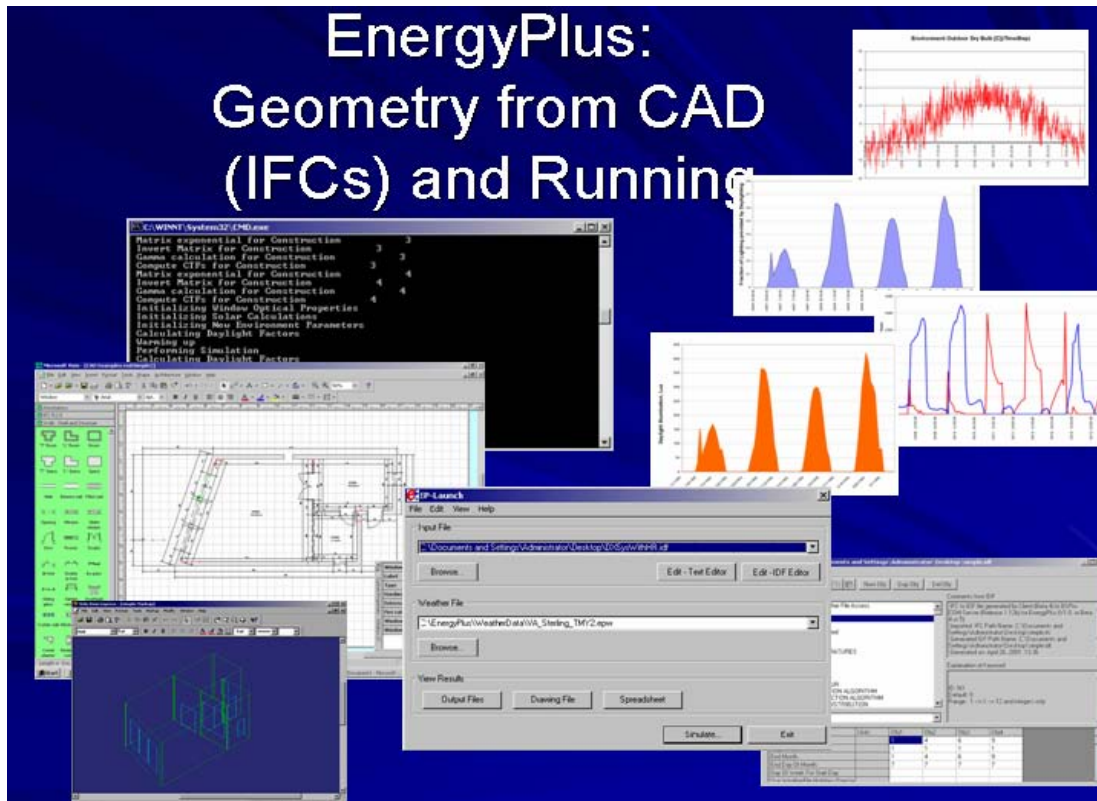
Cool New Stuff

- Fully Integrated Loads & HVAC Simulation
(New ASHRAE Loads Calculation method)
- Occupant Comfort
- Moisture storage and release
- Mix and match equipment and systems
- Photovoltaic systems
- Green Buildings (example: natural ventilation, COMIS)
- Import geometry from CAD
- Lots more
 - Low and high temperature radiant heating
 - Supply air plenums

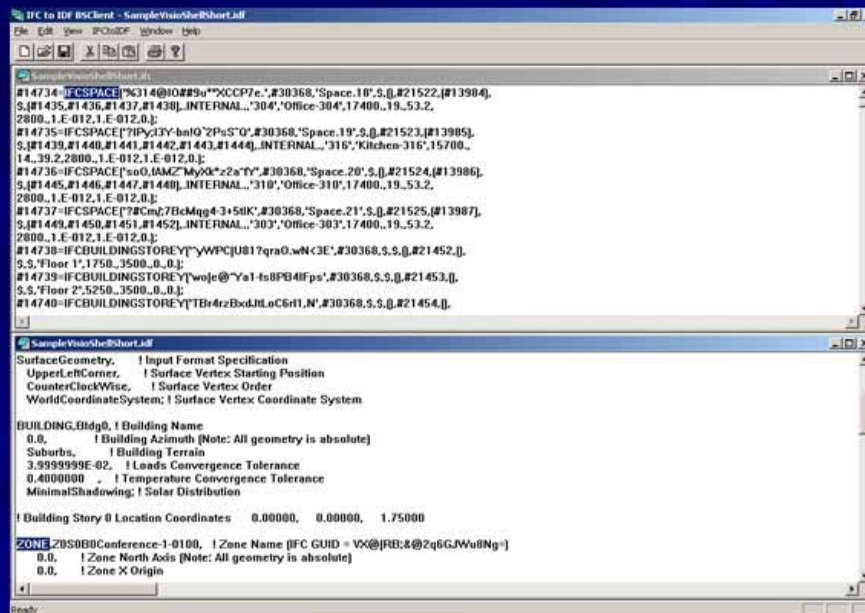
Under Development

- Displacement Ventilation (2004)
 - Have UF supply plenum, slab coupling, developing stratified zone model
 - Underfloor air distribution
- Cooled beams, cooled ceiling panels (2003)
- Heat recovery: more types, controls (2003)
- Site generation: more types (fuel cells, microturbines) (2004)
- Electric system simulation (2004)
- Duct loss (air and heat) (2004)
- Lots more!

EnergyPlus: Geometry from CAD (IFCs) and Running



IFC to IDF Mapping



CAD Programs Supporting IFCs

<http://www.bauwesen.fh-muenchen.de/iai/ImplementationOverview.htm>

■ ArchiCAD

Graphisoft

www.graphisoft.com

■ Architectural DeskTop (AutoCAD)

Autodesk

www.autodesk.com

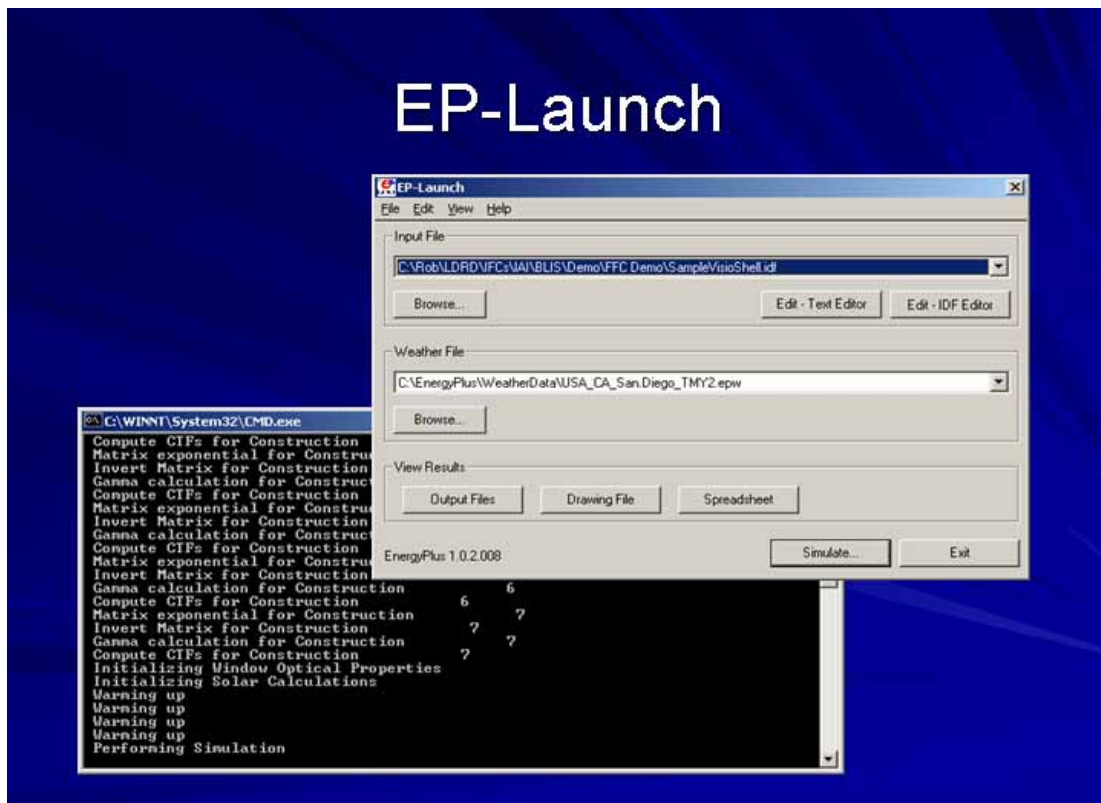
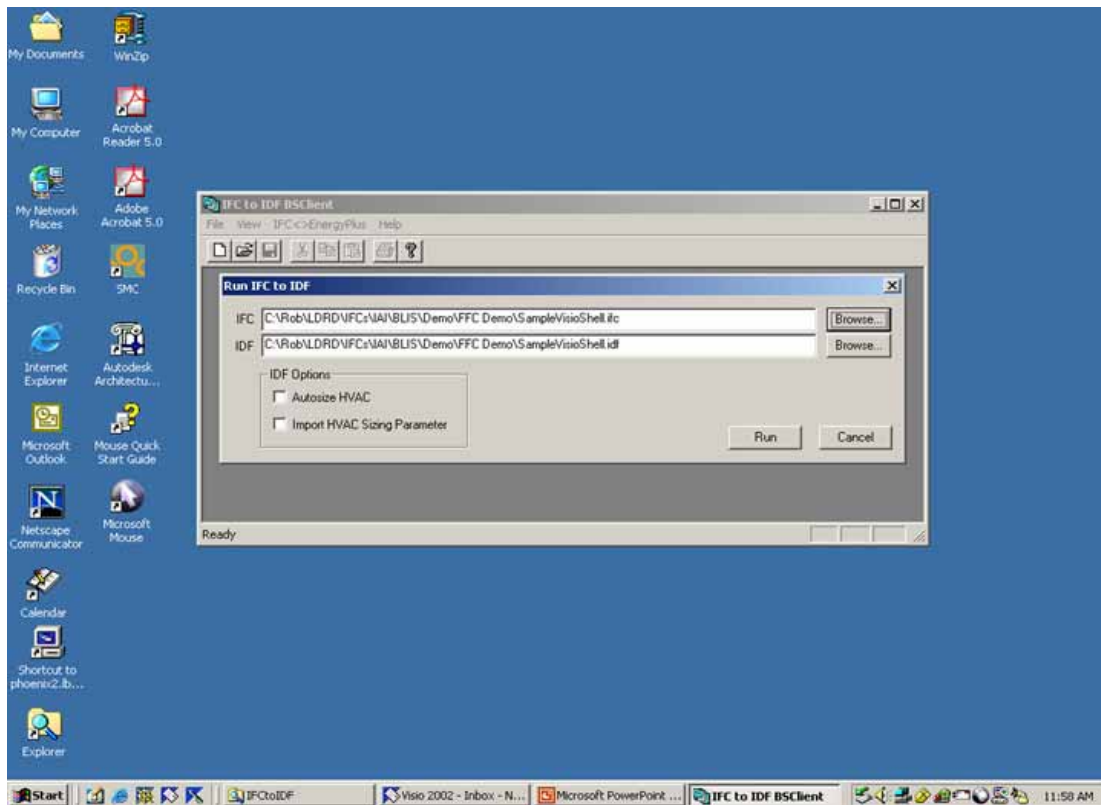
■ ALLPLAN FT

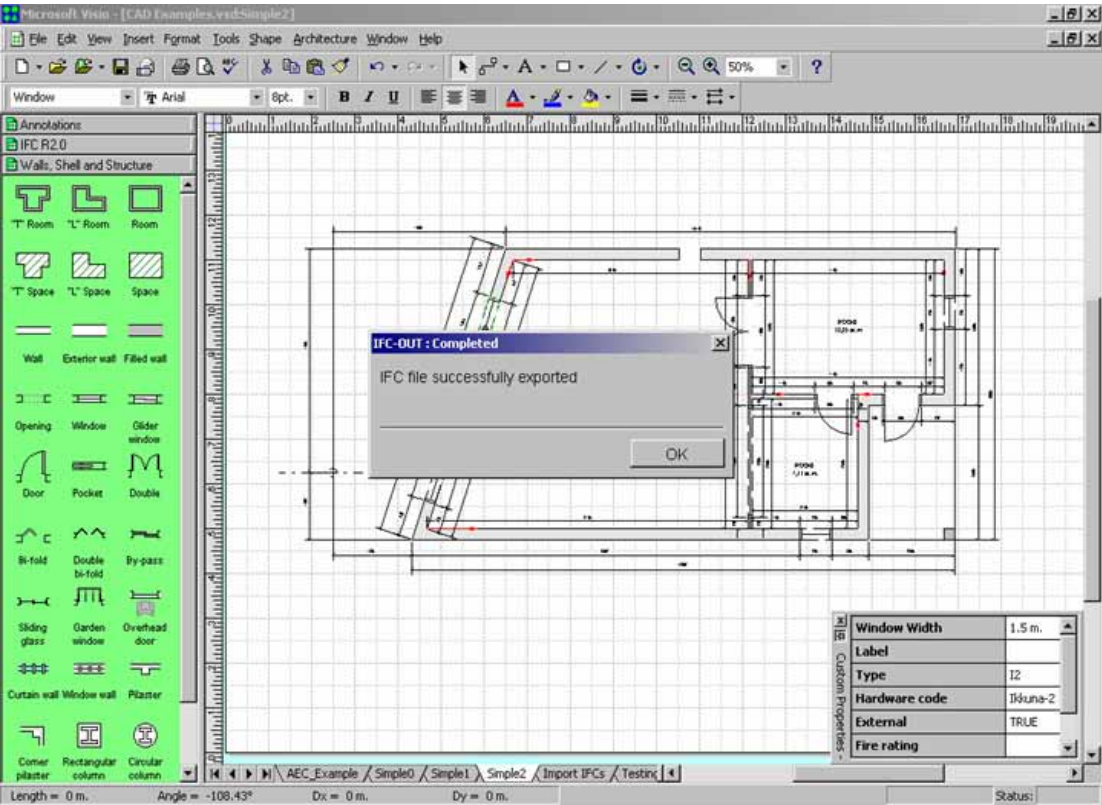
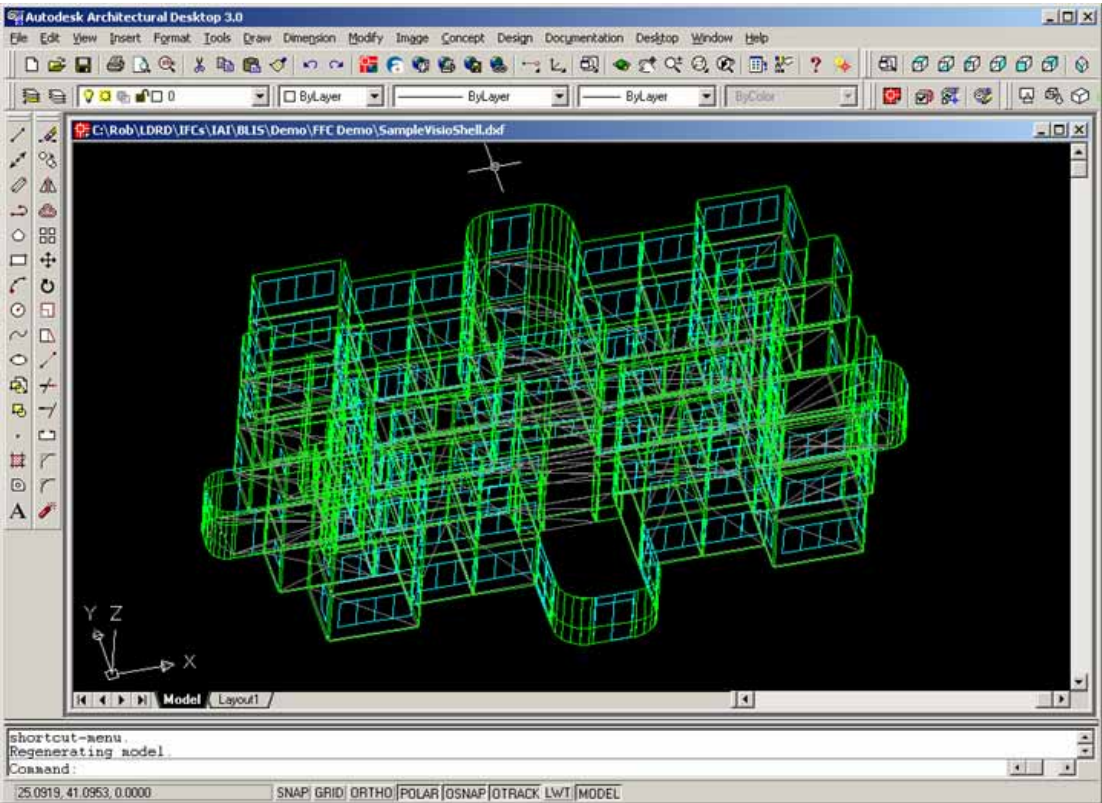
Nemetschek

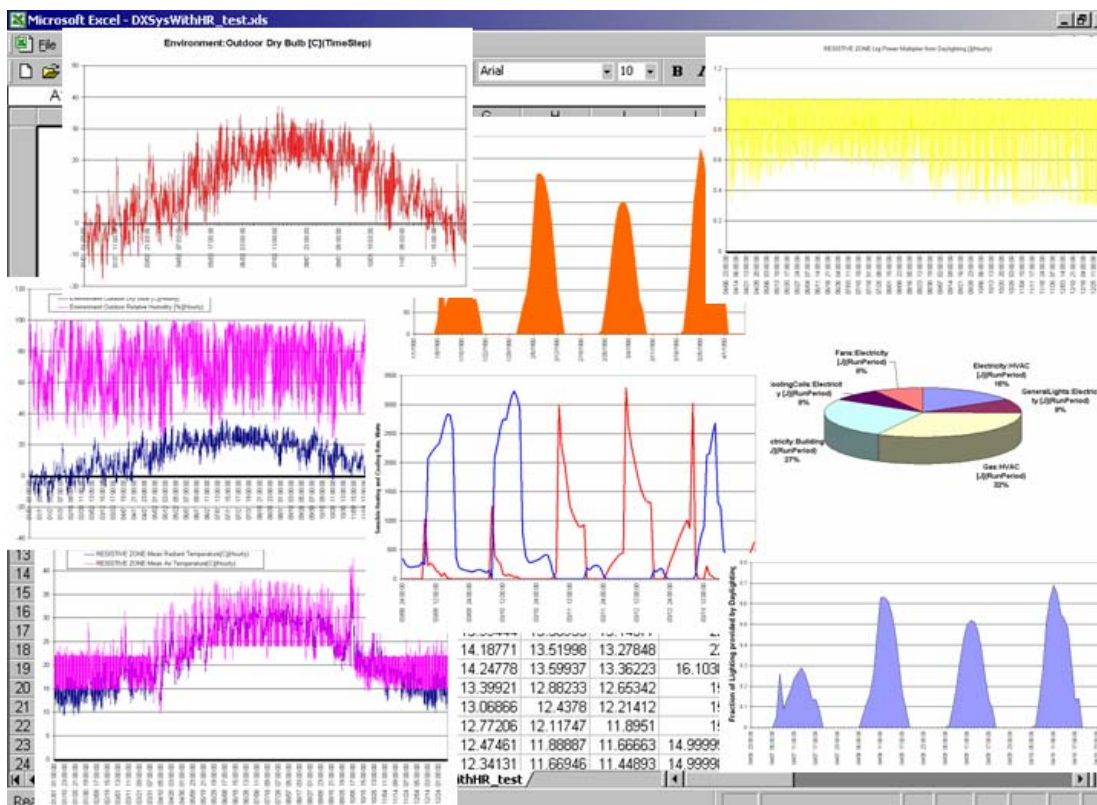
www.allplan-usa.com

■ Visio 2002 Technical – *no longer supported*

Microsoft







EnergyPlus Documentation

More than 1500
pages of
input/output
reference,
examples and
engineering
documentation



EnergyPlus Summary

- Design focused on connectivity, extensibility, and maintainability
- Many new capabilities
- A calculation engine—no GUI interface—yet with a number of Window auxiliary programs: EPLaunch, IDFEditor, IFCToIDF, Weather Converter
- Working with >50 module developers and 8 graphical interface developers
- Program, all documentation, and weather data for >550 locations available free of charge (web download)→

www.energyplus.gov

Web Resources

- Up-to-date information on interfaces, and links to download EnergyPlus, documentation and more than 550 weather files:

www.energyplus.gov

- Building Energy Tools Directory

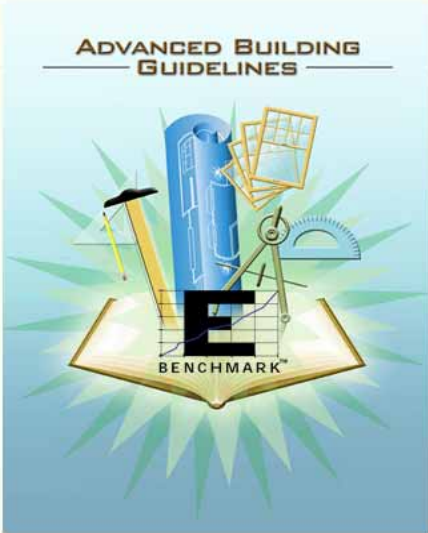
www.energytoolsdirectory.gov

- DOE Building Technologies Program

www.eren.doe.gov/buildings

A Pattern Approach to High Performance Buildings — E-Benchmark

Presenters: Mr. Jeff Johnson, New Building Institute and Ms. Abby Vogen, Energy Center of Wisconsin



**Advanced Buildings:
A Pattern for High
Performance**

**Jeff Johnson, NBI
Abby Vogen, ECW**

A not-for-profit public benefits
corporation helping to make
buildings better for people and
the environment

<http://www.newbuildings.org>

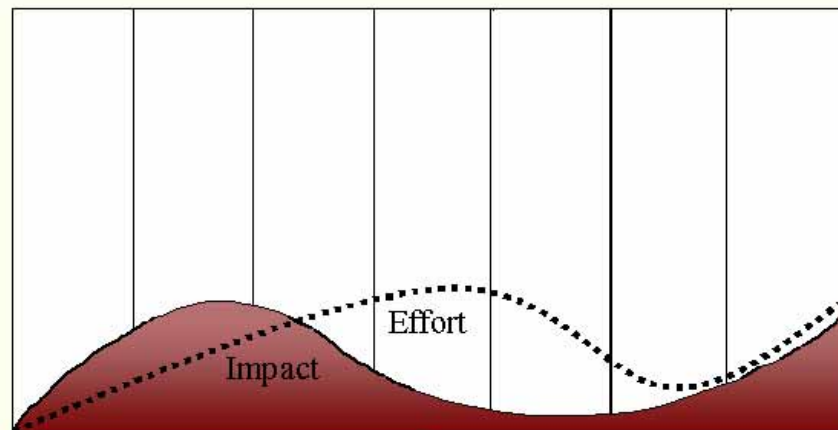


High Performance

- ♦ **Climate Responsive**
 - Provide Shelter First
- ♦ **Grid Responsive**
 - Integral to Peak-
 - Demand Management
 - Power Production (renewables)
- ♦ **Occupant Responsive**
- ♦ **Owner Responsive**



Design Process



Advanced Buildings



- ♦ Performance Criteria
 - National beyond-code criteria
- ♦ Designers Manual
 - How to from design team perspective
- ♦ Owners Guide
 - What are the benefits to building to the E-Benchmark?
- ♦ Education
 - Education and program for design professionals

Focus on Delivering Performance

Performance Criteria



- ◆ Nationally recognized efficiency targets
 - Envelope
 - Mechanical
 - Lighting
 - Power (demand and renewables)
- ◆ Exemplar Processes
 - Integrated Design
 - Commissioning
 - Operations/Maintenance
- ◆ Two Approaches
 - Prescriptive “patterns”
 - Whole-building simulation



Education



- ◆ Building Science and Outcome based training program
- ◆ Four Modules
 - Integrated Design Primer
 - Envelope and Moisture
 - Mechanical and Controls
 - Lighting and Daylighting

Education Program



- ♦ To Be Completed

LEED Connections



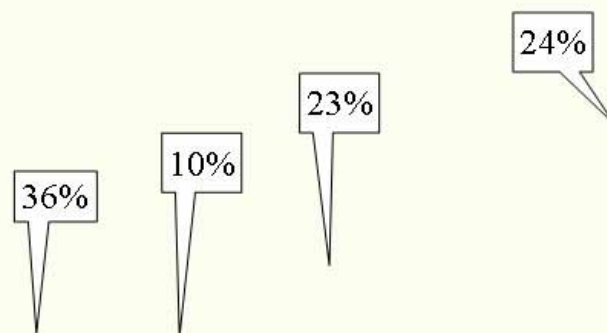
- ♦ To be completed

Impacts

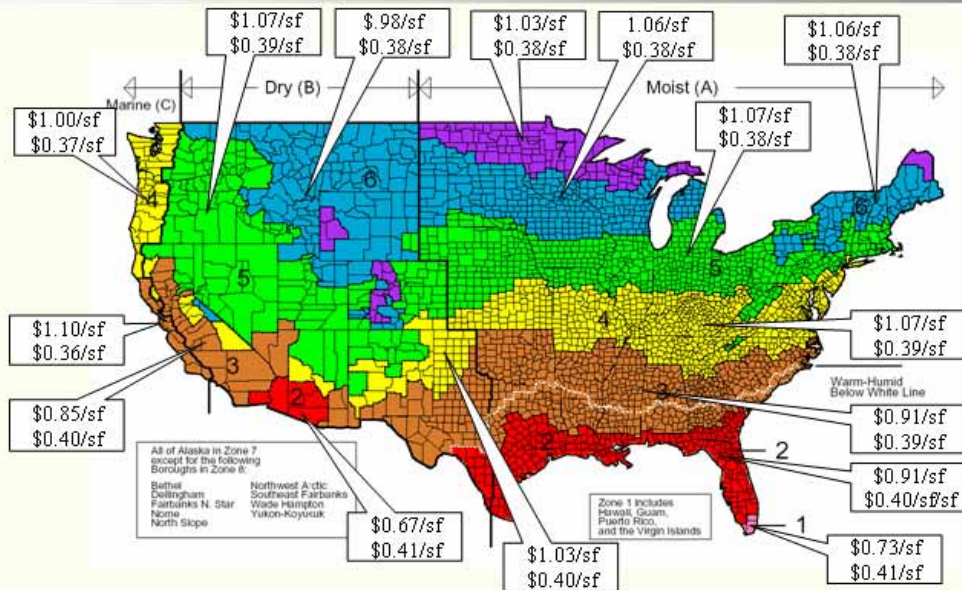


- ◆ To Be Completed

Example - End-use Impacts



Example Cost/Benefit



Range of Impacts



- ◆ **Costs**
 - Ranges from \$0.75 to \$1.40/sf with supermarket up to \$3.50/sf including commissioning
- ◆ **Savings**
 - Ranges from \$0.20 to \$0.80/sf with schools \$0.10 to \$0.15/sf
 - Electric savings at 4 to 8 kWh/sf
 - \$0.01 to \$0.03/kWh with schools up to \$0.07
 - Ventilation benefits not included in cost savings
- ◆ **Ventilation and Productivity**
 - \$154 to \$280 per employee (CMU-BIDS)
 - Direct result of explicit process requirements

Benefits



- ♦ Lower cost per transaction
 - High quality products and pre-defined path provide economical access to guide smaller buildings
- ♦ Cost effective whole-building performance solution
- ♦ Comprehensive educational materials
- ♦ Connections to LEED, utility rebates, etc.
- ♦ Assist in implementing market transformation strategy
 - Guidelines “pull” market beyond standard practice
 - Codes “push” market to standard practice

Retrofitting in Educational Buildings — Energy Concept Adviser for Technical Retrofit Measures

Presenter: Mr. Simon Wössner. Fraunhofer-Institut für Bauphysik. (Germany).
IEA Energy Conservation in Buildings & Community Systems Program (ECBCS).

Energy Concept Adviser

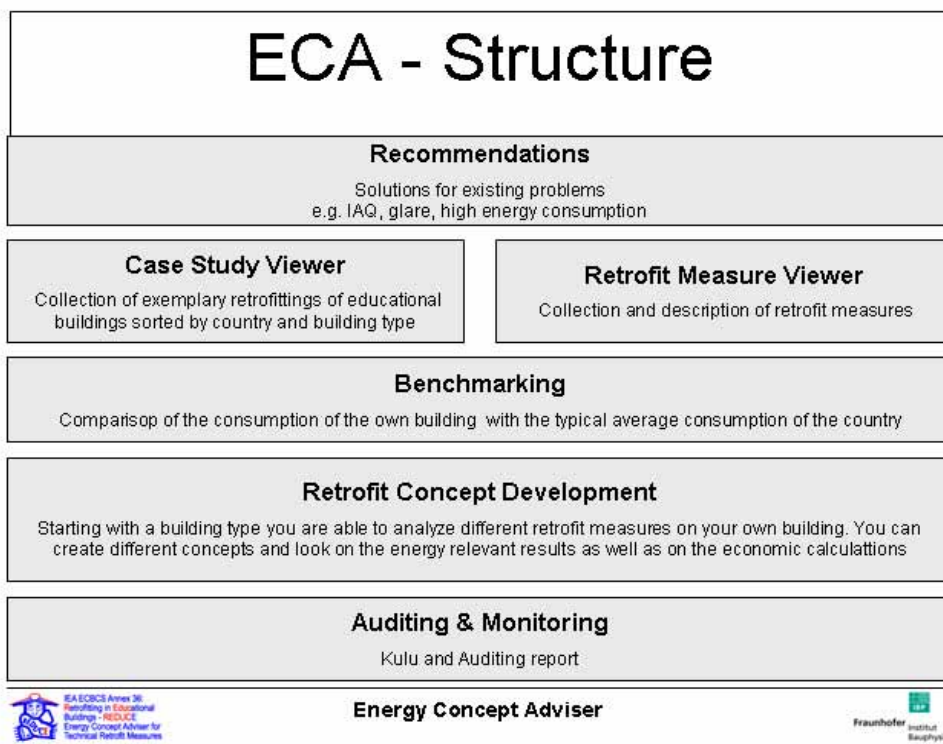
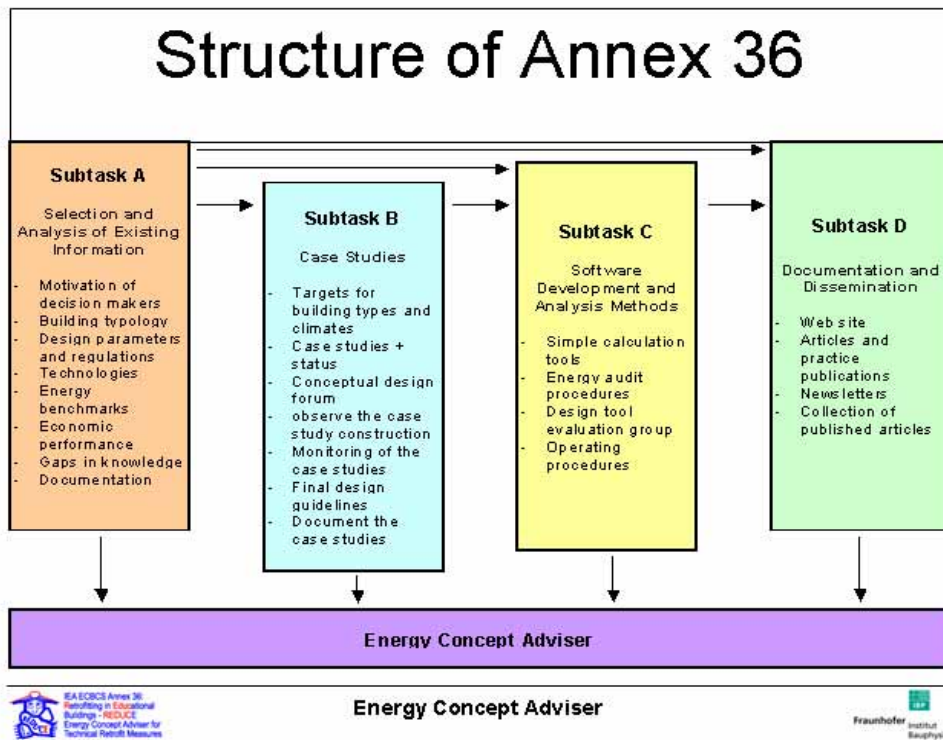
A New Internet-based Tool for Decision Makers and their Technical Staff

Dipl.-Ing. Simon Wössner

Fraunhofer Institut of Building Physics

What were the reasons, why the Energy Concept Adviser was developed?

- high energy consumption in educational buildings (nursery schools, schools, universities,...)
- decision makers are often not qualified enough informed
- many different factors for a high energy consumption
building itself, heating system, ventilation, lighting, controls, (cooling)
- an estimation of investment costs and the potential of energy savings not possible without tools





REDUCE Retrofitting in Educational Buildings



What is the Energy Concept Adviser?

The Energy Concept Adviser (ECA) is an electronic tool assisting in the design of renovations/retrofits focusing on energy savings of educational buildings (schools, university buildings and nursery schools). It will provide a potential list of solutions to specific energy related problems associated with the building shell, lighting or HVAC systems. The ECA contains more than 30 descriptions of exemplary retrofit/renovation projects and provides a wide and varied selection of retrofit technologies and strategies. The ECA will energy rate an existing educational building versus the national average for varied energy sources. Additionally, a calculation tool will provide energy savings and costs for retrofit technologies/strategies selected to be considered for improving the energy efficiency of the educational building.

Who is the target group of the Energy Concept Adviser?

The ECA was developed for educational building decision-makers and their staff, responsible for programming, planning and accomplishing the retrofit/renovation of existing facilities. With the use of the ECA, the energy saving potential within an existing building will be better understood during the development of a retrofit/renovation projects and therefore reduce the energy consumption of an existing building. The decision-makers will be provided with reliable information on conventional and innovative strategies and technologies and thereby gain improved planning reliability.

Who has developed the Energy Concept Adviser?

The Adviser was developed in the framework of the International Energy Agency (IEA) in the project Annex 36 of the Energy Conservation in Buildings and Community Systems division. Experts from 9 European countries and the USA brought in their national expertise, case studies and retrofit technologies to promote energy savings in the retrofit/renovation of existing buildings. See also [Info & Contact](#)

How to operate the Energy Concept Adviser?

The user-interface is developed for intuitive use; the information paths shall be recognized intuitively. Additional information in the retrofit concept development part is provided under [1.1](#) ; [1.2](#) is for help functions. The main navigation bars are reached by clicking on the project logo on the upper left side of each page.

[Start](#)


Energy Concept Adviser



REDUCE Retrofitting in Educational Buildings



ENERGY CONCEPT ADVISER for Technical Retrofit Measures

obtain recommendations for specific problems in your building

[Recommendations](#)

study more than 30 retrofitted buildings and retrofit measures

[Case Studies
&
Retrofit Measures](#)

compare your building's consumption to national data

[Performance Rating](#)

develop an energy efficient retrofit concept for your building

[Retrofit Concept](#)

programs and methods to analyse your building performance

[Utilities](#)

any questions

[Info & Contact](#)


Energy Concept Adviser





Problem Related Recommendation



General Information

This knowledge based list of recommended measures may fit only partly to your building.
 Select your problem in the left column and in the right column it is possible to group the measures in main groups. Select the useful measures manually and read detailed description in the lower part.

Select the existing problem

General Problems

- Heating energy consumption is high
- Electrical energy consumption is high
- Water consumption is high
- Indoor air quality problems

Specific Problems

- Building envelope not airtight
- Humidity or moisture problems
- Windows need replacement
- Roof covering needs replacing
- Heating controls need upgrading
- Pipework needs replacing
- Boiler or burner needs replacement
- Building fabric insulation is poor
- Pipework needs insulating
- Ventilation uncomfortable due to draughts

Group measures by

No grouping

Possible measures

Close off open chimneys to prevent ventilation losses an...
 Payback time: Very short Term (less than two years)

Close off unused air grilles behind radiators.
 Payback time: Very short Term (less than two years)

Weather strip windows and doors and seal gaps in buildi...
 Payback time: Very short Term (less than two years)

Install manual swimming pool cover.
 Payback time: Very short Term (less than two years)

Replace existing gas or oil-fired boilers with condensing...



Energy Concept Adviser



Select the existing problem

General Problems

- Heating energy consumption is high
- Electrical energy consumption is high
- Water consumption is high
- Indoor air quality problems

Specific Problems

- Building envelope not airtight
- Humidity or moisture problems
- Windows need replacement
- Roof covering needs replacing
- Heating controls need upgrading
- Pipework needs replacing
- Boiler or burner needs replacement
- Building fabric insulation is poor
- Pipework needs insulating
- Ventilation uncomfortable due to draughts

Group measures by

Building envelope

No grouping

Building envelope

Heating systems

Ventilation systems

Lighting and electrical appliances

Management

Payback time: Very short Term (less than two years)

Close off unused air grilles behind radiators.
 Payback time: Very short Term (less than two years)

Weather strip windows and doors and seal gaps in buildi...
 Payback time: Very short Term (less than two years)

Management of blinds and curtains
 Payback time: Very short Term (less than two years)

Fit closures to external doors.

Selected Measure

Weather strip windows and doors and seal gaps in building envelope.

 Payback-time:
Very short Term (less than two years)

Weather-strip and caulk around windows, doors, conduits, piping, exterior joints, or other areas of infiltration where it is worn, broken or missing.

 Can be carried out with routine maintenance



Energy Concept Adviser



Selected Measure

Install cooking sensor controls on the kitchen hood fans

Payback-time:
Very short Term (less than two years)

Kitchen extract fans extract large volumes of heated air and should only be on when required

Can be carried out with routine maintenance

Related Information

Retrofit Measure Viewer

Lighting and electrical appliances - Control systems

Case Study Viewer

Exemplary Retrofitting of a School (EROS) in Stuttgart, Germany

University of Stuttgart

University of Ulm

Case Studies & Retrofit Measures							
Sorting of:							
Case Studies by		country					
Retrofit Measures by		Energy technologies					
Country	Case Studies	Retrofit Measures	Energy technologies	Energy technologies	Energy technologies	Energy technologies	Energy technologies

 Case Studies & Retrofit Measures	
Sorting of:	Case Studies by age Retrofit Measures by country age typology
Country	Building Envelope
Case Studies Retrofit Measures	Windows Insulation materials & systems Over-cladding systems Doors
Pre 1930	
 	
 	✓ ✓ ✓
1930-1950	
 	✓ ✓ ✓

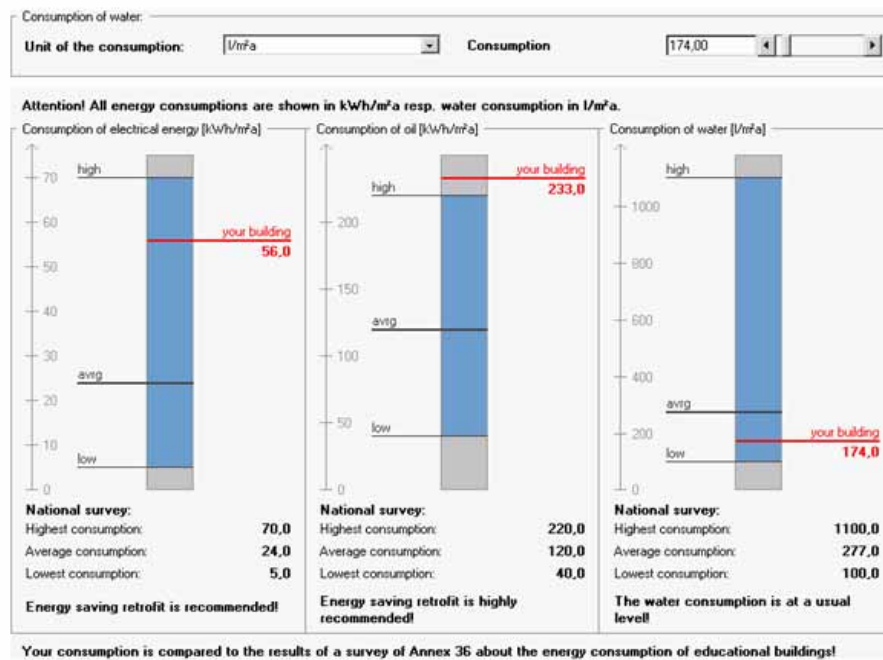

Energy Concept Adviser


 Case Study Viewer	Revnoation of Wausau West High School - Wausau, Wisconsin, United States	Download of REPORT as PDF														
General Data Site, Typology Before Retrofit Retrofit Concept Energy Savings User Evaluation Renovation Costs Lessons Learned Additional Information	General Data <table border="1"> <tr> <td>Address of project</td> <td>Wausau West High School, 1200 West Wausau Ave, Wausau, Wisconsin 54401, United States of America</td> </tr> <tr> <td>Year of construction</td> <td>1968</td> </tr> <tr> <td>Year of renovation</td> <td>1998-2001</td> </tr> <tr> <td>Total floor area</td> <td>25548 m²</td> </tr> <tr> <td>Number of pupils</td> <td>1850</td> </tr> <tr> <td>Number of classrooms</td> <td>65</td> </tr> <tr> <td>Typical classroom</td> <td>65 m² 25 pupils</td> </tr> </table> Project Summary This school building HVAC System resulted in complaints regarding Indoor Air Quality and energy inefficiency. The Local Public Health Department had received complaints and had investigated. The complaints included hot and cold rooms, poor ventilation and poor IAQ. In addition, the lighting systems needed upgrading. The project objective was to improve the IAQ, comfort, and overall energy efficiency of the building. Retrofit features The heating system was converted from steam to hot water boilers. Three 9 million BTU boilers were replaced with seven 2 million BTU hot water boilers. The domestic hot water was changed from steam to direct fired natural gas. The dishwasher hot water booster was changed from electricity to gas. Ten pieces of kitchen equipment were changed from electricity to natural gas. Green house changed from propane to natural gas. Lighting was upgraded from T-12 fluorescents with magnetic ballasts to T-8 with electronic ballasts. The HVAC was upgraded using a new concept using existing technologies resulting in 100% outdoor fresh air being introduced into the classrooms.	Address of project	Wausau West High School, 1200 West Wausau Ave, Wausau, Wisconsin 54401, United States of America	Year of construction	1968	Year of renovation	1998-2001	Total floor area	25548 m ²	Number of pupils	1850	Number of classrooms	65	Typical classroom	65 m ² 25 pupils	 Wausau West High School
Address of project	Wausau West High School, 1200 West Wausau Ave, Wausau, Wisconsin 54401, United States of America															
Year of construction	1968															
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Total floor area	25548 m ²															
Number of pupils	1850															
Number of classrooms	65															
Typical classroom	65 m ² 25 pupils															


Energy Concept Adviser


	Retrofit Measure Viewer	Solar control and cooling systems	Download of REPORT as PDF
Introduction	Shading systems and glare protections		
Shading & glare prot.	To choose a solar control device we need to consider: the site latitude, the orientation of the facade, the orientation of the openings, the aesthetic of the facade, the glazing type of the window, the need for daylight, the solar control devices.		
Cooling systems	The overall thermal and optical performance of a solar control device in respect to solar radiation impinging on it is based on the phenomena: primary transmission, reflected transmission, diffuse transmission, solar absorption.		
Air-conditioning	The global shading efficiency of a device is the result of all these direct and indirect transmission processes.		
Control systems	Shading devices are also essential to avoid glare situations. If their luminous transmittance is too high, the risk of glare is significant. Several types of shading devices are sufficient to avoid glare from the sky: screens, reflective film, ionised film, sealed blinds. Designers and decision makers must be conscious that the performance of the shading assembly might be different in the actual application conditions		
	 Shading systems and glare protections		

	Performance Rating		
Building Information			
The building is a: educational building(general)		Reference climate zone: mean climate	
It has a heated floor area of: 5000,00		Click here to get further information about the climate zones	
Consumption of electrical energy:			
☐ Includes heat energy consumption			
Unit of the consumption: kWh/m²a		Consumption of heat energy:	
Consumption: 56,00		Energy source: oil	
Unit of the consumption: kWh/m²a		Unit of the consumption: kWh/m²a	
Consumption: 233,00		Consumption: 233,00	
Consumption of water:			
Unit of the consumption: l/m²a		Consumption: 174,00	



Energy Concept Adviser



Retrofit Concept Development

General Information

The development part is structured in the below listed sectors. A sector can be opened or closed by clicking on its bar. For all needed informations (values, costs, etc.) defined values from national studies are deposited, but could be changed individually by the user, so please check the deposited values for your confidence. If you need help, click on [?](#), for background information click on [I](#)

Describe the existing building ? +

Select one retrofit measure for each building element ? +

Create and compare energy saving concept ? +

Summary and Report ? +



Energy Concept Adviser



Describe the existing building ? -

How to use this part -

The building, for which the possibilities for a energy efficient should be analysed, is defined in this section.
By choosing the basic values, a default building is created.
This building can be further defined in the lower part of this section.
If there was already a further definition, changes in the basic parts sets all the values back to default!

Define key values for a default building

Basic Data

Building Type: school

Construction year: pre 1950

Type of Roof: pitched (heated attic)

Type of basement: slab on ground

Total floor area [m²]: 6180.00

Number of storeys: 3

Orientation:

Click on diagram to select orientation

Example buildings

Typology: multi-storey school

Click on picture to have a look at the case study!

Western West High School, Wisconsin, USA

Consumption of heat energy:

Energy source: Oil

Consumption: 374.00 kWh/m²a

Further Refinement of the building -



Energy Concept Adviser



Further Refinement of the building -

Location ? +

Geometry and Elements of Building Envelope ? -

Heated volume: 33372.0

Floor area: 6180.0 m²

Ratio A/V: 0.32 1/m

Area of thermal envelope: 10815.0 m²

Switch through the different envelope elements:

|< << external wall pitched roof ground plate window north window east >> >|

external wall

Name: external wall

Area[m²]: 3955.20

Maintenance Costs: 4.00 €/m²a

Structure: double layered brickwork with 24 cm brick, 4 cm air, 11.5 cm brick and interior plaster

Existing U-Value: 30 cm light brickwork with interior and exterior plaster

30 cm concrete stone with pumice brickwork with interior and exterior plaster

30 cm brickwork with interior and exterior plaster

double layered brickwork with 24 cm brick, 4 cm air, 11.5 cm brick and interior plaster

concrete sandwich construction: interior plaster, 20 cm concrete, 4 cm insulation, 11.5 cm limestone brickwork, 4 cm insulation, interior and exterior plaster

☐ Does this component have to be retrofitted anyway? ☒ in a minor refurbishment ☐ in a major refurbishment

Heat and ventilation plant ? +



Energy Concept Adviser



Further Refinement of the building

Location

Geometry and Elements of Building Envelope

Heat and ventilation plant

Choose the existing plant:

The heat energy is generated by:

The type of ventilation is:

Details of selected plant



Detailed description of the chosen plant:

steam boilers, steam heating, 105 °C, cast iron heating elements, no room regulations, natural ventilation

Adjusted setback modes:

Used energy source:

☐ Does this component have to be retrofitted anyway? ☒ in a minor refurbishment ☐ in a major refurbishment

Lighting

Classrooms

Fraction of total floor area: %

Fraction Area window/facade: %

Mean room depth: m

Installed System:

Lighting control:

Maintenance Costs: €/m²a

☐ Does this component have to be retrofitted anyway? ☒ in a minor refurbishment ☐ in a major refurbishment

Cost data



Energy Concept Adviser



Further Refinement of the building

Location

Geometry and Elements of Building Envelope

Heat and ventilation plant

Lighting

Cost data

General values:

Inflation rate: %

Interest rate: %

Period of analysis: years

Energy prices:

	Basic Price:	Consumption Price:
Electrical energy	95.00 €/a	11 Ct/(kWh·a)
Oil	0.00 €/a	3 Ct/(l·a)
Gas	15.00 €/a	5 Ct/(m³·a)
Coal	0.00 €/a	4 Ct/(kg·a)



Energy Concept Adviser



Select one retrofit measure for each building element ? -

How to use this part -

This part is for the selection of retrofit measures for each building element, that is relevant for the consumption of energy. The measure with the best cost benefit value is automatically selected. The selection can be changed with the checkbox 'Select this measure as chosen retrofit measure for this element'.

Select a Component: Choose an element of the building

Select a Retrofit Measure: Shows all retrofit measures. Change the selection of the chosen measure here.

Overview: Shows the results of the retrofit measures for this element. All values are related to the unretrofitted building!

Select a component +

Select a retrofit measure +

Overview +

Select one retrofit measure for each building element ? -

How to use this part +

Select a component -

Main Group: Building envelope Element: external wall

Existing Structure: double layered brickwork with 24 cm brick, 4 cm air, 11.5 cm brick and interior plaster

Existing U-Value: 1.47 W/m²K

Select a retrofit measure -

1 internal insulation with 5 cm polystyrene, vapour barrier and gypsum board (mind thermal bridges, follow-up costs and sp)

improved U-Value: 0.46 W/m²K Investment costs: 50.00 €/m²
Maintenance costs: 4.00 €/m²a

☒ Select this measure as chosen retrofit measure for this element

2 external insulation with 12 cm mineral wool and plaster

improved U-Value: 0.25 W/m²K Investment costs: 80.00 €/m²
Maintenance costs: 4.00 €/m²a

☐ Select this measure as chosen retrofit measure for this element

3 external insulation with 20 cm mineral wool and plaster

improved U-Value: 0.17 W/m²K Investment costs: 100.00 €/m²
Maintenance costs: 4.00 €/m²a

Overview +

Select a retrofit measure

1 internal insulation with 6 cm polystyrene, vapour barrier and gypsum board (mind thermal bridges, follow-up costs and sp)

improved U-Value: Investment costs: €/m²
Maintenance costs: €/m²a

☒ Select this measure as chosen retrofit measure for this element

2 external insulation with 12 cm mineral wool and plaster

improved U-Value: Investment costs: €/m²
Maintenance costs: €/m²a

☐ Select this measure as chosen retrofit measure for this element

3 external insulation with 20 cm mineral wool and plaster

improved U-Value: Investment costs: €/m²
Maintenance costs: €/m²a

Overview

Retrofit Measures:	Heat Energy demand:	Capital Expenditure:	Cost Benefit Value:
Existing Building	1160.0 kWh/m²a		
1 internal insulation with 6 cm polystyrene, vapour barrier and	1060.0 kWh/m²a	197000 €	0.30 €/kWh/m²a
2 external insulation with 12 cm mineral wool and plaster	1040.0 kWh/m²a	316000 €	0.40 €/kWh/m²a
3 external insulation with 20 cm mineral wool and plaster	1030.0 kWh/m²a	395000 €	0.50 €/kWh/m²a
4 external insulation with 12 cm polystyrene foam and plaster (mind	1040.0 kWh/m²a	276000 €	0.30 €/kWh/m²a
5 external insulation with 20 cm polystyrene foam and plaster (mind	1030.0 kWh/m²a	336000 €	0.40 €/kWh/m²a

Create and compare energy saving concept

How to use this part

This part is for the creation and comparison of different concepts for an energy efficient retrofitting. There are five different concepts possible. After selecting elements for a concept, that should be retrofitted, the different concepts can be compared in the lower part.

Select elements for the different concepts

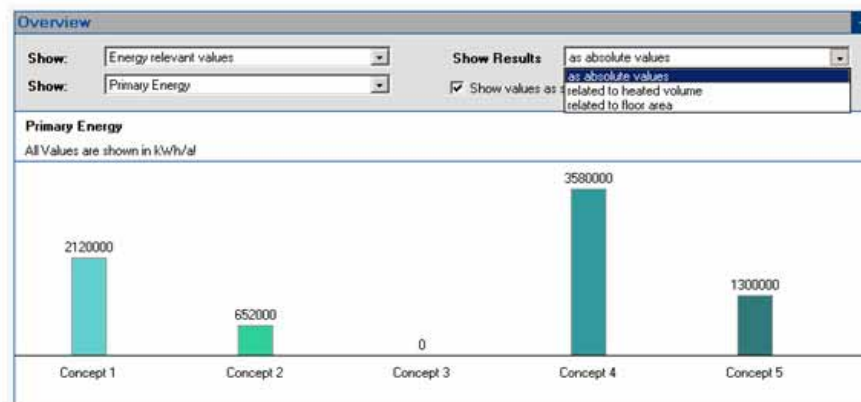
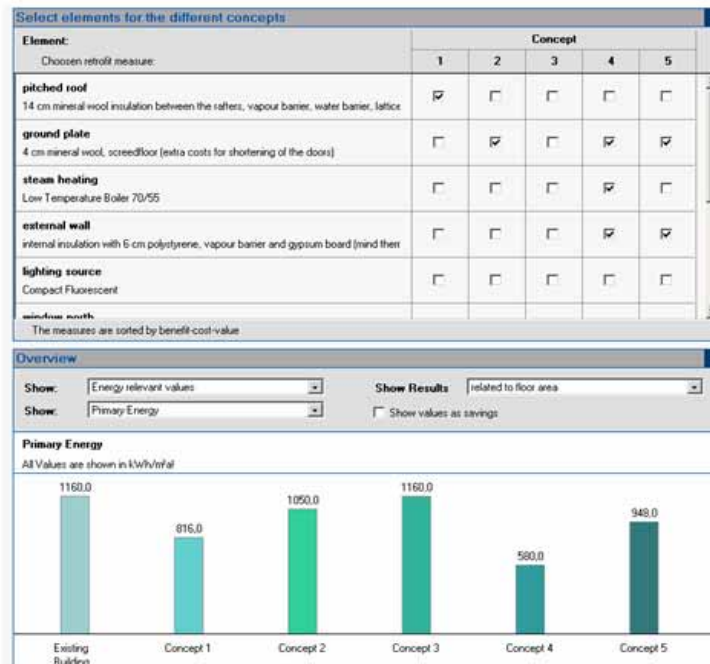
Choose here, which elements shall be retrofitted within a concept

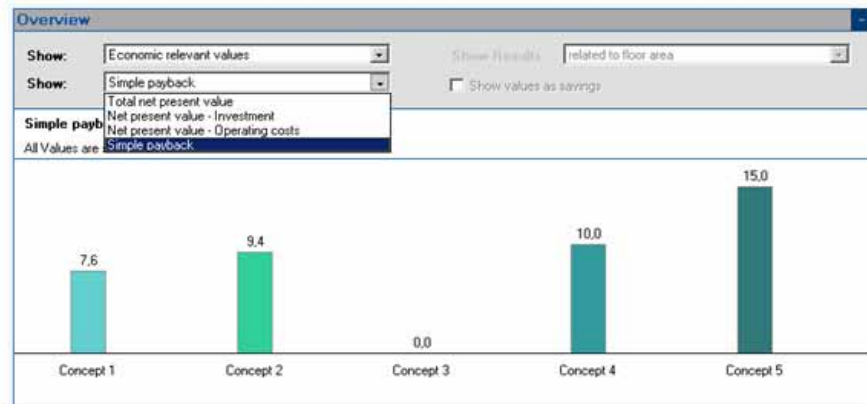
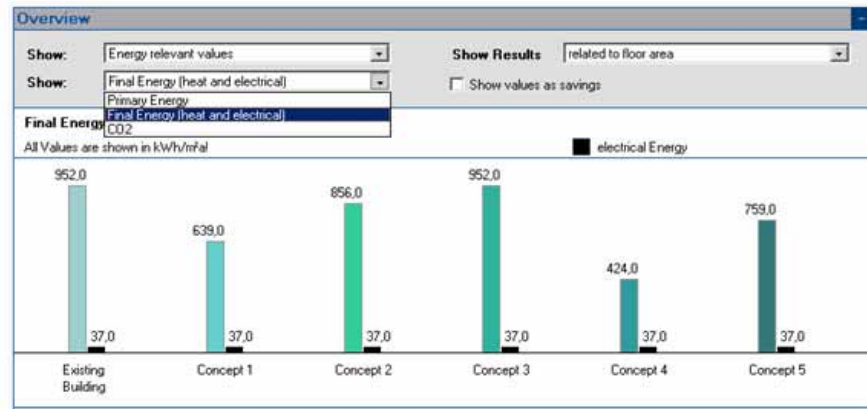
Overview:

Look at the results of the different concepts. Various energy and economy relevant values can be displayed.

Select elements for the different concepts

Overview





Summary and Report ? -

How to use this part -

An output can be created in this part.

Summary This is a short summary of the input values and the selected retrofit measures. It is shown in a popup window.

Report The report is a comprehensive list of the whole concept including input values and results. It is also possible to include the diagrams into the report. The report can include all concepts or just one selected. It is delivered by email as a pdf document.

Options -

Summary

Select a concept:

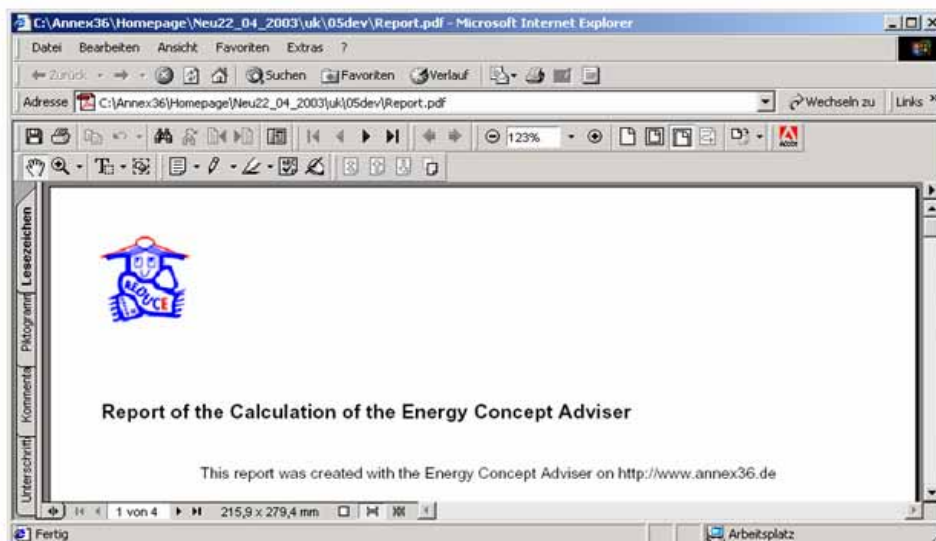
Report

Show: ☐ show Diagramms

Enter your Email-address:



Energy Concept Adviser



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Participating Countries & Members of Annex36			
Dänemark Ove Mørck (Subtaskleiter B) Cenergia Energy Consultants oom@cenergia.dk Kirsten Engelund Thomsen By og Byg ket@by-og-byg.dk Finnland Timo Kaupinen VTT Building timo.kaupinen@vtt.fi Jorma Pietilainen VTT Building and Transport jorma.pietilainen@vtt.fi Frankreich Gerard Guerracino ENTPE DGCB-LASH gerard.guerracino@entpe.fr Richard Cantin ENTPE DGCB-LASH richard.cantin@entpe.fr	Deutschland Hans Erhorn (Annexleiter) Fraunhofer-Institut für Bauphysik erh@ibp.fhg.de Heike Kluttig Fraunhofer-Institut für Bauphysik hk@ibp.fhg.de Jan de Boer Fraunhofer-Institut für Bauphysik jdb@ibp.fhg.de Fritz Schmidt (Subtaskleiter C) Universität Stuttgart (KE) fritz.schmidt@ke.uni-stuttgart.de Raphael Haller Universität Stuttgart Lehrstuhl für Heizungs- und Raumlufttechnik raphael.haller@po.uni-stuttgart.de Ingo Lüttemeyer Fachhochschule Bremen ilu@fhs-bremen.de	Griechenland Euphrosyne Triantis National Technical University of Athens etrias@ntua.gr Italien Styliani Fanou ENEA ERG-SIRE/DINT styliani.fanou@casaccia.enea.it Norwegen Karl Thunshelle Norwegian Building Research Institute kth@byggforsk.no Großbritannien Richard Daniels Schools Building & Design Unit Dept. of Education and Employment richard.daniels@des.gsi.gov.uk Matt Dickinson BRESCO - BRE matt.dickinson@bre.co.uk	Polen Tomasz Mroz (Subtaskleiter A) Poznan University of Technology Inst. of Environmental Engineering tomasz.mroz@put.poznan.pl Stanislaw Mierzwinski Silesian University of Technology kowito@kowitz.pozn.pl USA Lorenz Schöff (Subtaskleiter D) U.S. Department of Energy lschoff@rev.net



Energy Concept Adviser



Information

<http://www.annex36.bizland.com/>

Energy Design Assistance for High Performance Buildings

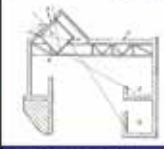
Presenter: Mr. David A. Eijadi. The Weidt Group



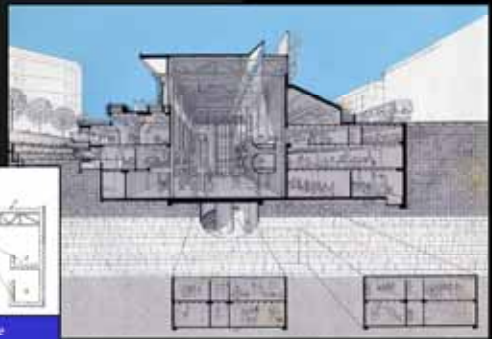


Building Energy Performance
Through Advanced Technologies ...

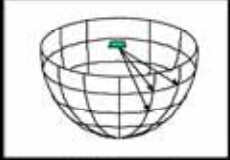
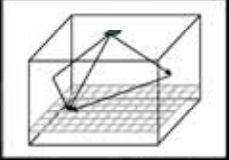
... The Early years



Introduced the
concepts of
Reflective and
Refractive Solar
Optics as well as
Solar Photometrics.



Civil / Mineral Engineering Building 1978 - 1983
BRW Architects



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Page 4

Architectural Lighting Design vs. Engineering Lighting Design

A complex block containing various images and text. At the top left, the text "Building Energy Performance Through Advanced Technologies ..." is followed by "... The Early years" and a small orange logo. Below this is a photograph of a modern interior space with a large, curved, wooden structure and a person sitting on a bench. To the right of this photo is a diagram showing a cross-section of a building with a large, curved, wooden structure and a person sitting on a bench. Below this diagram is a blue box with white text: "Introduced the concepts of Reflective and Refractive Solar Optics as well as Solar Photometrics." To the right of the blue box is a photograph of a building facade with a large, curved, wooden structure and a person sitting on a bench. Below this photo is the text "Civil / Mineral Engineering Building 1978 - 1983 BRW Architects". Below the photograph of the building facade are two diagrams: one showing a cross-section of a building with a large, curved, wooden structure and a person sitting on a bench, and another showing a cross-section of a building with a large, curved, wooden structure and a person sitting on a bench. At the bottom left is the text "© THE WEIDT GROUP 2003 Page 4". At the bottom right is the text "Architectural Lighting Design vs. Engineering Lighting Design".

Building Energy Performance Through Advanced Technologies ...

... The Early years

Evolutionary Development

1978 - 1983
BRW Architects

Peoria Innovations

- Reclaimed Desert from Farmland
- Reduced non permeable areas
- Shaded pedestrian areas
- Water conservation
 - Xeriscape
 - Cooling tower/ Water feature
 - Desert walk
- Energy Efficiency
 - Heat exchanger
 - Articulated skin
 - Reduced office depth
 - Daylighting
- Local materials



Peoria, Arizona



Sedona, Arizona



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Page 5

Building Energy Performance Through Advanced Technologies ...

Leading Edge Projects with The Weidt Group



Andersen Skylight Prototype



WalMart EcoMart



ADC Corporate World Headquarters



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Page 6



Building Energy Performance Through Advanced Technologies ...



The Weidt Group

A History of Innovation in Measurable Successes

- Founding Members Building Energy Performance Standards (B.E.P.S)
- Founding Members of ASHRAE 90.1 Committee
- Founding Members of the NFRC
- Participants in DOE's Whole Building Design Round Table
- Pioneers in software for the A/E Industry
- Founding Members International Program for Measurement and Verification Protocols (IPMVP) for New Construction
- LEED Certified Consultants
- Contributors to NCARB Sustainable Design monograph

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Page 9

Building Energy Performance Through Advanced Technologies ...

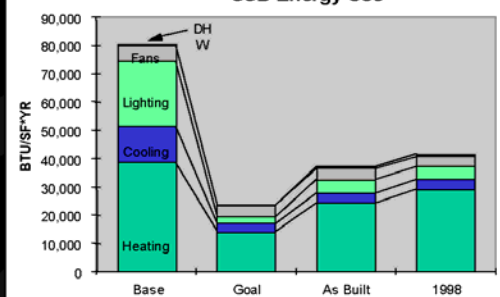


Security State Bank

Very Long Term Verification

- 18 Years Later, Does It Still Work?
- Yes, still performing as built
- Compared to Standard 1980 Practice
 - Fans 60% of base
 - Lighting 20% of base
 - Cooling 30% of base
 - Heating 75% of base

SSB Energy Use



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Page 10

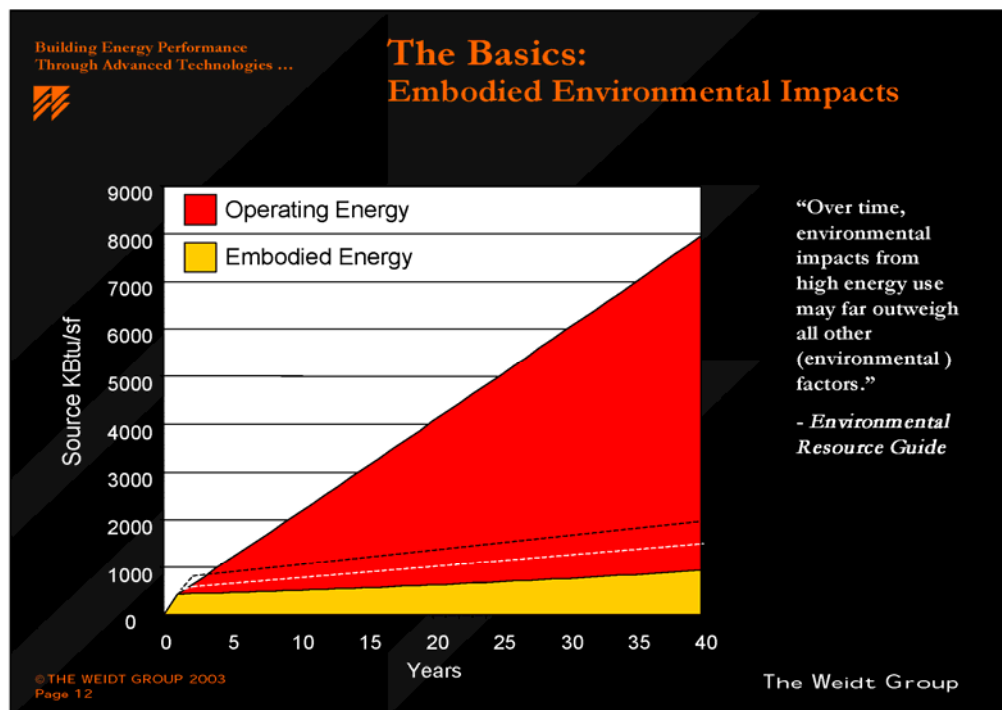
Building Energy Performance Through Advanced Technologies ...



Recent Recognition

- Illumination Design Award
UW-Whitewater Fieldhouse
IESNA 2002
- Project of Distinction
Jordan Park Schools
Council of Facility Planners International 2002
- Merit Award for New Construction
The Pharmacia Building Q
Presented by Chicago Building Congress 2001
- Architecture + Energy Award
Iowa Association of Municipal Utilities 2001
- The Program Most Likely to Meet the Intent of the Kyoto Protocol in the Shortest Time
Presented by European Council for an Energy Efficient Economy (ECEEE)
Xcel Energy's Energy Assets Program 2001
- AIA's Top 10 for Earth Day 2000
Presented by the Committee on the Environment
The Green Institute's Phillips Eco-Enterprise Center and Northland College Student Housing 2000
- Environmental Initiative Award
presented by the Minnesota Environmental Initiative
NSP Energy Assets 2000
- Energy Efficiency Design Award of the Year
Presented by Mid-American Energy
Meredith Publishing Company 1997

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Page 11



Building Energy Performance
Through Advanced Technologies ...



Outline

- Who we are
- ▶ Rules and Practice
- Failure and Success
- Examples

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Page 13

Fundamentals

Every man's work, whether it be
literature or music or pictures or
architecture or anything else, is
always a portrait of himself.

Samuel Butler

Building Energy Performance
Through Advanced Technologies ...



The Wizard of Oz

Examining the Effectiveness of Rules

- What would you do if I asked you to write a description of The Wizard of Oz using the following Rules?
 - Only one sentence under 30 words will be accepted so, be efficient.
 - Write in standard English using correct grammatical structure and punctuation.
 - Do not use abbreviations or slang.
 - Be comprehensive, have a beginning, middle and end.
 - Be accurate.

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Building Energy Performance
Through Advanced Technologies ...



Nature of the beast

- Conservation and efficiency may be antithetical to human behavior
- Behavioral Norms
 - Survival
 - Security
 - Comfort
- Which of these is not optimized by having more than we need ?

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Page 16

Building Energy Performance Through Advanced Technologies ...



Seven Tactical Options for Addressing Conservation

- 1. More restrictive code**
 - Requirements for unassociated but more restrictive components.
- 2. Component rebates**
 - Cash assistance for using specific technologies
- 3. Plan Review**
 - A "second look" consulting proposition
- 4. Prescriptive guidelines**
 - Requirements for associated (bundled) and more restrictive components
- 5. Performance Contracting**
 - Provisions for commercially provided product based analysis
- 6. Custom Energy Design Assistance**
 - Project specific comparative analysis
- 7. Tool Based Energy Design Assistance**
 - Design team lead comparative analysis

Each has advantages and disadvantages

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Building Energy Performance Through Advanced Technologies ...



Definitions

"Do THIS and we'll call it compliance without ever knowing its true impact, merits or performance indicators."

- Prescriptive**
 - A strategy or guideline based on or **stipulating a norm** or standard as the means **for meeting a goal**.

"Meet this goal and show us how the performance indicators were calculated and can be verified."

- Performance**
 - A strategy or guideline **stipulating** a calculable and **measurable outcome** for meeting a goal.

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Page 18

Building Energy Performance Through Advanced Technologies ...



Change Cycle
 • Challenge and Innovation
 • Creativity and Development
 • Compromise and Codification
 • Complacency and Stagnation
Repeat
 • Challenge and Innovation
 • Creativity and Development
 • Compromise and Codification
 • Complacency and Stagnation
Repeat

Rules and Practice

- **Make Rules**
 - Develop Codes
 - Develop Guidelines
 - Develop Enforcement
 - Certify
- **Perform Analysis**
 - Improve tools
 - Improve consulting practices
 - Improve reporting
 - Verify

Organizational efficiency at an operational cost

Operational efficiency at an organizational cost

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Building Energy Performance Through Advanced Technologies ...



Rules and Practice

- **Code Compliance**
 - General
 - Regressive
 - Product/technology based
- **Manufacture Driven Change**
 - “Performance” Contracting
 - Product/Profit Based
- **Analytically Driven Change**
 - Independent Comparative analysis
 - Educationally Based / Progressive

“We have to sell what we have to sell.”
Attributed to a former CEO of a major Minnesota manufacturer

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Tools / guidelines
Workshops / Seminars
Assistance / Verification

Rules and Practice

- Change is best implemented when the effected parties have the ability to
 1. Perceive the nature, magnitude and event horizon of the problem
 2. Correctly evaluate the technical and economical feasibility of solutions
 3. Afford and implement selected solutions
 4. Profit

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Rules and Practice

- Incremental change requires both the development of technology and its *socialization*.

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The Wizard of Oz

Examining the Effectiveness of Rules

- What would you do if I asked you to write a description of The Wizard of Oz using the following Rules?
 - Only one sentence under 30 words will be accepted so, be efficient.
 - Write in standard English using correct grammatical structure and punctuation.
 - Do not use abbreviations or slang.
 - Be comprehensive, have a beginning, middle and end.
 - Be accurate.

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The Wizard of Oz

- One day a tornado hit the family farm and Dorothy dreamed about a beautiful place that gave her courage, knowledge and the ability to love. 25
- A young girl from Kansas navigating a long, winding road, picking up three different but pleasant characters en rout, meets less pleasant characters before her dream ends. 27

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The Wizard of Oz

- A Kansas girl, rendered unconscious by a tornado, dreams of a land called OZ, where various adventures lead her to a wizard who reveals the secret to return home. 30
- Transported to a surreal landscape, a girl and her dog kill the first woman they meet and then team up with three apparent strangers to kill again before returning home. 30

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So what...

- **Everyone who responded was technically competent but came up with a different result.**
- **It matters who is implementing a rules.**

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Outline

- Who we are
- Rules and Practice
- ▶ ▪ Failure and Success
- Examples

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Fundamental Truths

The only thing harder to change than
law is custom.

Will Durant
The History of Western Civilization

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Failure Modes

- **Conceptual Failure**
 - Failed Social Construct
 - Failed Operational Construct
- **Technological Failure**
 - Immature Design
 - Quality Control
- **Design Failure**
 - Unfamiliarity
 - Incomplete Specification
- **Construction / Implementation Failure**
 - Unfamiliarity
 - Incomplete Specification
- **Operational Failure**
 - Failed Social Construct
 - Failed Operational Construct

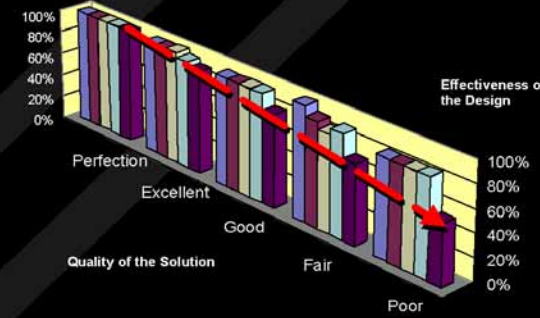
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Rules and Practice System Efficacy

Component	Perfection	Excellent	Good	Fair	Poor
Window size	100%	98%	95%	100%	85%
Sun shading	100%	98%	95%	91%	85%
Lighting design	100%	99%	95%	85%	85%
Calibration	100%	95%	95%	90%	85%
Total	100%	90%	81%	70%	52%



Effectiveness of the Design

Quality of the Solution

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Fundamentals of Integrated Daylighting Design

Daylight Building Section Concept

Electric Lighting System
 To reduce electrical energy required for lighting of electrically connected space
 Illumination level of 30 ft. x 30 ft. connected space (density of 1.15 w/sf)
 When a daylight meter shows lighting on its reference

Window System
 Low E window glass provides maximum transmittance and low heat gain

West Daylight zone
 The zone between West wall and West window
 1. No direct sunlight enters
 2. No direct sunlight enters
 3. No direct sunlight enters
 4. No direct sunlight enters

Central Daylight zone
 The zone between West wall and East window
 1. No direct sunlight enters
 2. No direct sunlight enters
 3. No direct sunlight enters
 4. No direct sunlight enters

East Daylight zone
 The zone between East wall and East window
 1. No direct sunlight enters
 2. No direct sunlight enters
 3. No direct sunlight enters
 4. No direct sunlight enters

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- No *one person* does Daylighting
- It is a collaborative effort of the design team
 - Architect
 - Lighting designer
 - Electrical engineer
 - Interior Designer

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Daylighting Component Performance

Daylighting System Performance

	Scenario 1	Scenario 2	Scenario 3	Scenario 4
1 Glazing Location	100%	70%	100%	100%
2 Glazing Type	100%	93%	100%	100%
4 Interior Finishes	100%	85%	100%	100%
3 Sun Control	100%	65%	100%	100%
5 Partition Height	100%	70%	100%	100%
6 Lighting Design				
Lamp Type	100%	100%	100%	100%
Fixture Type	100%	100%	100%	100%
Fixture Layout	100%	100%	100%	100%
7 Lighting Control				100%
Circuiting of fixtures	100%	100%	50%	100%
Photosensor location	100%	100%	50%	100%
Photo Sensor Calibration	100%	100%	100%	5%
8 HVAC Design	100%	100%	100%	100%
System Performance	100%	25%	25%	5%

Controls the Quantity and Quality of Daylight in the space

Also Controls the Quantity and Quality of Light in the space AND Controls the amount of electric lighting energy which can be saved

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GOOD:
Generally Works well,
need to consider
orientation issues
earlier in design

FAIR:
Window blind/ shade
selection to consider daylight
effectiveness, furnishing color
to consider contrast with
windows

POOR:
Biggest barrier for current
practice

Current State of Practice Occupant Requirements

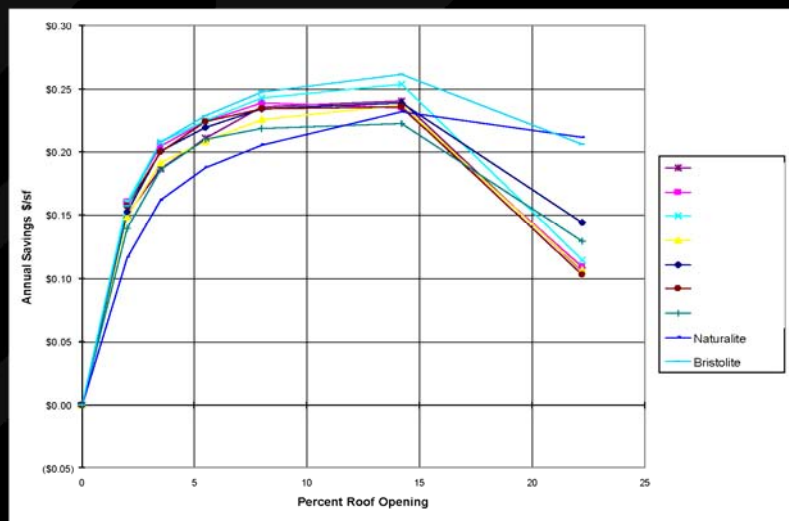
1. Having enough daylight inside a space to make it an effective illumination source, and to have views of the outside.
2. Maintain appropriate interior luminance contrast ratios by modulating the daylight sources to
3. Implementing a lighting control strategy that controls the electric lights dynamically based on daylight to save energy without distracting occupants.

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Total Annual Savings vs. Roof Opening Boston

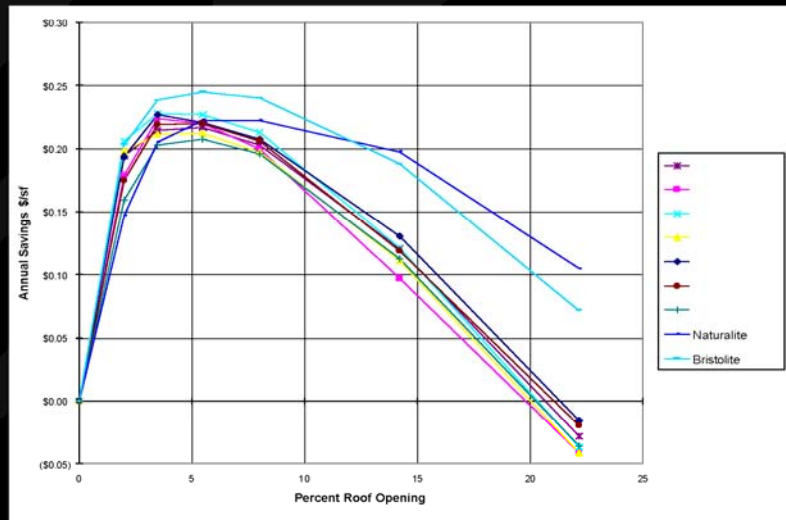


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Total Annual Savings vs. Roof Opening Phoenix

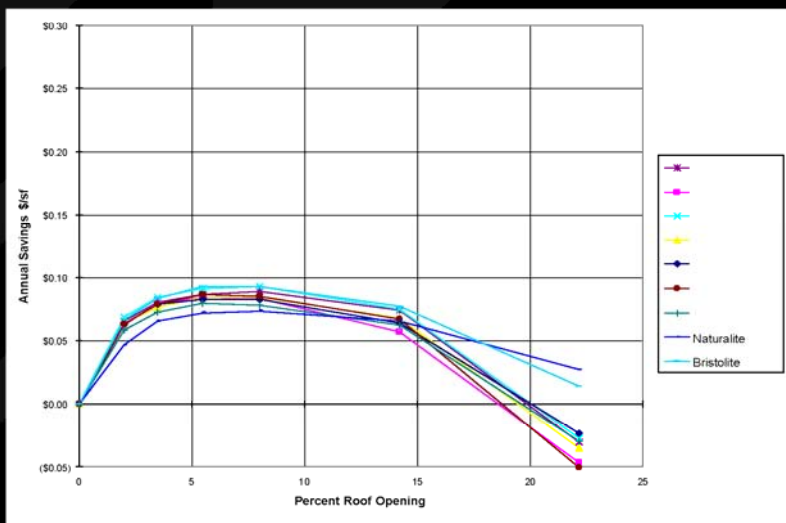


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Total Annual Savings vs. Roof Opening Minneapolis

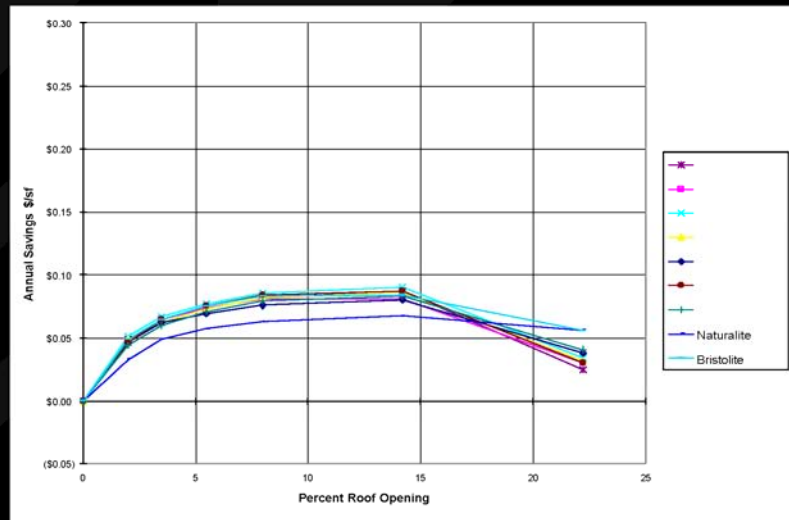


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Total Annual Savings vs. Roof Opening Seattle



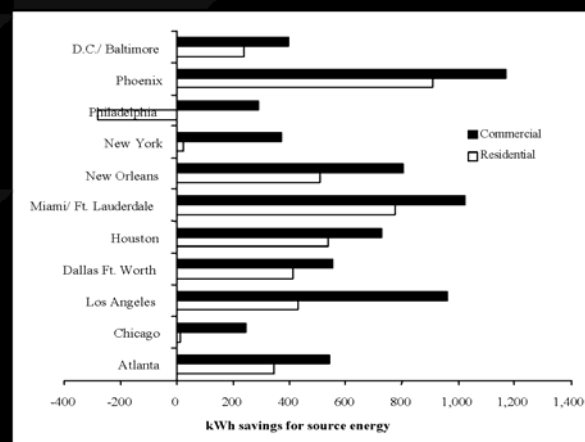
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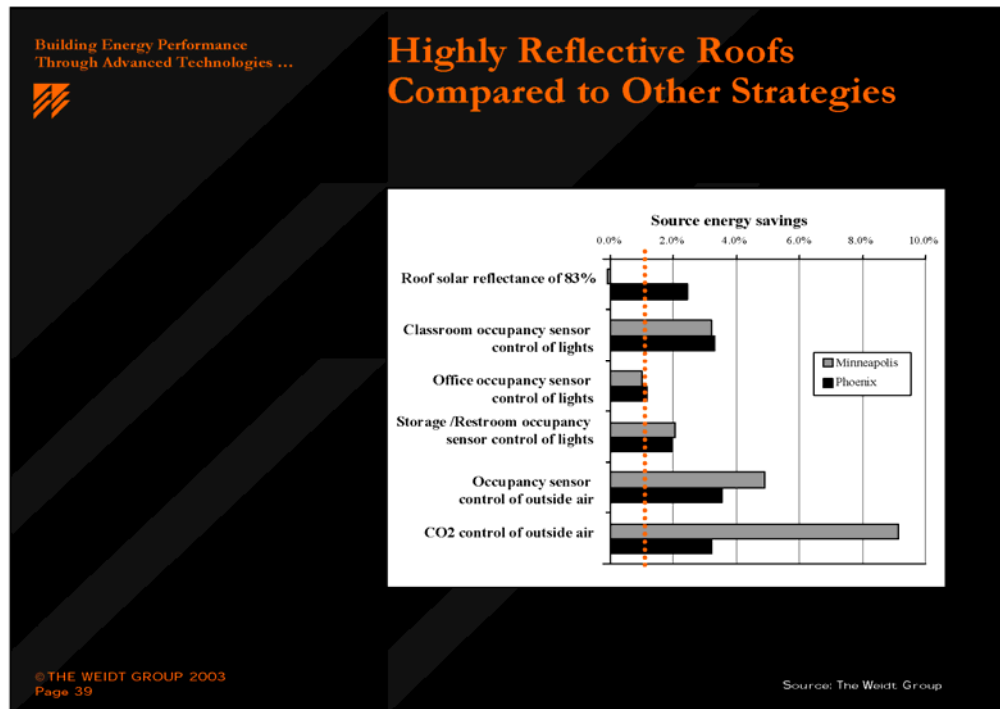


Highly Reflective Roofs and Annual Energy Savings

Source Energy Savings in
kWh per 100m² of light
colored roof application
based on data from Akbari
and Konopacki (1998).



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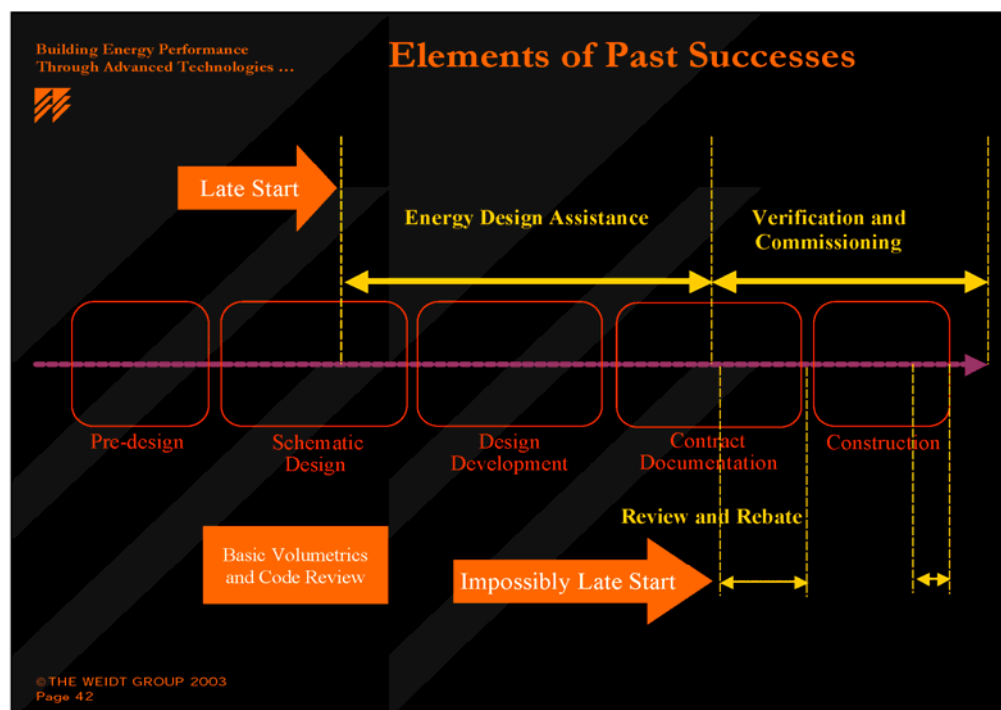
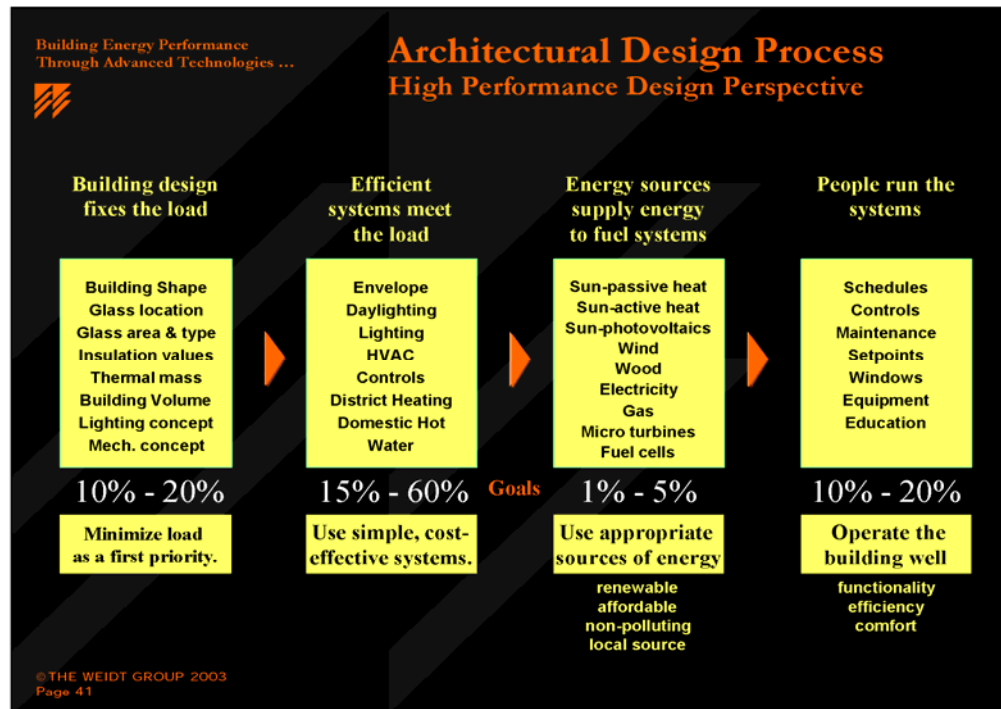
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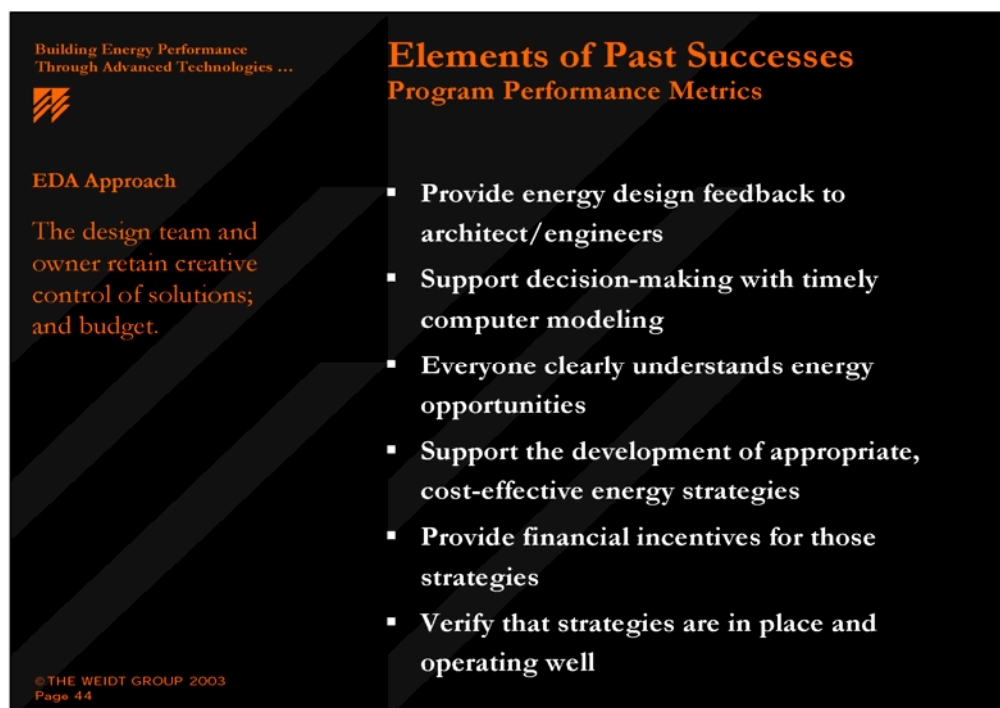
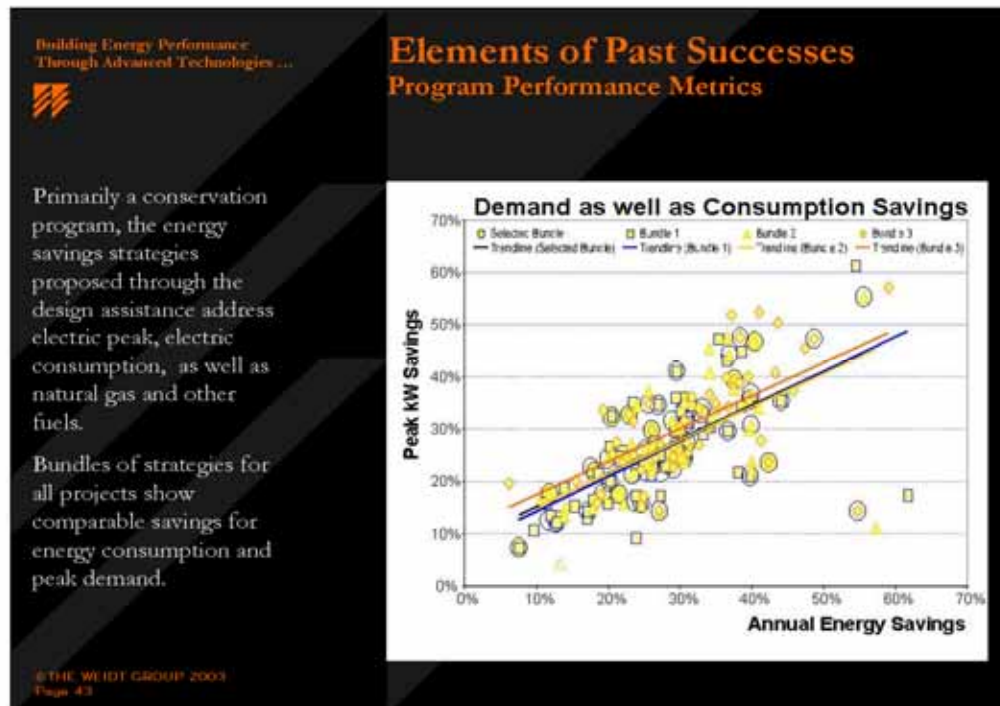
Elements of Past Successes

The greatest obstacle to discovery is not ignorance—it is the illusion of knowledge.
- Daniel J Boorstin

- Groups make decisions that they can stick with and will repeat when the individuals involved
 - Are confident in the process
 - Are respected for their expertise
 - Are presented an appropriate number of variables in an appropriate sequence
 - Are allowed to contrast and compare solutions early in decision making
 - Are able to verify their decisions through successive design and construction phases

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Elements of Past Successes

Relationship Based Decision Making

Introductory Meeting

- Review building design
- Review building characteristics
- Review preliminary strategy list

Building Characteristics Confirmation

- Design drawings - CAD Files
- BC Form 1 (Envelope / Operating Characteristics)
- BC Form 2 (Mechanical / Plant Characteristics)

Strategy List Refinement

- Send revised strategy list descriptions

DOE 2.1E computer models

- Code base model
- 10 strategy groups (approx. 75 strategies)

Cost Analysis

- Send detailed strategy information
- Cost analysis (Design Team)

Bundle Meeting

- Review strategy results & costs, and assemble 3 bundles

Final Meeting

- Proposes incentives based on bundle simulations
- Introduce verification and validation process

Verification/Validation Process

- Owner agrees to implement one bundle
- Construction documents reviewed for strategies
- Field visits to verify strategies installed and working

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Program cost-effectiveness

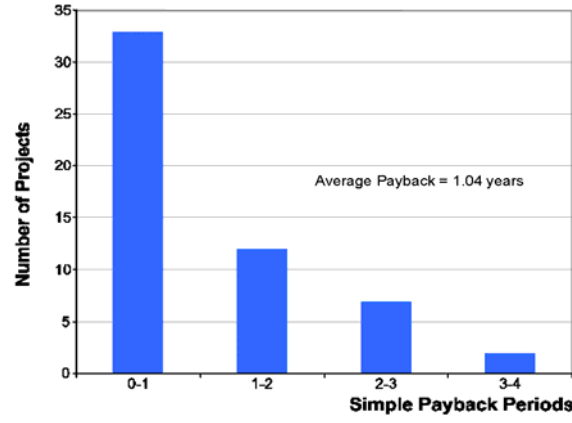
Paybacks Ranges

Paybacks Averages are Low but Vary from 1.04 to 1.20 Years

The payback period averages range based on building type, sample size, sample time and market conditions.

Paybacks shown here are calculated **without** incentive money from a utility company.

Paybacks for a selected bundle are calculated for its incremental cost and energy savings compared to a cost base design.



Simple Payback Periods	Number of Projects
0-1	33
1-2	12
2-3	7
3-4	2

Average Payback = 1.04 years

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During verification, an average of 94% of the peak kW savings predicted in the modeling are confirmed.

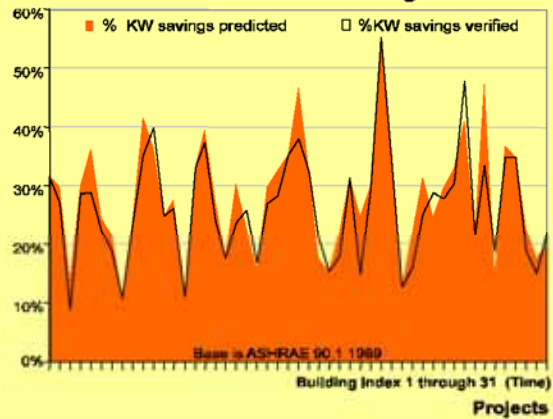
2001 Winner



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ECEE

Site Verification Proves Savings Predicted



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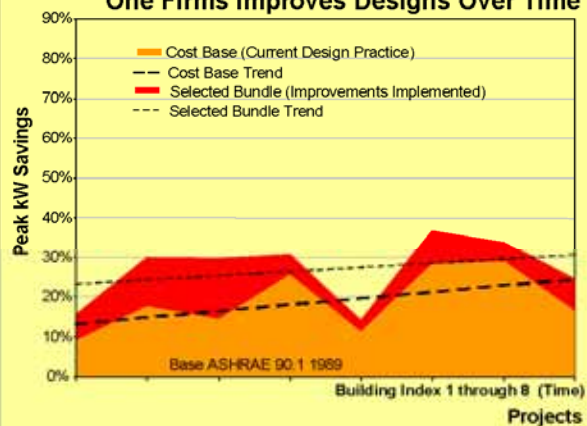
Design firms that have participated more often show a more significant improvement in their cost base designs. This tends to be the larger, more competitive firms.

2001 Winner

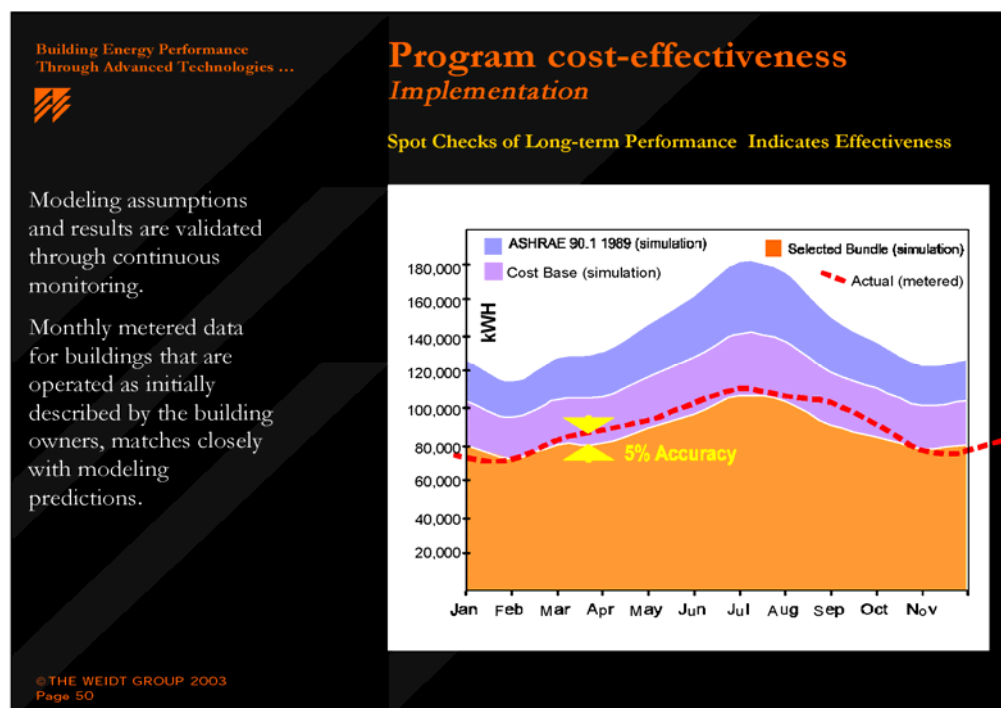
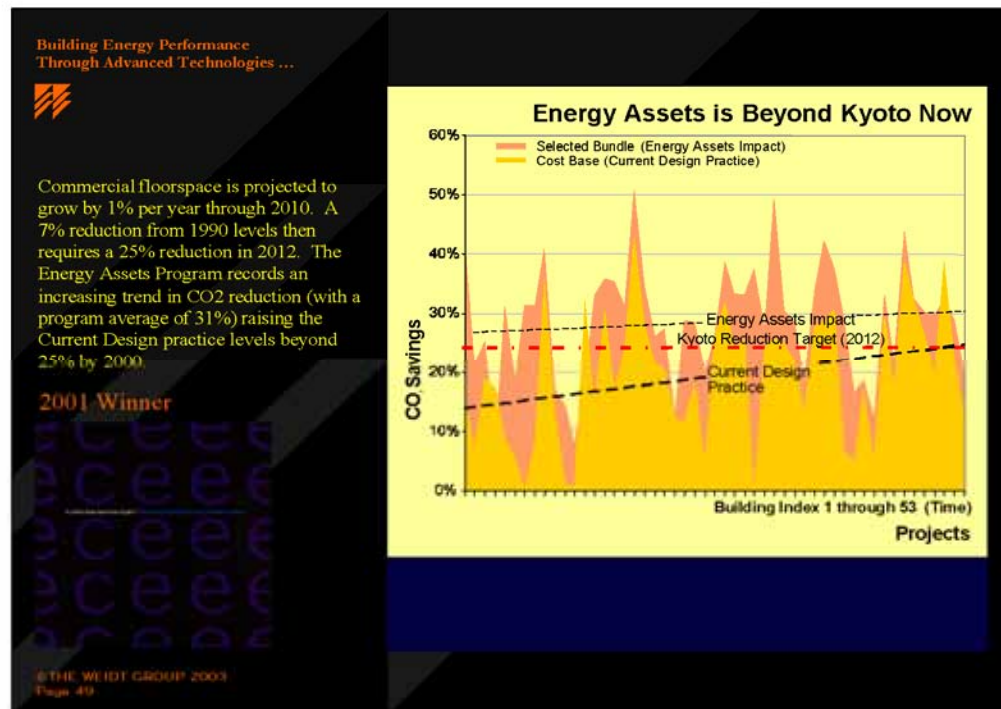


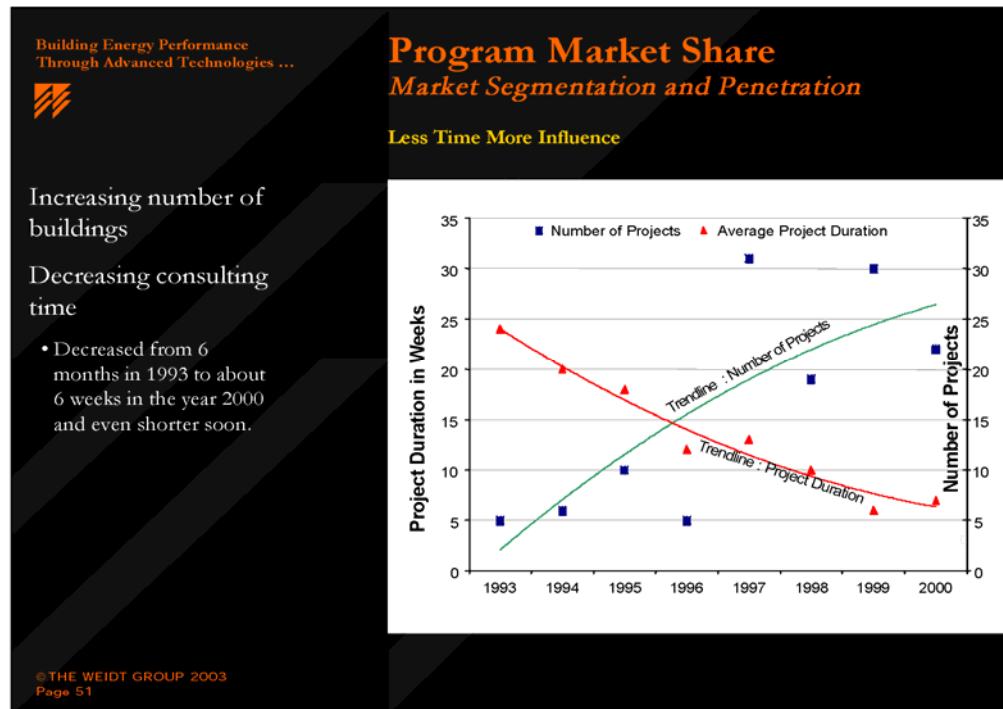
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One Firm Improves Designs Over Time



7% vs. 4%





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Outline

- Who we are
- Rules and Practice
- Failure and Success
- Examples

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Building Energy Performance Through Advanced Technologies ...



IAMU by RDG with The Weidt Group

Elements of Past Successes *Market Segmentation and Penetration*

- 80% of architectural firms that have participated, have participated at least twice
- 70% of architectural firms that have participated, have participated more than 3 times.
- The Design Assistance service has influenced design and owner communities to raise baseline designs.

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Building Energy Performance Through Advanced Technologies ...



IAMU by RDG with The Weidt Group



Oberlin College by Others

Elements of Past Successes *Program cost-effectiveness*

- It depends on how the Base is set...
- Trade-offs: modeling is critical to the “value engineering” process
- Payback for modeling services is measured in weeks or months on most projects

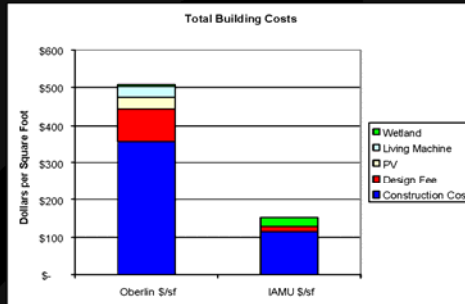
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Program cost-effectiveness

Do advanced building practices always increase construction costs?



IAMU building has a 30% lower energy load due to building design after adjusting for climate and building type

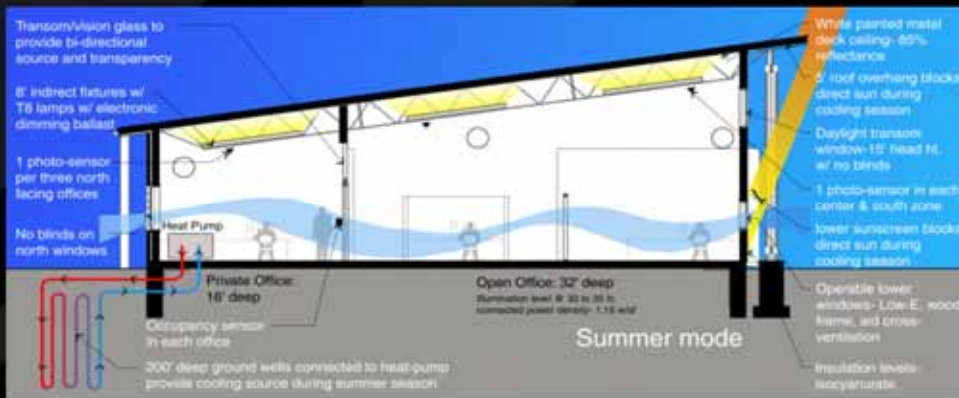
- Oberlin cost nearly 3.5 times IAMU to build
- Construction costs were 3 times that of IAMU
- Design fees were over 7 times those of IAMU
- The performance of Oberlin was, even with compromised operation, about equal to IAMU at about 30 Kbtu/SF/Yr including equipment loads

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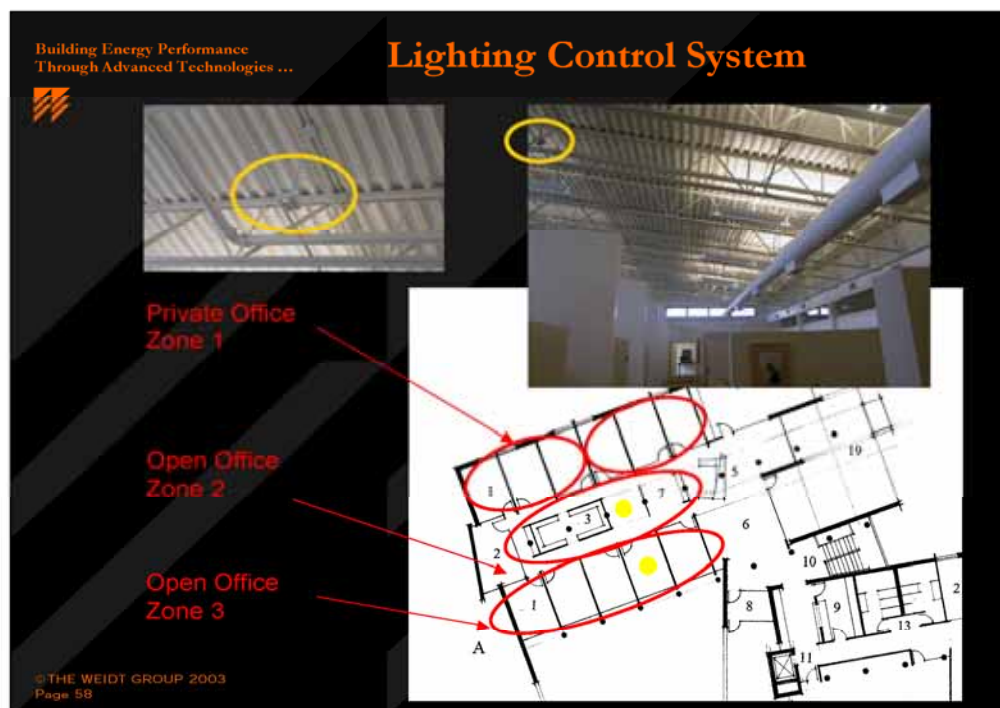


Daylight Building Section Concept Summer Mode



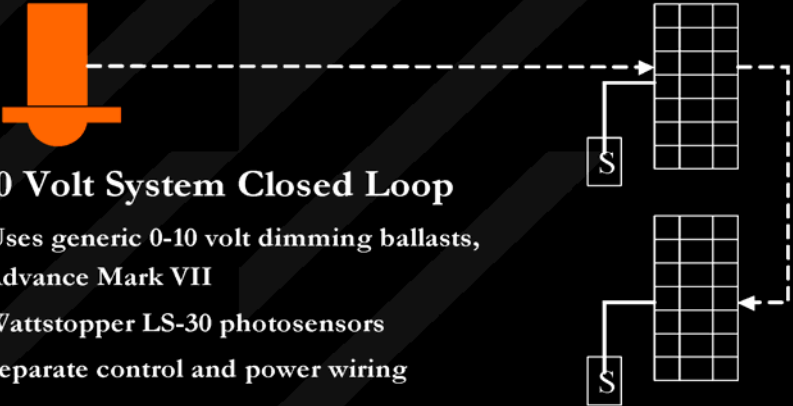
Iowa Association of Municipal Utilities
Architects - RDG

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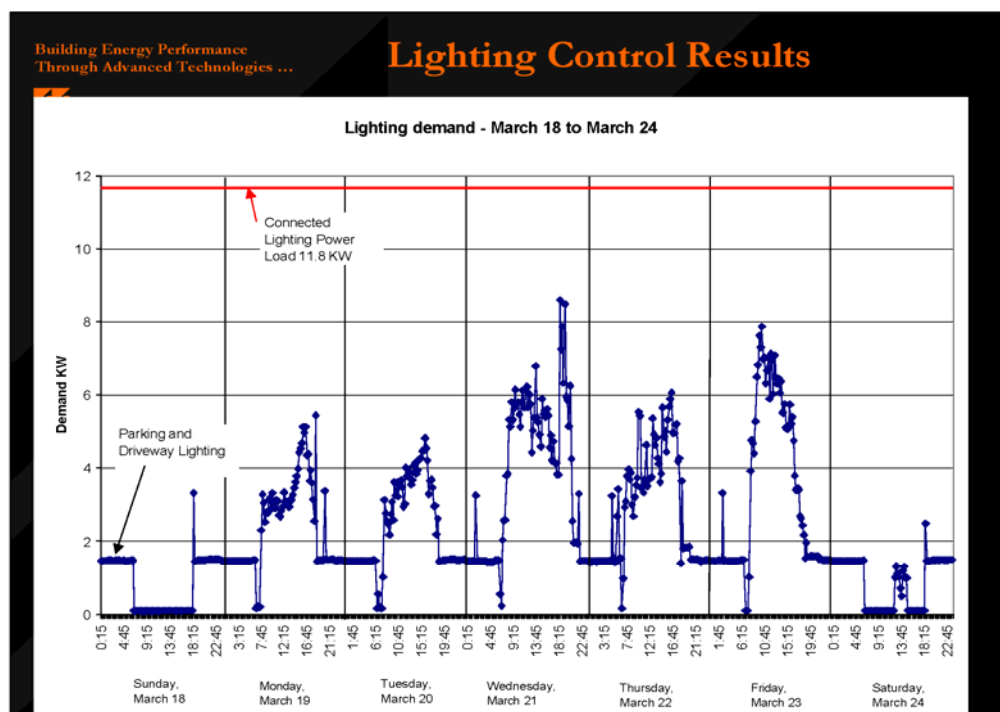
Lighting Control System

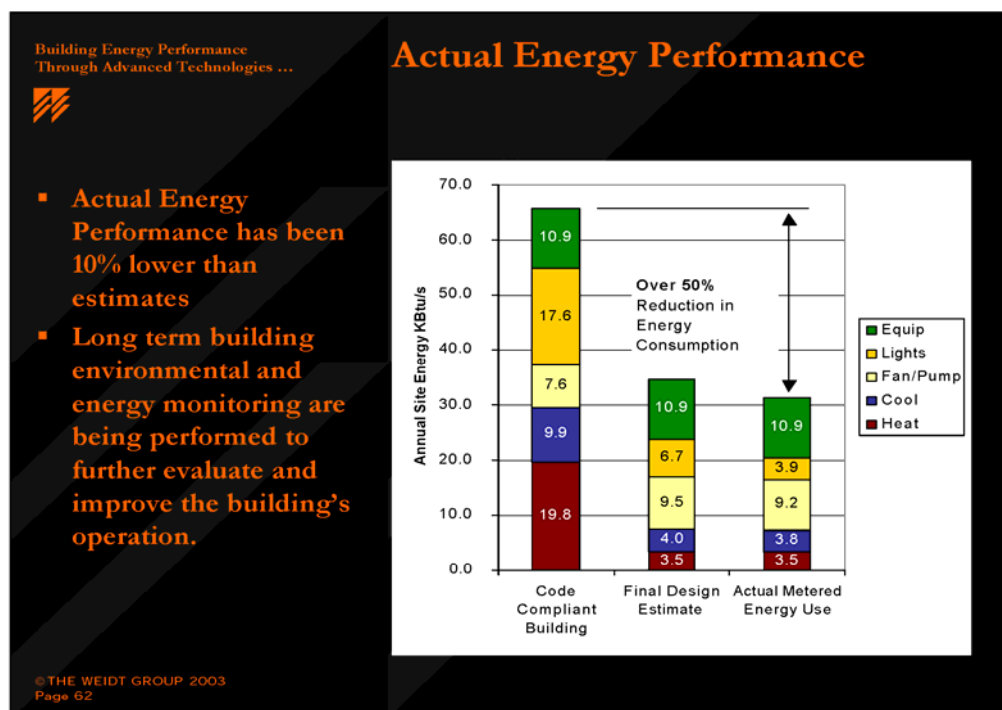


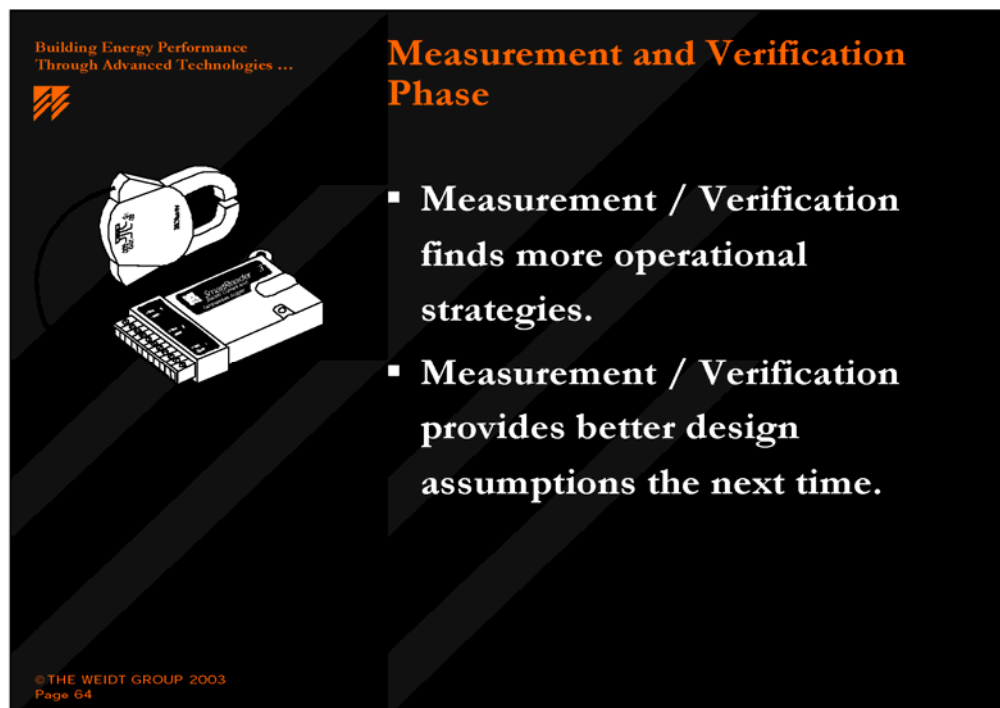
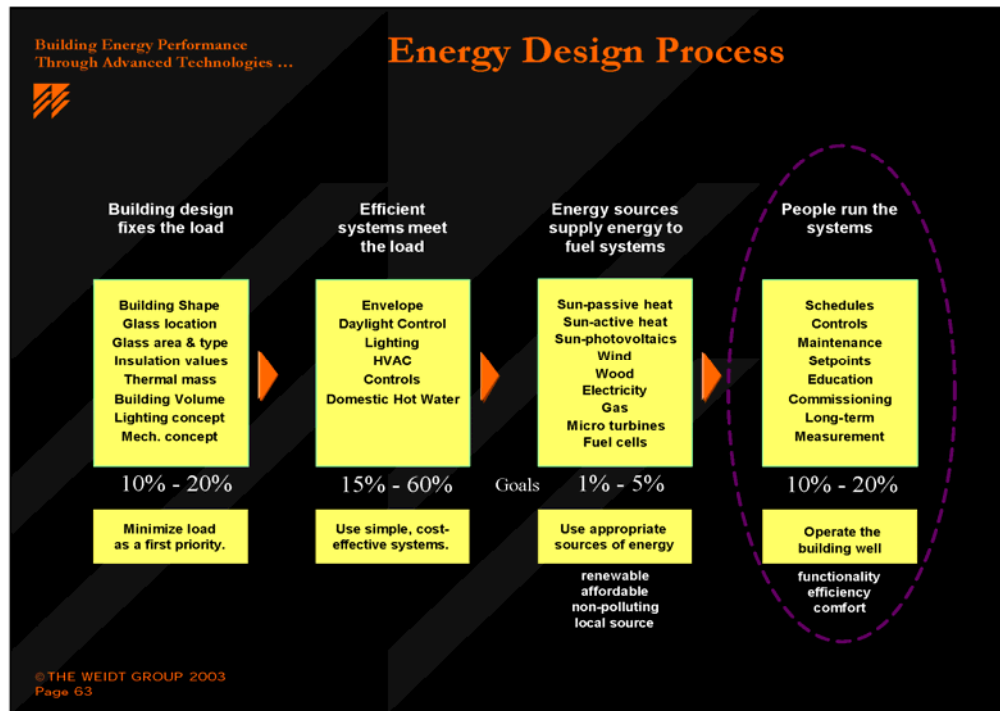
0-10 Volt System Closed Loop

- Uses generic 0-10 volt dimming ballasts, Advance Mark VII
- Wattstopper LS-30 photosensors
- Separate control and power wiring

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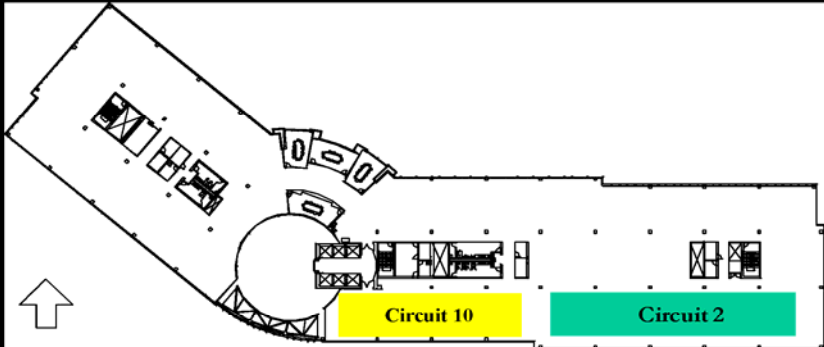




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Sidelighting Results Photo Sensor Controlled Stepped Daylighting



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Sidelighting Results

Photo Sensor Controlled Stepped Daylighting

1. Only Half of Fixtures are on Daylighting Controlled Circuit
2. Controlled Fixtures are working as expected

Weekend period all lights off

Lights off with available daylight

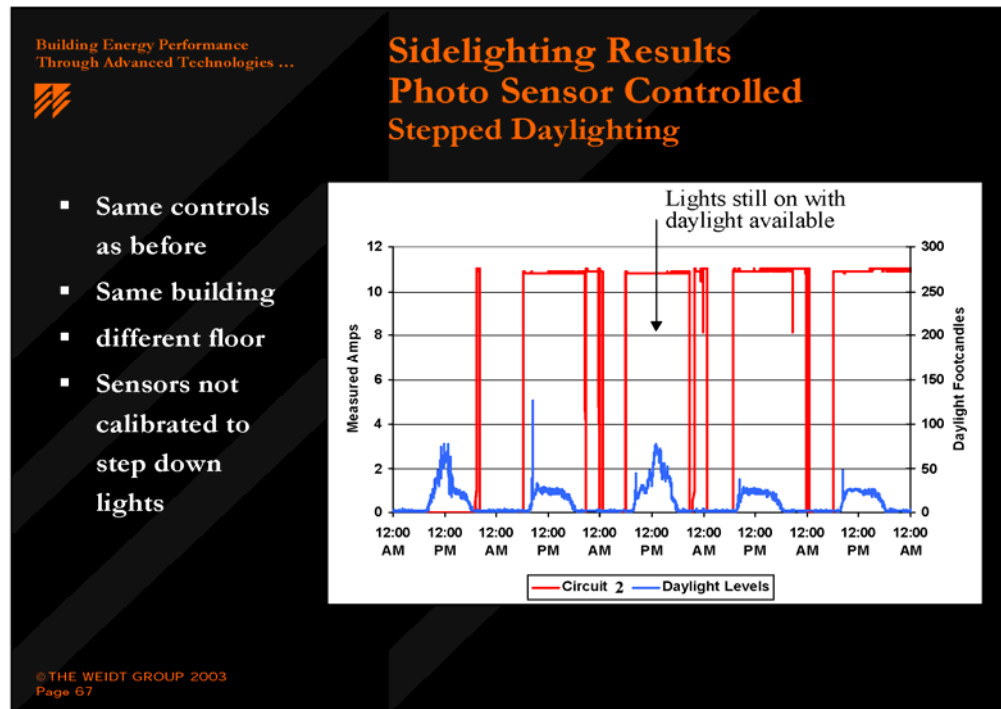
Measured Amps

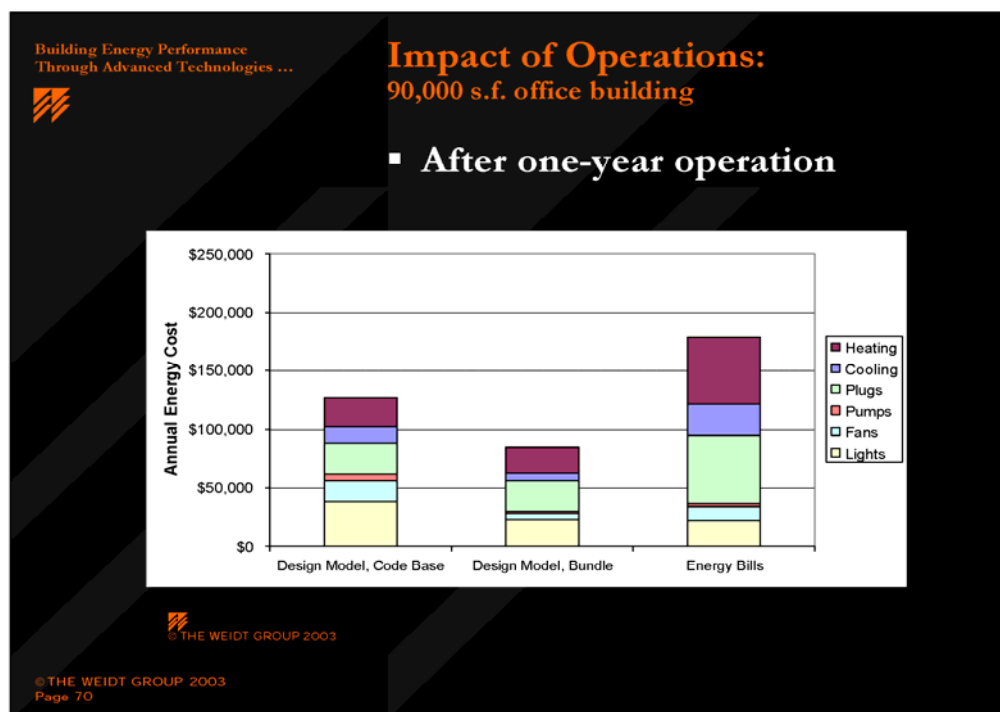
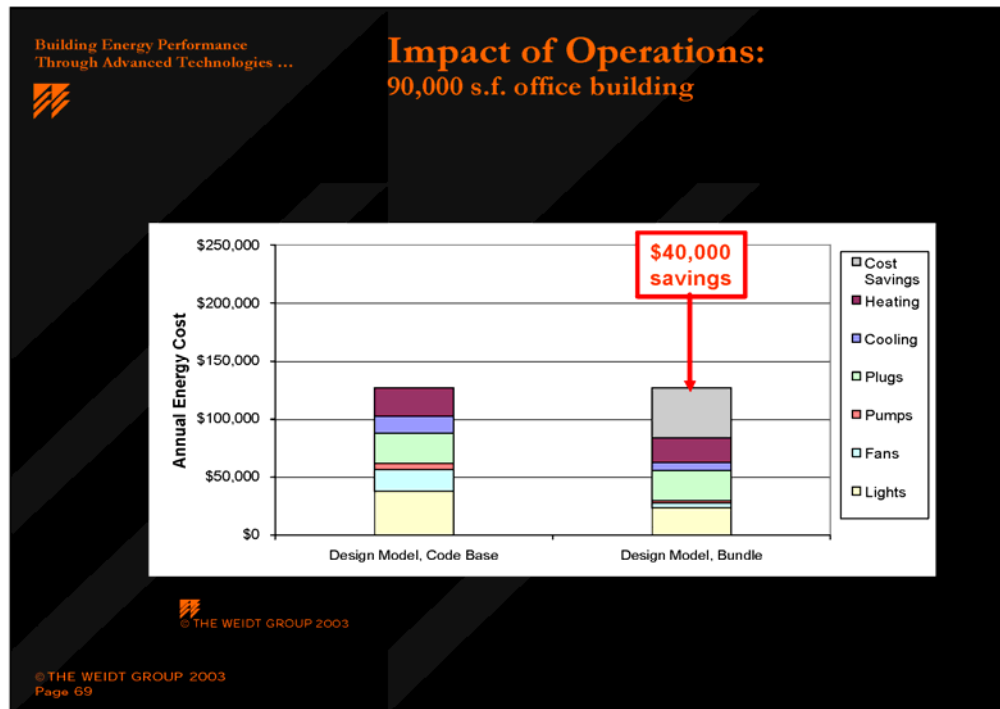
Daylight Footcandles

12:00 AM 12:00 PM 12:00 AM 12:00 PM 12:00 AM 12:00 PM 12:00 AM 12:00 PM 12:00 AM 12:00 PM 12:00 AM 12:00 PM 12:00 AM 12:00 PM 12:00 AM

— Circuit 10 — Daylight Levels

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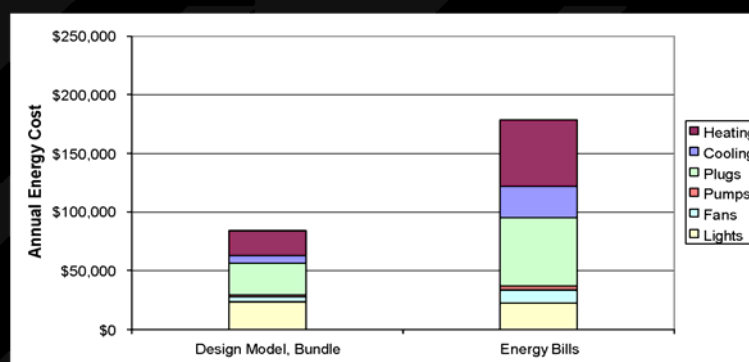


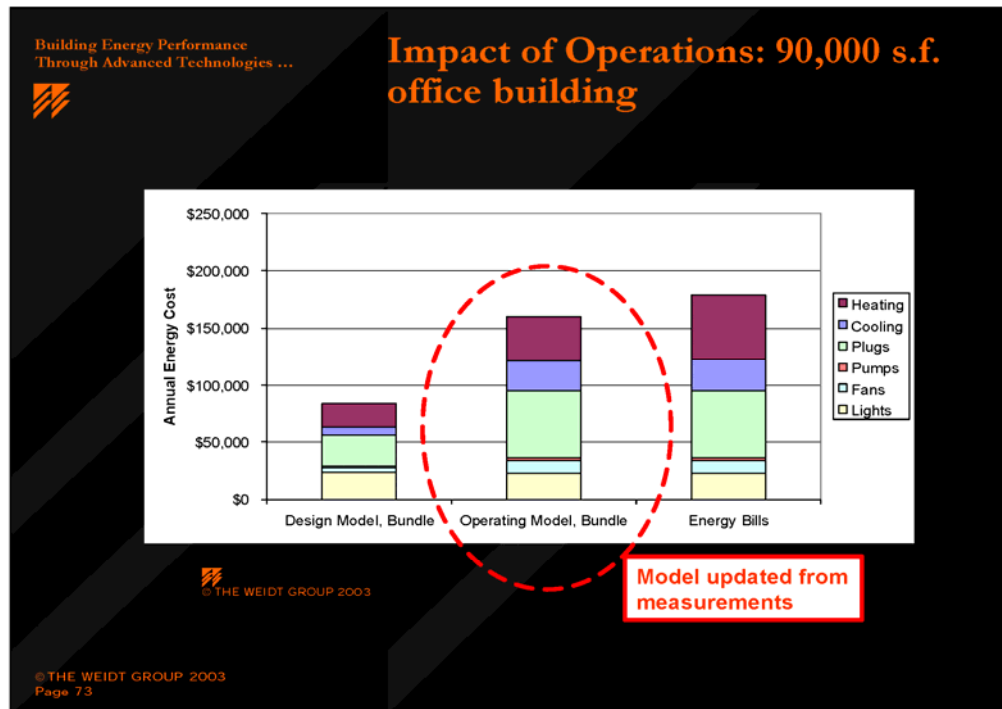
Impact of Operations: 90,000 s.f. office building

- Can we model the impact of these design / operational changes?
 - Yes, through detailed measurement during occupancy.
 - A quick investigation accounts for 80% of the difference.
- What happened?
 - Added 24/7 web-site and call center operation
 - Added second shift and two-shift copy center
 - Mechanical controls settings not as efficient as modeled



Impact of Operations: 90,000 s.f. office building



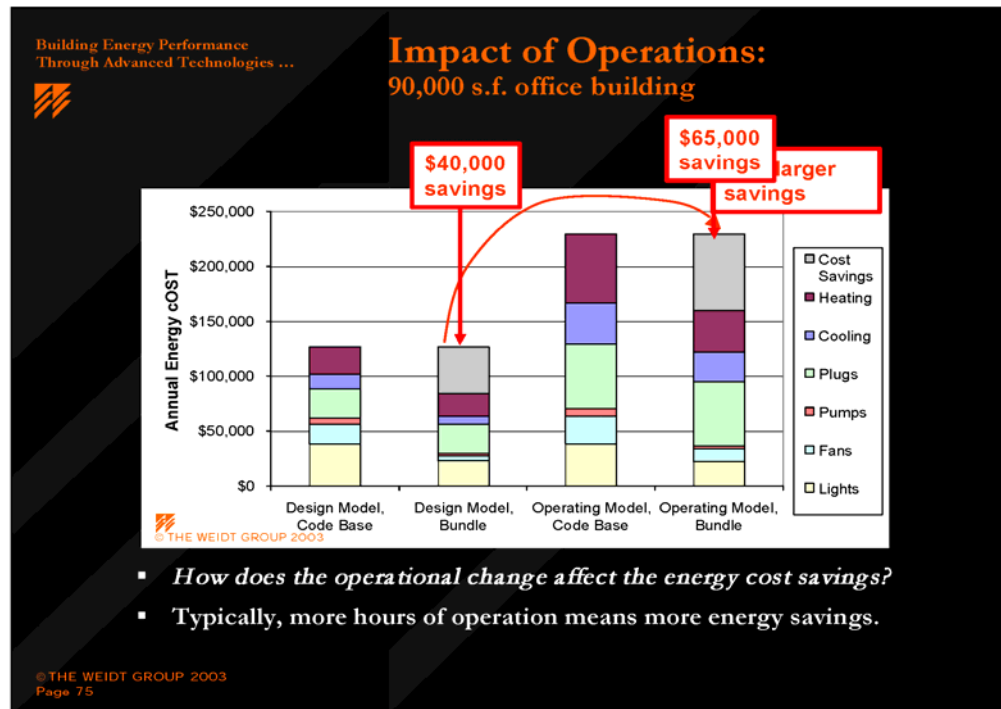


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Impact of Operations: 90,000 s.f. office building

- How does the operational change affect the energy savings?
- Typically, more hours of operation means more energy savings.

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Analysis
Research

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