

Design and Simulation Tools for Window System Energy Performance



Nils Petermann
npetermann@ase.org
Alliance to Save Energy
www.ase.org



Kerry Haglund
khaglund@umn.edu
Center for Sustainable Building
Research
University of Minnesota
www.csbr.umn.edu

www.efficientwindows.org / www.commercialwindows.org



Center for Sustainable Building Research

College of Design
UNIVERSITY OF MINNESOTA

EcoBuild Fall: Washington, DC
December 8-11, 2008

1

Efficient Windows Collaborative

The Efficient Windows Collaborative is a coalition of window, door, skylight, and component manufacturers, federal, state and local government agencies, research institutions, and others who partner to expand the market for energy efficient window products.

Lead Organizations

- Alliance to Save Energy
- University of Minnesota
- Lawrence Berkeley National Labs
- AZS Consulting
- 160+ Active industry members and affiliates



Center for Sustainable Building Research

College of Design
UNIVERSITY OF MINNESOTA

EcoBuild Fall: Washington, DC
December 8-11, 2008

2

Acknowledgement and Disclaimer

Acknowledgement: This material is based upon work supported by the Department of Energy, National Energy Technology Laboratory under Award Number DE-FC26-06NT42766.

Disclaimer: This presentation was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.



Center for Sustainable Building Research

College of Design
UNIVERSITY OF MINNESOTA

EcoBuild Fall: Washington, DC
December 8-11, 2008

3

Why are Windows Important?



Photo: Pella Windows & Doors



Photo: PGT Industries



Photo: Velux-America



Photo: JELD-WEN



Photo: Associated Materials

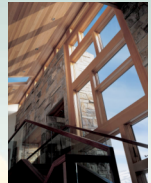


Photo: Andersen Corporation



Center for Sustainable Building Research

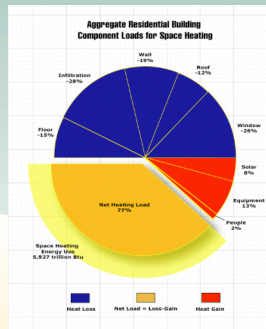
College of Design
UNIVERSITY OF MINNESOTA

EcoBuild Fall: Washington, DC
December 8-11, 2008

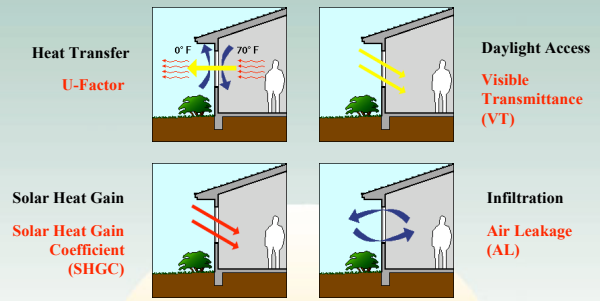
4

The Impact of Window Performance: A Simple Example

- Typical residential windows area: 1/6 of exterior wall area
- Heat loss per ft² of standard windows (R-2) is easily 6 times the heat loss per ft² of standard wall (R-13)
- With high-performance windows (R-3 to R-5), window heat loss can be cut in half. Similar to doubling wall R-value from 13 to 26.
- *There's more to window performance than heat loss...*



Window Energy Parameters



The Information Source for Window Energy Properties: The NFRC Label

World's Best Window Co. Millennium 2000® VirtuCool® Double Glazing - Argon Fill - Low E Product Type: Window/Door	
ENERGY PERFORMANCE RATINGS	
U-factor (U.S./SI-P) 0.35	Solar Heat Gain Coefficient 0.32
ADDITIONAL PERFORMANCE RATINGS	
Visible Transmittance 0.51	Air Leakage (U.S./SI-P) 0.2
Condensation Resistance 51	

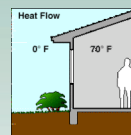
Manufacturer declares that these energy window properties (NFRC ratings) for determining energy performance (ASHRAE 90.1-2005) are based on test and performance standards (ASTM) and are in accordance with NFRC's procedures for determining energy performance. NFRC does not warrant the accuracy or reliability of data provided for its quality seal. Third-party verification of data is required for NFRC's quality seal.

The National Fenestration Rating Council (NFRC) has established a voluntary national energy performance rating and labeling system for fenestration products.

NFRC ratings show the complete aggregated performance of the whole product, including:

- frame
- glazing
- spacer

U-Factor

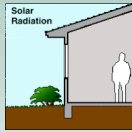


The rate of heat loss is indicated in terms of the U-factor (U-value) of a window assembly. The U-factor is the inverse of the R-value. The lower the U-factor, the greater a window's resistance to heat flow and the better its insulating value.

U-factor is the measure of the rate of non-solar heat loss or gain through a material or assembly. It is expressed in units of Btu/hr-sq ft-°F (W/sq m-°C).

A U-factor of 0.35 (whole window) or less is recommended in cold climates. In warm climates a low U-factor is helpful during hot days or whenever heating is needed, but it is less important than SHGC.

Solar Heat Gain Coefficient (SHGC)



The SHGC is the fraction of incident solar radiation admitted through a window, both directly transmitted and absorbed and subsequently released inward. SHGC is expressed as a number between 0 and 1. The lower a window's solar heat gain coefficient, the less solar heat it transmits.

A SHGC of 0.40 or less is recommended in warm climates. In heating-dominated climates, a high SHGC increases passive solar gain for heating, but reduces cooling season performance. A low SHGC improves cooling season performance, but reduces passive solar gain.



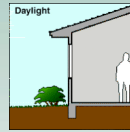
Center for Sustainable Building Research

College of Design
UNIVERSITY OF MINNESOTA

EcoBuild Fall: Washington, DC
December 8-11, 2008

9

Visible Transmittance (VT)



The visible transmittance (VT) is an optical property that indicates the amount of visible light transmitted through the glass. VT is expressed as a number between 0 and 1. The higher the VT, the more daylight is transmitted.

A high VT is desirable to maximize daylight.



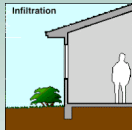
Center for Sustainable Building Research

College of Design
UNIVERSITY OF MINNESOTA

EcoBuild Fall: Washington, DC
December 8-11, 2008

10

Air Leakage (AL)



Heat loss and gain occur by infiltration through cracks in the window assembly. It is indicated by an air leakage rating (AL) expressed as the equivalent cubic feet of air passing through a square foot of window area. The lower the AL, the less air will pass through cracks in the window assembly.

An air leakage rating (AL) of 0.30 cfm/sq ft or less (whole window) is recommended.



Center for Sustainable Building Research

College of Design
UNIVERSITY OF MINNESOTA

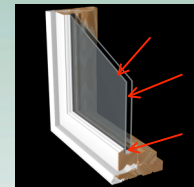
EcoBuild Fall: Washington, DC
December 8-11, 2008

11

What Makes an Energy-Efficient Window?



U-factor: 0.49
SHGC: 0.56



ENERGY STAR® Qualified
In All 50 States



Center for Sustainable Building Research

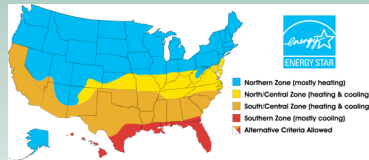
College of Design
UNIVERSITY OF MINNESOTA

EcoBuild Fall: Washington, DC
December 8-11, 2008

12

Window Energy Performance also Depends on...

- Climate



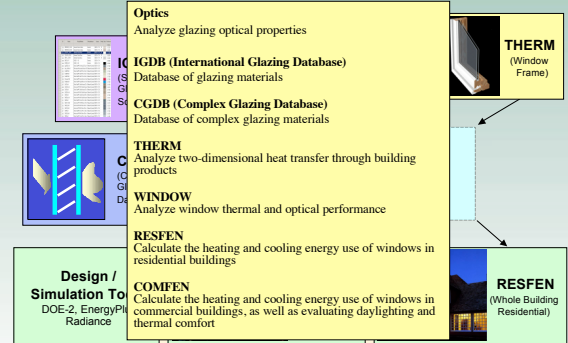
- Building Type



- Orientation, etc.

Tools to Determine Window Performance

Developed by: Lawrence Berkeley National Lab



Help with Sorting Through the Complexities of Window Performance



Residential Windows Info

www.efficientwindows.org

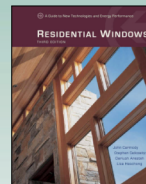


Commercial Windows Info

www.commercialwindows.org



Efficient Windows Collaborative



Residential Tools and Information

- 3rd edition of book: "Residential Windows: A Guide to New Technology and Energy Performance"
- EWC web site: www.efficientwindows.org
- Fact sheets for 100 cities
- Education and training materials
- Window Selection Tool
- RESFEN



The Window Selection Process



1. Look for the ENERGY STAR
Look for a product that qualifies for the Energy Star in your area.
2. Look for Energy Efficient Window Properties on the NFRF Label
The key window properties are U-factor, Solar Heat Gain Coefficient (SHGC), and Visible Transmittance (VT). The NFRF label provides the only reliable way to determine the window properties and to compare products.
3. Compare Annual Energy Costs for a Typical House
The annual energy use from computer simulations for a typical 2000-square-foot house in your region can be compared for different window options.
4. Estimate and Compare Annual Energy Costs for Your House
Using a computer program such as RESFEN to compare window options is the only method of obtaining reasonable estimates of the heating and cooling costs for your climate, house design, and utility rates.

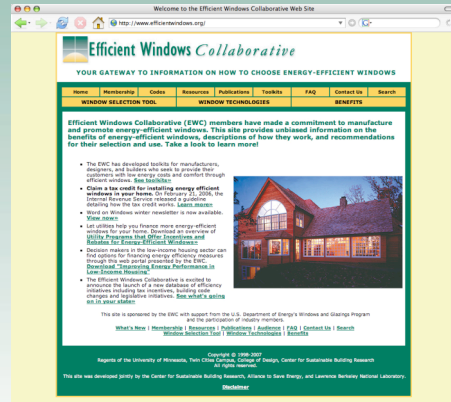


Center for Sustainable Building Research

College of Design
UNIVERSITY OF MINNESOTA

EcoBuild Fall: Washington, DC
December 8-11, 2008

17

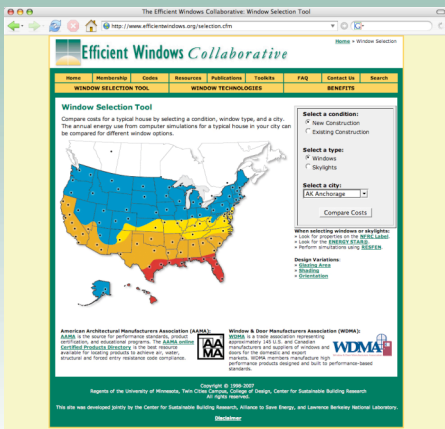


Center for Sustainable Building Research

College of Design
UNIVERSITY OF MINNESOTA

EcoBuild Fall: Washington, DC
December 8-11, 2008

18



Center for Sustainable Building Research

College of Design
UNIVERSITY OF MINNESOTA

EcoBuild Fall: Washington, DC
December 8-11, 2008

19



Center for Sustainable Building Research

College of Design
UNIVERSITY OF MINNESOTA

EcoBuild Fall: Washington, DC
December 8-11, 2008

20

The Efficient Windows Collaborative: Window Selection Tool

Efficient Windows Collaborative

Minneapolis, Minnesota

ENERGY STAR® Properties

Window Search

Select Glass: [All glass types]

Select Frame: [All frame types]

ENERGY STAR: Yes

Construction Type: New Existing

Product Type: Windows Skylights

Search for Windows

Window Type	Properties	Annual Energy Use	ENERGY STAR Qualified	Manufacturer Information
Product: Single glazed with Low-E, Argon Gas	U = .24 SHGC = .25 VT = .55	[Bar chart showing energy use]	✓	Products
Product: Single glazed with Low-E, Argon Gas	U = .24 SHGC = .25 VT = .55	[Bar chart showing energy use]	✓	Products
Product: Single glazed with Low-E, Argon Gas	U = .24 SHGC = .25 VT = .55	[Bar chart showing energy use]	✓	Products
Product: Single glazed with Low-E, Argon Gas	U = .24 SHGC = .25 VT = .55	[Bar chart showing energy use]	✓	Products
Product: Single glazed with Low-E, Argon Gas	U = .24 SHGC = .25 VT = .55	[Bar chart showing energy use]	✓	Products
Product: Single glazed with Low-E, Argon Gas	U = .24 SHGC = .25 VT = .55	[Bar chart showing energy use]	✓	Products
Product: Single glazed with Low-E, Argon Gas	U = .24 SHGC = .25 VT = .55	[Bar chart showing energy use]	✓	Products
Product: Single glazed with Low-E, Argon Gas	U = .24 SHGC = .25 VT = .55	[Bar chart showing energy use]	✓	Products
Product: Single glazed with Low-E, Argon Gas	U = .24 SHGC = .25 VT = .55	[Bar chart showing energy use]	✓	Products
Product: Single glazed with Low-E, Argon Gas	U = .24 SHGC = .25 VT = .55	[Bar chart showing energy use]	✓	Products

Center for Sustainable Building Research

College of Design

University of Minnesota

EcoBuild Fall: Washington, DC

December 8-11, 2008

21

Examples of Frame and Glazing Options

Frame Types

Aluminum Wood Vinyl Fiberglass

Glazing Types

Single Pane

Double Pane, Moderate-Solar-Gain Low-E, Gas Fill

Triple Pane, Low-Solar-Gain Low-E, Gas Fill

Center for Sustainable Building Research

College of Design

University of Minnesota

EcoBuild Fall: Washington, DC

December 8-11, 2008

22

The Efficient Windows Collaborative

Efficient Windows Collaborative

Minneapolis, Minnesota

ENERGY STAR® Properties

Window Search

Select Glass: [All glass types]

Select Frame: [All frame types]

ENERGY STAR: Yes

Construction Type: New Existing

Product Type: Windows Skylights

Search for Windows

Window Type	Properties	Annual Energy Use	ENERGY STAR Qualified	Manufacturer Information
Product: Single glazed with Low-E, Argon Gas	U = .24 SHGC = .25 VT = .55	[Bar chart showing energy use]	✓	Products
Product: Single glazed with Low-E, Argon Gas	U = .24 SHGC = .25 VT = .55	[Bar chart showing energy use]	✓	Products
Product: Single glazed with Low-E, Argon Gas	U = .24 SHGC = .25 VT = .55	[Bar chart showing energy use]	✓	Products
Product: Single glazed with Low-E, Argon Gas	U = .24 SHGC = .25 VT = .55	[Bar chart showing energy use]	✓	Products
Product: Single glazed with Low-E, Argon Gas	U = .24 SHGC = .25 VT = .55	[Bar chart showing energy use]	✓	Products
Product: Single glazed with Low-E, Argon Gas	U = .24 SHGC = .25 VT = .55	[Bar chart showing energy use]	✓	Products
Product: Single glazed with Low-E, Argon Gas	U = .24 SHGC = .25 VT = .55	[Bar chart showing energy use]	✓	Products
Product: Single glazed with Low-E, Argon Gas	U = .24 SHGC = .25 VT = .55	[Bar chart showing energy use]	✓	Products
Product: Single glazed with Low-E, Argon Gas	U = .24 SHGC = .25 VT = .55	[Bar chart showing energy use]	✓	Products
Product: Single glazed with Low-E, Argon Gas	U = .24 SHGC = .25 VT = .55	[Bar chart showing energy use]	✓	Products

Center for Sustainable Building Research

College of Design

University of Minnesota

EcoBuild Fall: Washington, DC

December 8-11, 2008

23

The Efficient Windows Collaborative

Efficient Windows Collaborative

Minneapolis, Minnesota

ENERGY STAR® Properties

Window Search

Select Glass: [All glass types]

Select Frame: [All frame types]

ENERGY STAR: Yes

Construction Type: New Existing

Product Type: Windows Skylights

Search for Windows

Window Type	Properties	Annual Energy Use	ENERGY STAR Qualified	Manufacturer Information
Product: Single glazed with Low-E, Argon Gas	U = .24 SHGC = .25 VT = .55	[Bar chart showing energy use]	✓	Products
Product: Single glazed with Low-E, Argon Gas	U = .24 SHGC = .25 VT = .55	[Bar chart showing energy use]	✓	Products
Product: Single glazed with Low-E, Argon Gas	U = .24 SHGC = .25 VT = .55	[Bar chart showing energy use]	✓	Products
Product: Single glazed with Low-E, Argon Gas	U = .24 SHGC = .25 VT = .55	[Bar chart showing energy use]	✓	Products
Product: Single glazed with Low-E, Argon Gas	U = .24 SHGC = .25 VT = .55	[Bar chart showing energy use]	✓	Products
Product: Single glazed with Low-E, Argon Gas	U = .24 SHGC = .25 VT = .55	[Bar chart showing energy use]	✓	Products
Product: Single glazed with Low-E, Argon Gas	U = .24 SHGC = .25 VT = .55	[Bar chart showing energy use]	✓	Products
Product: Single glazed with Low-E, Argon Gas	U = .24 SHGC = .25 VT = .55	[Bar chart showing energy use]	✓	Products
Product: Single glazed with Low-E, Argon Gas	U = .24 SHGC = .25 VT = .55	[Bar chart showing energy use]	✓	Products
Product: Single glazed with Low-E, Argon Gas	U = .24 SHGC = .25 VT = .55	[Bar chart showing energy use]	✓	Products

Center for Sustainable Building Research

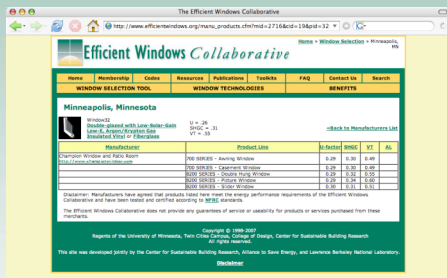
College of Design

University of Minnesota

EcoBuild Fall: Washington, DC

December 8-11, 2008

24



RESFEN

for Calculating the Heating and Cooling Energy Use of Windows in Residential Buildings

RESFEN can be used to run performance comparisons of different window and skylight options and to calculate annual energy use, peak heating and cooling loads, and costs.



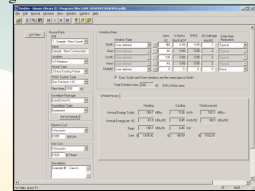
Calculates the heating and cooling energy use of a building:

- for a specific house
- in a specific location
- with specific window products

Compares different window options

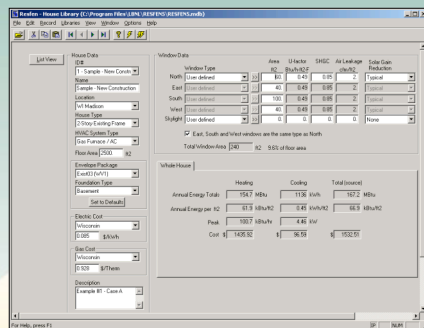
Helps select energy-efficient windows

windows.lbl.gov/software/resfen/resfen.html



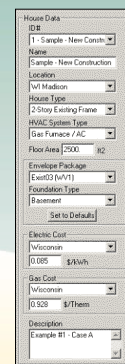
RESFEN

- Location
- House Description
- Window Description



RESFEN

- Location
 - 250+ cities
- Number of stories
 - 1 or 2
- Construction
 - Frame
 - Masonry
- Foundation type
 - Slab
 - Crawlspace
 - Basement
- HVAC System
 - Furnace
 - Heat Pump
- Floor area
- Utility costs
 - defaults by location
 - can be edited



RESFEN

- Describe by orientation
 - Size of windows (SF or % of Floor area)
 - U-factor
 - SHGC
 - Infiltration (CFM/F²)
 - Solar Gain Reduction
 - Overhangs
 - Interior drapes
 - Neighboring buildings (obstructions)

Window Type	Area sq ft	U-factor Btu/h·ft ² ·°F	SHGC	Air Leakage cfm/f ²	Solar Gain Reduction
North: [Window Type] [Low-E]	22	0.25	0.56	2	Typical
East: [Window Type] [Low-E]	40	0.25	0.56	2	Typical
South: [Window Type] [Low-E]	100	0.25	0.56	2	Typical
West: [Window Type] [Low-E]	40	0.25	0.56	2	Typical
Skylight: [Window Type] [Low-E]	0	0	0	0	None

☒ East, South and West windows are the same type as North

Total Window Area: [500] H2: 9.6% of floor area

www.efficientwindows.org

Toolkit for Builders
 Toolkit for Manufacturers
 Toolkit for Designers

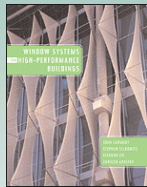
Window Selection Tool

State Fact Sheets

Benefits & Technologies

Code Information

Efficient Windows Collaborative

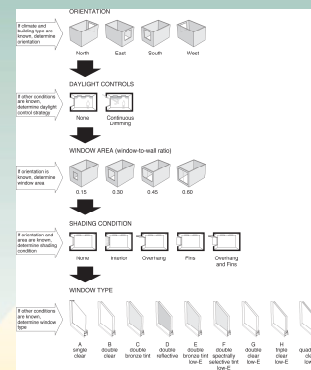


Commercial Tools and Information

- Book: "Window Systems for High Performance Buildings"
- Web site
 - www.commercialwindows.umn.edu
 - 2006 Crystal Achievement Award from Glass Magazine
 - www.commercialwindows.org
 - Prototype—in development
- Education and training materials
- COMFEN



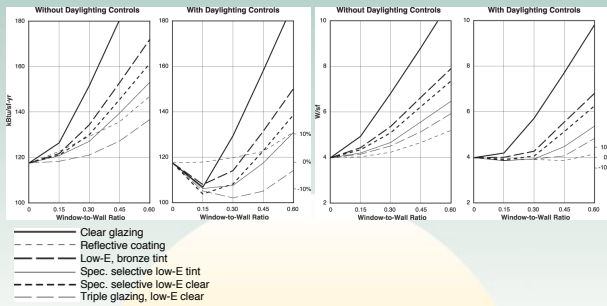
Decision-making Process



Energy-related Issues

Annual energy use and peak demand comparison by lighting system

All cases are in Chicago and south-facing with no shading. Numbers are expressed per sf within a 15 foot deep perimeter zone.



Center for Sustainable Building Research

College of Design
UNIVERSITY OF MINNESOTA

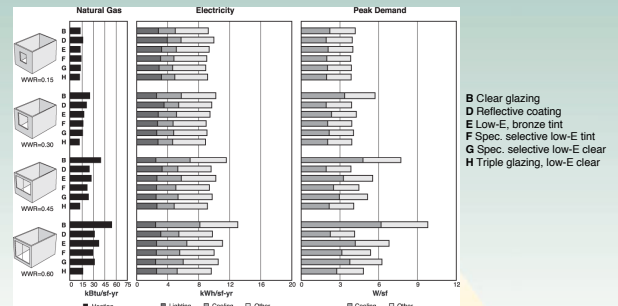
EcoBuild Fall: Washington, DC
December 8-11, 2008

33

Energy-related Issues

Annual energy use and peak demand comparison by window area

All cases are in Chicago and south-facing with no shading and daylighting controls. Numbers are expressed per sf within a 15 foot deep perimeter zone.



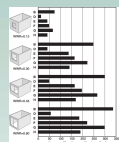
Center for Sustainable Building Research

College of Design
UNIVERSITY OF MINNESOTA

EcoBuild Fall: Washington, DC
December 8-11, 2008

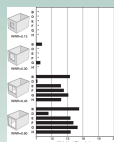
34

Human Factor Issues



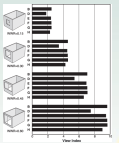
Average Daylight Illuminance

Average daylight illuminance is calculated at a point 10 feet from the window. All cases are in Chicago and south-facing with no shading.



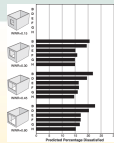
Weighted Glare Index

Glare index is calculated at a point 5 feet from the window for a person facing the side wall. A lower index is better. All cases are in Chicago and south-facing with no shading.



View Index

View index is calculated at a point 10 feet from the window. A higher index is better. All cases are in Chicago and south-facing with no shading.



Thermal Comfort

Thermal comfort is calculated at a point 5 feet from the window. A lower PPD is better. All cases are in Chicago and south-facing with no shading.



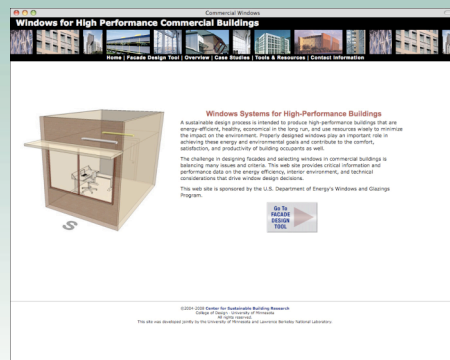
Center for Sustainable Building Research

College of Design
UNIVERSITY OF MINNESOTA

EcoBuild Fall: Washington, DC
December 8-11, 2008

35

www.commercialwindows.org



Center for Sustainable Building Research

College of Design
UNIVERSITY OF MINNESOTA

EcoBuild Fall: Washington, DC
December 8-11, 2008

36

Façade Design Tool

Welcome to the Façade Design Tool

The Façade Design Tool lets you choose the design conditions of a window and rank and compare the performance data in terms of annual energy, peak demand, carbon, daylight illuminance, glare, and thermal comfort.

1. First select a location.
2. Then select a building type.
3. After a location and type have been selected, you have the choice to Rank or Compare the performance data of window design options that you define in terms of orientation, window area, daylight controls, interior shades, exterior shades, and window type. If you need more information regarding the design conditions, [click here](#).

Locations: [Dropdown Menu]

Building Type: [Dropdown Menu]

Rank Set design conditions and use a ranking of performance information in Boston, MA.

Compare Set design conditions and compare performance information between four options in Boston, MA.

©2008-2009 Center for Sustainable Building Research
College of Design, University of Minnesota
This site was developed jointly by the University of Minnesota and Lawrence Berkeley National Laboratory.



Center for Sustainable Building Research

College of Design
UNIVERSITY OF MINNESOTA

EcoBuild Fall: Washington, DC
December 8-11, 2008

37

Façade Design Tool

Define Design Condition to Rank

Orientation: [Dropdown Menu] **Window Area:** [Dropdown Menu] **Daylight Controls:** [Dropdown Menu] **Interior Shades:** [Dropdown Menu] **Exterior Shades:** [Dropdown Menu] **Window:** [Dropdown Menu]

How to Perform a Design Ranking

1. Choose the design attributes to define the condition(s) you want to use to rank. You must choose a specific attribute. The other attributes can be set to "All" or "Specifically Defined".
2. If you need more information regarding the design conditions, [click here](#).
3. Click the Rank Design Condition button to see the results for annual energy, peak demand, carbon, daylight illuminance, glare, and thermal comfort.
4. Once the results are displayed, you can modify the design condition to view other results.

©2008-2009 Center for Sustainable Building Research
College of Design, University of Minnesota
This site was developed jointly by the University of Minnesota and Lawrence Berkeley National Laboratory.



Center for Sustainable Building Research

College of Design
UNIVERSITY OF MINNESOTA

EcoBuild Fall: Washington, DC
December 8-11, 2008

38

Façade Design Tool

Ranking Performance in Boston, Massachusetts

Rank	Orientation	Window Area	Daylight Controls	Interior Shades	Exterior Shades	Window	Annual Energy (kWh)	Peak Demand (kW)	Carbon (kg)	Daylight Illuminance (lux)	Glare (DGP)	Thermal Comfort (PPD)
1	South	100%	No Controls	No	No	Double Low-E Clear	10000	100	1000	1000	1000	1000
2	South	100%	No Controls	No	No	Double Low-E Tint	10000	100	1000	1000	1000	1000
3	South	100%	No Controls	No	No	Double Low-E Bronze Tint	10000	100	1000	1000	1000	1000
4	South	100%	No Controls	No	No	Double Low-E Clear Tint	10000	100	1000	1000	1000	1000

©2008-2009 Center for Sustainable Building Research
College of Design, University of Minnesota
This site was developed jointly by the University of Minnesota and Lawrence Berkeley National Laboratory.



Center for Sustainable Building Research

College of Design
UNIVERSITY OF MINNESOTA

EcoBuild Fall: Washington, DC
December 8-11, 2008

39

Façade Design Tool

Compare Performance Options in Boston, Massachusetts

Scenario	Orientation	Window Area	Daylight Controls	Interior Shades	Exterior Shades	Window
Scenario 1	South	100%	No Controls	No	No	Double Low-E Clear
Scenario 2	South	100%	No Controls	No	No	Double Low-E Tint
Scenario 3	South	100%	No Controls	No	No	Double Low-E Bronze Tint
Scenario 4	South	100%	No Controls	No	No	Double Low-E Clear Tint

How to Perform a Comparison

1. Choose the design conditions for each of the 4 scenarios in which to compare.
2. If you need more information regarding the design conditions, [click here](#).
3. Click the Compare Design Conditions button to see the results for annual energy, peak demand, carbon, daylight illuminance, glare, and thermal comfort.
4. Once the results are displayed, you can modify the design conditions to view other comparisons.

©2008-2009 Center for Sustainable Building Research
College of Design, University of Minnesota
This site was developed jointly by the University of Minnesota and Lawrence Berkeley National Laboratory.



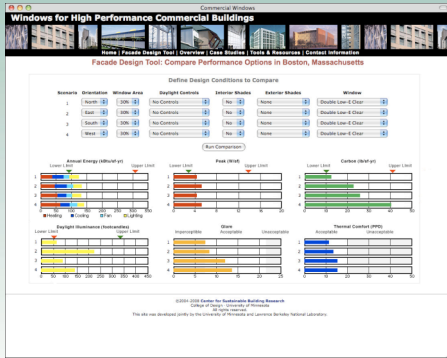
Center for Sustainable Building Research

College of Design
UNIVERSITY OF MINNESOTA

EcoBuild Fall: Washington, DC
December 8-11, 2008

40

Façade Design Tool



Center for Sustainable Building Research

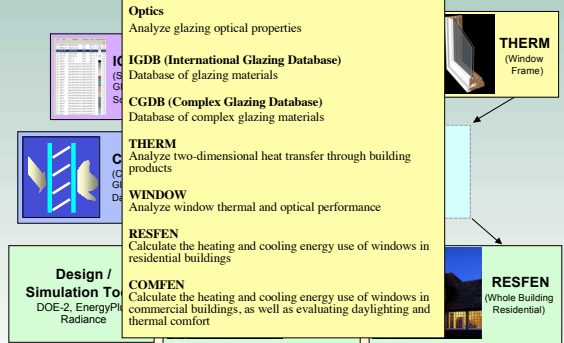
College of Design
UNIVERSITY OF MINNESOTA

EcoBuild Fall: Washington, DC
December 8-11, 2008

41

Tools to Determine Window Performance

Developed by: Lawrence Berkeley National Lab



Center for Sustainable Building Research

College of Design
UNIVERSITY OF MINNESOTA

EcoBuild Fall: Washington, DC
December 8-11, 2008

42

COMFEN Version 1 A Computer Tool to Optimize Commercial Building Façade Design

- Up to four comparative façade cases
- Multiple glazing and exterior shading options on each façade
- EnergyPlus simulation engine
- Graphical Output
 - Energy Consumption (Heating/Cooling/Fans/Lighting)
 - Peak Demand
 - CO₂ Emissions
 - Daylighting Illuminance
 - Visual and Thermal Comfort Indices



windows.lbl.gov/software/comfen/1/



Center for Sustainable Building Research

College of Design
UNIVERSITY OF MINNESOTA

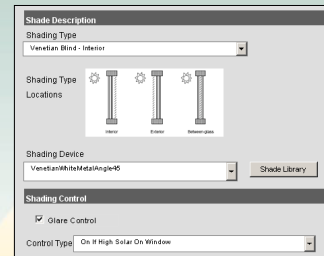
EcoBuild Fall: Washington, DC
December 8-11, 2008

43

COMFEN Version 2

New Features:

- Location Library – can add new cities
- Glazing System Library – create custom glazing systems
- Shading Systems – create custom shading systems



Center for Sustainable Building Research

College of Design
UNIVERSITY OF MINNESOTA

EcoBuild Fall: Washington, DC
December 8-11, 2008

44

COMFEN: Façade Library–Add Windows

Façade Layout

Display: All Windows # of Window: 1

Overhangs: # of Overhangs: 1 Display: All Overhangs

Section

Plan

Windows

Window	SB Height (feet)	Dist From Left Wall (feet)	Height (feet)	Width (feet)	Area (sq ft)	Window Setback (feet)	Glazing System	Tint	SHGC (Bulfinch)	U-Factor (Bulfinch)	Frame Type	Frame Width (inches)
1	6	1	3	10	30	0	Double Low-E Glass	0.443	0.481	0.311	Aluminum	2
2	1	1	4	5	20	0	Double Low-E Glass	0.443	0.481	0.311	Aluminum	2
3	1	7.75	4	5	20	0	Double Low-E Glass	0.443	0.481	0.311	Aluminum	2
4	1	16	4	5	20	0	Double Low-E Glass	0.443	0.481	0.311	Aluminum	2



Center for Sustainable Building Research

College of Design
UNIVERSITY OF MINNESOTA

EcoBuild Fall, Washington, DC
December 8-11, 2008

45

COMFEN: Façade Library–Add Overhangs

Façade Layout

Display: All Windows # of Window: 1

Overhangs: # of Overhangs: 1 Display: All Overhangs

Section

Plan

Windows

Window	SB Height (feet)	Dist From Left Wall (feet)	Height (feet)	Width (feet)	Area (sq ft)	Window Setback (feet)	Glazing System	Tint	SHGC (Bulfinch)	U-Factor (Bulfinch)	Frame Type	Frame Width (inches)
1	6	1	3	10	30	0	Double Clear Air (Res)	0.704	0.704	0.474	Aluminum	2
2	1	1	4	5	20	0	Double Clear Air (Res)	0.704	0.704	0.474	Aluminum	2
3	1	7.75	4	5	20	0	Double Clear Air (Res)	0.704	0.704	0.474	Aluminum	2
4	1	16	4	5	20	0	Double Clear Air (Res)	0.704	0.704	0.474	Aluminum	2



Center for Sustainable Building Research

College of Design
UNIVERSITY OF MINNESOTA

EcoBuild Fall, Washington, DC
December 8-11, 2008

46

COMFEN: Façade Library–Add Fins

Façade Layout

Display: All Windows # of Window: 4

Overhangs: # of Overhangs: 1 Display: All Overhangs

Section

Plan

Windows

Window	SB Height (feet)	Dist From Left Wall (feet)	Height (feet)	Width (feet)	Area (sq ft)	Window Setback (feet)	Glazing System	Tint	SHGC (Bulfinch)	U-Factor (Bulfinch)	Frame Type	Frame Width (inches)
1	6	1	3	10	30	0	Double Spec. Sol Low-E Clear	0.703	0.381	0.291	Aluminum	2
2	1	1	4	5	20	0	Double Spec. Sol Low-E Clear	0.703	0.381	0.291	Aluminum	2
3	1	7.75	4	5	20	0	Double Spec. Sol Low-E Clear	0.703	0.381	0.291	Aluminum	2
4	1	16	4	5	20	0	Double Spec. Sol Low-E Clear	0.703	0.381	0.291	Aluminum	2



Center for Sustainable Building Research

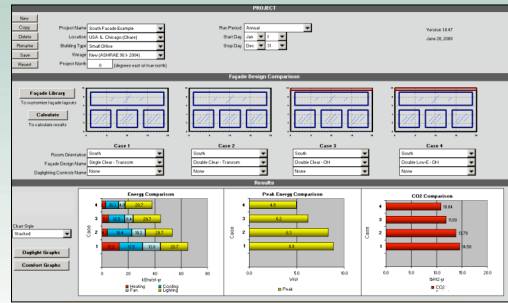
College of Design
UNIVERSITY OF MINNESOTA

EcoBuild Fall, Washington, DC
December 8-11, 2008

47

COMFEN: Glazing and Shading Example

- Location = Chicago
- Results show decrease in Annual Energy Consumption based on high efficiency glazing and overhangs



Center for Sustainable Building Research

College of Design
UNIVERSITY OF MINNESOTA

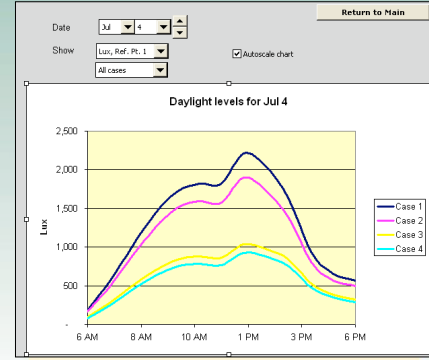
EcoBuild Fall, Washington, DC
December 8-11, 2008

48

COMFEN: Monthly Results

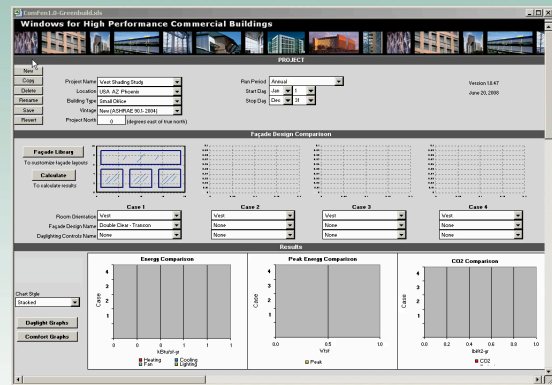
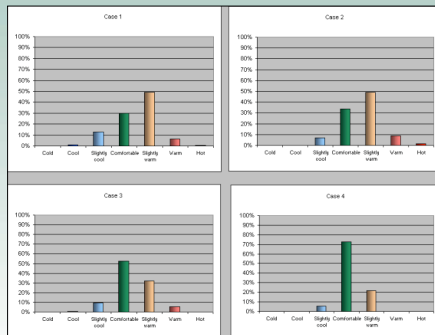


COMFEN: Daylighting Results



COMFEN: Thermal Comfort Results

- Highest comfort rating results from high efficiency glazing with exterior overhang (Case 4)



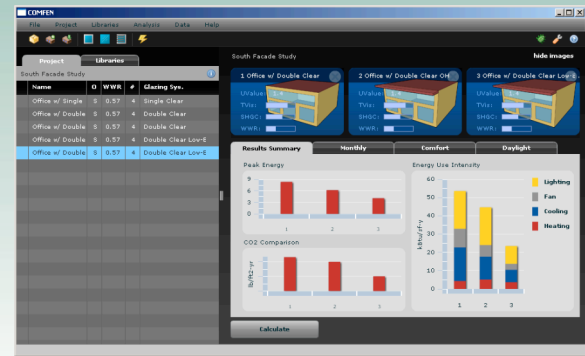
COMFEN 3 – The Next Version

‘Sketching’ with Simulation?

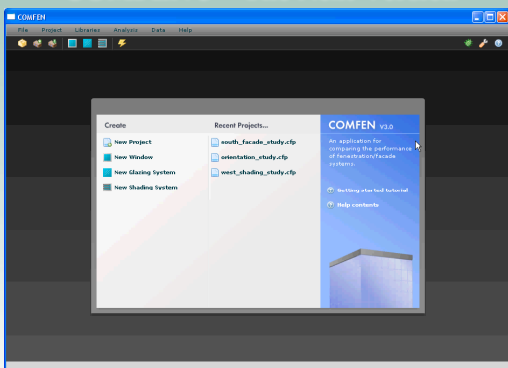
- What if building performance analysis took the lead from architects?
 - Don’t make early design performance sketches with limited sketching ‘tools’
 - Use the best performance analysis ‘tools’
- To sketch with Radiance or Energy+?
 - The simulation model is a ‘sketch’ / idealisation of the building itself – to explore an idea
 - Rapid turnaround of performance analysis ideas using validated, trustable performance calculation engines
- Improved, stand-alone GUI interface
- Uses a project and scenario paradigm for use pattern
 - A ‘project’ might be School X in City A or Office Y in City B
 - A ‘scenario’ is a combination of window, glazing and shading in the School or Office



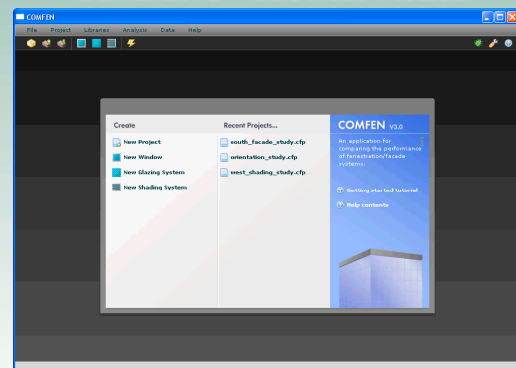
COMFEN 3 – The Next Version



COMFEN 3 – The Next Version

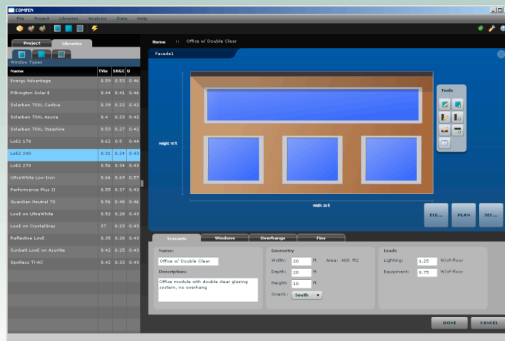


COMFEN 3 – The Next Version



COMFEN 3 – The Next Version

Facade Design: Drag and drop library selection for windows, glazing systems, and shading systems



Center for Sustainable Building Research

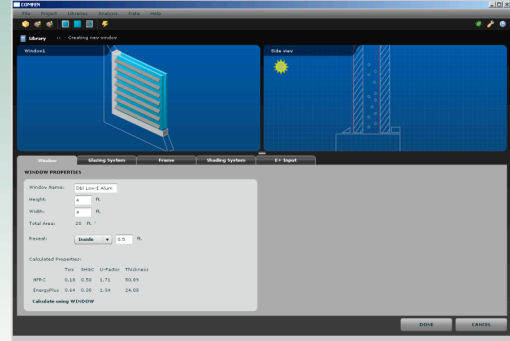
College of Design
UNIVERSITY OF MINNESOTA

EcoBuild Fall: Washington, DC
December 8-11, 2008

57

COMFEN 3 – The Next Version

Window Library: Define the **geometry** of the window



Center for Sustainable Building Research

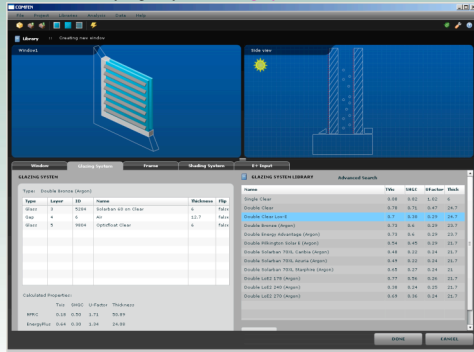
College of Design
UNIVERSITY OF MINNESOTA

EcoBuild Fall: Washington, DC
December 8-11, 2008

58

COMFEN 3 – The Next Version

Window Library: Specify the **Glazing System** for the window



Center for Sustainable Building Research

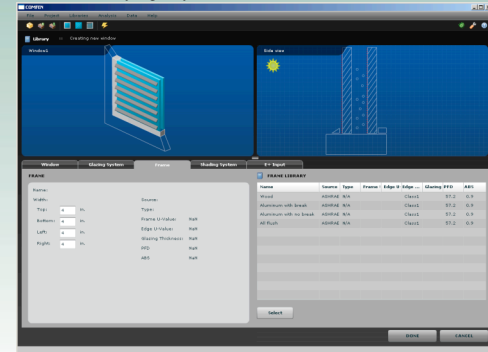
College of Design
UNIVERSITY OF MINNESOTA

EcoBuild Fall: Washington, DC
December 8-11, 2008

59

COMFEN 3 – The Next Version

Window Library: Specify the **Frame** for the window



Center for Sustainable Building Research

College of Design
UNIVERSITY OF MINNESOTA

EcoBuild Fall: Washington, DC
December 8-11, 2008

60

Window Library: Specify the **Shading System** for the window



Downloaded from <http://ajph.org/> at University of California, San Diego on June 11, 2015



Sources and Links

CSBR Center for Sustainable Building Research College of Design
UNIVERSITY OF MINNESOTA **EcoBuild Fall: Washington, DC**
December 8-11, 2008

Contact Information

CSBR Center for Sustainable Building Research
College of Design
UNIVERSITY OF MINNESOTA
EcoBuild Fall: Washington, DC
December 8-11, 2008