ESL-TR-03-12-06

TEST FOR MODELING WINDOWS IN DOE 2.1E FOR COMPARING THE WINDOW LIBRARY WITH THE SHADING COEFFICIENT METHOD FOR A SINGLE-FAMILY RESIDENCE IN TEXAS

A Project for Texas' Senate Bill 5 Legislation For Reducing Pollution In Non-Attainment and Affected Areas

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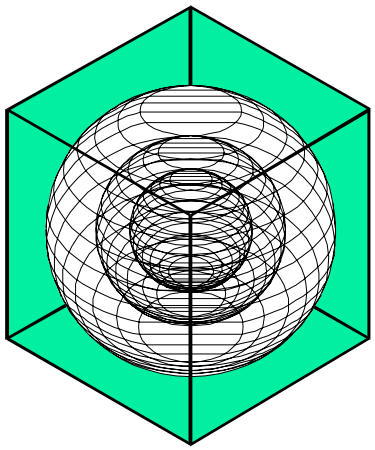

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ABSTRACT

This study examines the difference of the window simulation test between the Shading Coefficient (SC) and the Window Library (WL) Methods on DOE 2.1E of the 2000 IECC (International Energy Conservation Code) for single-family residences in Texas. The window simulation tests are performed using single-pane, double-pane, and low-e glass on two standard DOE 2.1E single-family house models: 1) the model which has the R-value for wall, roof and floor according to 2000 IECC (Quick Wall), and 2) the model which has the real wood frame wall and has the same R-value as the first one (Thermal Wall).

The analysis showed different results according to the types of the glass, simulation method (Shading Coefficient or Window Library), and types of wall (quick wall and thermal wall). The saving of daily peak heating (kBtu/day) from single-pane to low-e glass on thermal mass and quick wall shows the most variation.

This report, with the attached CD-ROM, includes all DOE-2 input files that were used in this study and documents that were used for this research.

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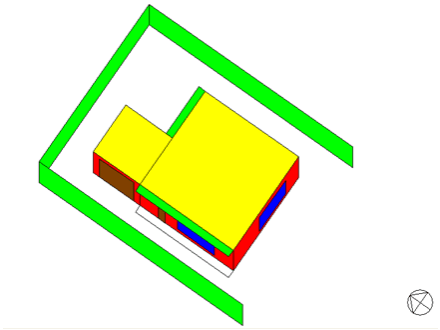
TABLES

1 Base Case DOE-2e Model (IECC1105.inp)

The thermal properties construction materials such as wall, roof, window, and floor of the base case model are based on the International Energy Conservation Code 2000 (IECC 2000). The inputs include assumptions about Chapters 4 and 5 of IECC 2000 to describe the standard house.

Table 1. House dimension / heating and cooling controls of the base case house.

Parameter	Value	DrawBDL of input file
Length*Width*Height	50ft * 50ft * 8ft	
Window Ratio of Wall	15 %	
Room Temp.	73 °F	
Heating	68 °F	
Cooling	78 °F	
Set back / Set up	5 °F	

* Room temperature is the average value of winter and summer set points that are taken from Table 402.1.3.5 of IECC 2000. Set back is adjusted in systems.

Window dimensions

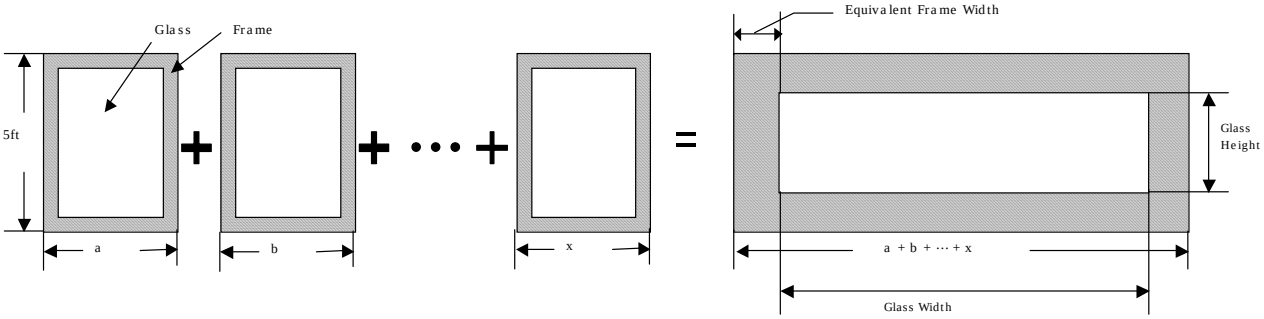


Figure 1. Window simulation.

Table 2. Window size for simulation (15 % of wall area).

Glass Height (ft) for DOE input	Glass Width (ft) for DOE input	Equivalent Frame Width (ft) for DOE input
11.53	4.53	0.2344

- Original Window size: 12ft * 5ft = 60 ft^2 (15 % of wall area), frame width: 0.125 ft.

2 Simulation Input Files

There are 12 input files for testing window simulation according to the kinds of windows and wall properties.

Table 3. Name of simulation input files.

	Single pane	Double Pane	Double Pane Low-e
Quick Wall	Shading Coefficient quick_sc_single.inp	Shading Coefficient quick_sc_double.inp	Shading Coefficient quick_sc_lowe.inp
	Window Library quick_lib_single.inp	Window Library quick_lib_double.inp	Window Library quick_lib_lowe.inp
Thermal Mass	Shading Coefficient thermal_sc_single.inp	Shading Coefficient thermal_sc_double.inp	Shading Coefficient thermal_sc_lowe.inp
	Window Library thermal_lib_single.inp	Window Library thermal_lib_double.inp	Window Library thermal_lib_lowe.inp

3 Summary of Results

Table 4. Summary of results.

Glass Type		Shading Coefficient Saving. (%)		Window Library Saving. (%)		Diff. (%) (SC-WL)	((SC-WC)/WC) *100
Quick mode	SP→DP	Annual BEPS (mBtu)	-5.7	Annual BEPS (mBtu)	-6.0	0.3	-5.3
		Hourly Peak Cooling (kBtu/hr)	-8.9	Hourly Peak Cooling (kBtu/hr)	-10.3	1.4	-15.7
		Daily Peak Cooling (kBtu/day)	-7.6	Daily Peak Cooling (kBtu/day)	-8.3	0.7	9.2
		Hourly Peak Heating (kBtu/hr)	-15.9	Hourly Peak Heating (kBtu/hr)	-15.7	-0.2	1.3
		Daily Peak Heating (kBtu/day)	-19.7	Daily Peak Heating (kBtu/day)	-18.4	-1.3	6.6
	SP→ Low-e	Annual BEPS (mBtu)	-12.3	Annual BEPS (mBtu)	-11.8	-0.5	4.1
		Hourly Peak Cooling (kBtu/hr)	-30.7	Hourly Peak Cooling (kBtu/hr)	-29.7	-1.0	3.3
		Daily Peak Cooling (kBtu/day)	-26.7	Daily Peak Cooling (kBtu/day)	-25.4	-1.3	4.9
		Hourly Peak Heating (kBtu/hr)	-21.1	Hourly Peak Heating (kBtu/hr)	-21.2	0.1	0.5
		Daily Peak Heating (kBtu/day)	-7.3	Daily Peak Heating (kBtu/day)	-9.5	2.2	-30.14
	DP→ Low-e	Annual BEPS (mBtu)	-6.9	Annual BEPS (mBtu)	-6.1	-0.8	11.6
		Hourly Peak Cooling (kBtu/hr)	-23.9	Hourly Peak Cooling (kBtu/hr)	-21.6	-2.3	9.6
		Daily Peak Cooling (kBtu/day)	-20.7	Daily Peak Cooling (kBtu/day)	-18.7	-2.0	9.7
		Hourly Peak Heating (kBtu/hr)	-6.2	Hourly Peak Heating (kBtu/hr)	-6.5	0.3	-4.8
		Daily Peak Heating (kBtu/day)	15.47	Daily Peak Heating (kBtu/day)	10.92	4.6	29.7
Thermal mass mode	SP→DP	Annual BEPS (mBtu)	-4.4	Annual BEPS (mBtu)	-4.6	0.2	-4.5
		Hourly Peak Cooling (kBtu/hr)	-8.7	Hourly Peak Cooling (kBtu/hr)	-8.0	-0.7	8.0
		Daily Peak Cooling (kBtu/day)	-6.0	Daily Peak Cooling (kBtu/day)	-6.5	0.5	-8.3
		Hourly Peak Heating (kBtu/hr)	-14.8	Hourly Peak Heating (kBtu/hr)	-14.3	-0.5	3.4
		Daily Peak Heating (kBtu/day)	-17.8	Daily Peak Heating (kBtu/day)	-16.7	-1.1	6.2
	SP→ Low-e	Annual BEPS	-8.8	Annual BEPS	-8.4	0.4	4.5
		Hourly Peak Cooling (kBtu/hr)	-26.9	Hourly Peak Cooling (kBtu/hr)	-24.2	2.7	-10.0
		Daily Peak Cooling (kBtu/day)	-23.1	Daily Peak Cooling (kBtu/day)	-21.5	-1.6	6.9
		Hourly Peak Heating (kBtu/hr)	-16.3	Hourly Peak Heating (kBtu/hr)	-16.3	0.0	0.0
		Daily Peak Heating (kBtu/day)	-6.2	Daily Peak Heating (kBtu/day)	-8.3	2.1	-33.9
	DP→ Low-e	Annual BEPS (mBtu)	-4.6	Annual BEPS	-4.0	0.6	-13.0
		Hourly Peak Cooling (kBtu/hr)	-19.9	Hourly Peak Cooling (kBtu/hr)	-17.6	2.3	-11.6
		Daily Peak Cooling (kBtu/day)	-18.1	Daily Peak Cooling (kBtu/day)	-16.0	-2.1	11.6
		Hourly Peak Heating (kBtu/hr)	-1.7	Hourly Peak Heating (kBtu/hr)	-2.4	-0.7	41.2
		Daily Peak Heating (kBtu/day)	14.2	Daily Peak Heating (kBtu/day)	10.1	4.1	28.9

Quick Wall

The following are DOE input files of single-pane, double-pane and low-e glass with the Shading Coefficient and Window Library Method on quick wall and the DOE output file from those input files.

3.1 Single Pane Simulation

Input of Single Pane:

Shading Coefficient (quick_sc_single.inp)

```
W-1 = GLASS-TYPE
          SHADING-COEF = 1                      $(0 TO 1)
          PANES = 1                             $MIN=1,MAX=3
          GLASS-CONDUCTANCE = 1.434             $(BTU/HR.FT^2.F)
          VIS-TRANS = .898                      $DOE-2 DEFAULT = 0.9(0 TO 1)
          FRAME-CONDUCTANCE = 3.037             $DOE-2 DEFAULT = 0.434(BTU/HR.FT^2.F)
          FRAME-ABS = 0.9                       $DOE-2 DEFAULT = 0.7(0 TO 1)
                     ..                         $END OF GLASS-TYPE COMMAND

W-F-1 = WINDOW
             WIDTH = 11.53                    $(FT)
             HEIGHT = 4.53                    $(FT)
             X = P-BUILDINGLENGTH TIMES 0.4
             Y = 1                            $COORDINATES
             SETBACK = 0.0                    $(FT)
             GLASS-TYPE = W-1
             FRAME-WIDTH = .2344              $EXPLANATION IN THE PARAMETER SECTION
             SKY-FORM-FACTOR = 0.5            $ARBITRARY VALUE(0 TO 1)
             GND-FORM-FACTOR = 0.5            $ARBITRARY VALUE(0 TO 1)
             SHADING-DIVISIONS = 10           $DOE-2 DEFAULT, (0 TO 40)UNITS
                       ..                     $END OF WINDOW COMMAND
```

Window Library (quick_lib_single.inp)

```
W-1 = GLASS-TYPE
          GLASS-TYPE-CODE = 1000
          FRAME-CONDUCTANCE = 3.037             $DOE-2 DEFAULT = 0.434(BTU/HR.FT^2.F)
          FRAME-ABS = 0.9                       $DOE-2 DEFAULT = 0.7(0 TO 1)
                     ..                         $END OF GLASS-TYPE COMMAND

W-F-1 = WINDOW
             WIDTH = 11.53                    $(FT)
             HEIGHT = 4.53                    $(FT)
             X = P-BUILDINGLENGTH TIMES 0.4
             Y = 1                            $COORDINATES
             SETBACK = 0.0                    $(FT)
             GLASS-TYPE = W-1
             FRAME-WIDTH = .2344              $EXPLANATION IN THE PARAMETER SECTION
             SKY-FORM-FACTOR = 0.5            $ARBITRARY VALUE(0 TO 1)
             GND-FORM-FACTOR = 0.5            $ARBITRARY VALUE(0 TO 1)
             SHADING-DIVISIONS = 10           $DOE-2 DEFAULT, (0 TO 40)UNITS
                       ..                     $END OF WINDOW COMMAND
```

Table 5. Window Library for Single Pane.

									LAY1		GAP1		LAY2	
ID	U-SI	U-IP	SC	SHGC	Tsol	Rfsol	Tvis	Rfvis	ID	WID	GAS	WID	ID	WID
1000	6.31	**1.118**	**1.00**	.86	.84	.08	.90	.08	2	3.0				

Uall = 1/(1/Ucenter - .197) = 1/(1/1.118 - .197) = **1.434**

DOE Output for Glazing (Single Pane):

REPORT- LV-C

Shading Coefficient (quick_sc_single.out)

EXTERIOR WINDOWS (U-VALUE INCLUDES OUTSIDE AIR FILM)

GLASS HEIGHT (FT)	CENTER-OF-GLASS WINDOW	GLASS U-VALUE (BTU/HR-SQFT-F)	VISIBLE MULTIPLIER TRANS	GLASS AREA (SQFT)	GLASS SHADING COEFF	NUMBER OF PANES	GLASS TYPE CODE	SET-BACK (FT)	GLASS WIDTH (FT)
4.53	W-F-1	1.120	1.0 0.898	52.25	1.00	1	1	0.00	11.53
4.53	W-R-1	1.120	1.0 0.898	52.25	1.00	1	1	0.00	11.53
4.53	W-B-1	1.120	1.0 0.898	52.25	1.00	1	1	0.00	11.53
4.53	W-L-1	1.120	1.0 0.898	52.25	1.00	1	1	0.00	11.53

Window Library (quick_lib_single.out)

EXTERIOR WINDOWS (U-VALUE INCLUDES OUTSIDE AIR FILM)

GLASS HEIGHT (FT)	CENTER-OF-GLASS WINDOW	GLASS U-VALUE (BTU/HR-SQFT-F)	VISIBLE MULTIPLIER TRANS	GLASS AREA (SQFT)	GLASS SHADING COEFF	NUMBER OF PANES	GLASS TYPE CODE	SET-BACK (FT)	GLASS WIDTH (FT)
4.53	W-F-1	1.118	1.0 0.898	52.25	1.00	1	1000	0.00	11.53
4.53	W-R-1	1.118	1.0 0.898	52.25	1.00	1	1000	0.00	11.53
4.53	W-B-1	1.118	1.0 0.898	52.25	1.00	1	1000	0.00	11.53
4.53	W-L-1	1.118	1.0 0.898	52.25	1.00	1	1000	0.00	11.53

DOE Output for Glazing (Single Pane):

REPORT- LV-D

Shading Coefficient (quick_sc_single.out)

(U-VALUE INCLUDES OUTSIDE AIR FILM; WINDOW INCLUDES FRAME, IF DEFINED)

-W A L L + W I N D O W S- SURFACE	SPACE		- - - W I N D O W S - - - U-VALUE (BTU/HR-SQFT-F)	AREA (SQFT)	- - - - W A L L - - - - U-VALUE (BTU/HR-SQFT-F)	AREA (SQFT)
BACK-1	RM-1		1.221	59.98	0.075	340.02
0.247	400.00	NORTH				
RIGHT-1	RM-1		1.221	59.98	0.075	340.02
0.247	400.00	EAST				
FRONT-1	RM-1		1.221	59.98	0.075	340.02
0.247	400.00	SOUTH				
LEFT-1	RM-1		1.221	59.98	0.075	164.02
0.382	224.00	WEST				

Window Library (Window ID:1000) (quick_lib_single.out)

-W A L L + W I N D O W S- SURFACE	SPACE		- - - W I N D O W S - - - U-VALUE (BTU/HR-SQFT-F)	AREA (SQFT)	- - - - W A L L - - - - U-VALUE (BTU/HR-SQFT-F)	AREA (SQFT)
BACK-1	RM-1		1.220	59.98	0.075	340.02
0.246	400.00	NORTH				
RIGHT-1	RM-1		1.220	59.98	0.075	340.02
0.246	400.00	EAST				
FRONT-1	RM-1		1.220	59.98	0.075	340.02
0.246	400.00	SOUTH				
LEFT-1	RM-1		1.220	59.98	0.075	164.02
0.381	224.00	WEST				

3.2 Double Pane Simulation

Input of Double Pane:

Shading Coefficient (quick_sc_double.inp)

```
W-1 = GLASS-TYPE
          SHADING-COEF = .88                    $(0 TO 1)
          PANES = 2                             $MIN=1,MAX=3
          GLASS-CONDUCTANCE = .653              $(BTU/HR.FT^2.F)
          VIS-TRANS = .812                      $DOE-2 DEFAULT = 0.9(0 TO 1)
          FRAME-CONDUCTANCE = 3.037             $DOE-2 DEFAULT = 0.434(BTU/HR.FT^2.F)
          FRAME-ABS = 0.9                       $DOE-2 DEFAULT = 0.7(0 TO 1)
                    ..                          $END OF GLASS-TYPE COMMAND

W-F-1 = WINDOW
             WIDTH = 11.53                    $(FT)
             HEIGHT = 4.53                    $(FT)
             X = P-BUILDINGLENGTH TIMES 0.4
             Y = 1                            $COORDINATES
             SETBACK = 0.0                    $(FT)
             GLASS-TYPE = W-1
             FRAME-WIDTH = .2344              $EXPLANATION IN THE PARAMETER SECTION
             SKY-FORM-FACTOR = P-VIEWFACTORF  $ARBITRARY VALUE(0 TO 1)
             GND-FORM-FACTOR = 0.5            $ARBITRARY VALUE(0 TO 1)
             SHADING-DIVISIONS = 10           $DOE-2 DEFAULT, (0 TO 40)UNITS
                      ..                      $END OF WINDOW COMMAND
```

Window Library (quick_lib_double.inp)

```
W-1 = GLASS-TYPE
          GLASS-TYPE-CODE = 2000
          FRAME-CONDUCTANCE = 3.037             $DOE-2 DEFAULT = 0.434(BTU/HR.FT^2.F)
          FRAME-ABS = 0.9                       $DOE-2 DEFAULT = 0.7(0 TO 1)
                    ..                          $END OF GLASS-TYPE COMMAND
W-F-1 = WINDOW
             WIDTH = 11.53                    $(FT)
             HEIGHT = 4.53                    $(FT)
             X = P-BUILDINGLENGTH TIMES 0.4
             Y = 1                            $COORDINATES
             SETBACK = 0.0                    $(FT)
             GLASS-TYPE = W-1
             FRAME-WIDTH = .2344              $EXPLANATION IN THE PARAMETER SECTION
             SKY-FORM-FACTOR = P-VIEWFACTORF  $ARBITRARY VALUE(0 TO 1)
             GND-FORM-FACTOR = 0.5            $ARBITRARY VALUE(0 TO 1)
             SHADING-DIVISIONS = 10           $DOE-2 DEFAULT, (0 TO 40)UNITS
                      ..                      $END OF WINDOW COMMAND
```

Table 6. Window Library for Double Pane.

									LAY1		GAP1		LAY2	
ID	U-SI	U-IP	SC	SHGC	Tsol	Rfsol	Tvis	Rfvis	ID	WID	GAS	WID	ID	WID
2000	3.23	**.579**	**.88**	.76	.70	.13	.81	.15	2	3.0	Air	6.3	2	3.0

Uall = 1/(1/Ucenter - .197) = 1/(1/.579 - .197) = **.653**

DOE Output for Glazing (Double Pane):

REPORT- LV-C

Shading Coefficient (quick_sc_double.out)

EXTERIOR WINDOWS (U-VALUE INCLUDES OUTSIDE AIR FILM)

GLASS HEIGHT (FT)	CENTER-OF-GLASS WINDOW	U-VALUE (BTU/HR-SQFT-F)	VISIBLE MULTIPLIER TRANS	GLASS AREA (SQFT)	GLASS SHADING COEFF	NUMBER OF PANES	GLASS TYPE CODE	SET-BACK (FT)	GLASS WIDTH (FT)
4.53	W-F-1	0.579	1.0 0.812	52.23	0.88	2	1	0.00	11.53
4.53	W-R-1	0.579	1.0 0.812	52.23	0.88	2	1	0.00	11.53
4.53	W-B-1	0.579	1.0 0.812	52.23	0.88	2	1	0.00	11.53
4.53	W-L-1	0.579	1.0 0.812	52.23	0.88	2	1	0.00	11.53

Window Library (quick_lib_double.out)

EXTERIOR WINDOWS (U-VALUE INCLUDES OUTSIDE AIR FILM)

GLASS HEIGHT (FT)	CENTER-OF-GLASS WINDOW	U-VALUE (BTU/HR-SQFT-F)	VISIBLE MULTIPLIER TRANS	GLASS AREA (SQFT)	GLASS SHADING COEFF	NUMBER OF PANES	GLASS TYPE CODE	SET-BACK (FT)	GLASS WIDTH (FT)
4.53	W-F-1	0.579	1.0 0.812	52.23	0.88	2	2000	0.00	11.53
4.53	W-R-1	0.579	1.0 0.812	52.23	0.88	2	2000	0.00	11.53
4.53	W-B-1	0.579	1.0 0.812	52.23	0.88	2	2000	0.00	11.53
4.53	W-L-1	0.579	1.0 0.812	52.23	0.88	2	2000	0.00	11.53

DOE Output for Glazing (Double Pane):

REPORT- LV-D

Shading Coefficient (quick_sc_double.out)

-W A L L + W I N D O W S- SURFACE	SPACE		- - - W I N D O W S - - - U-VALUE (BTU/HR-SQFT-F)	AREA (SQFT)	- - - - W A L L - - - - U-VALUE (BTU/HR-SQFT-F)	AREA (SQFT)
BACK-1	RM-1		0.750	59.98	0.075	340.02
0.176	400.00	NORTH				
RIGHT-1	RM-1		0.750	59.98	0.075	340.02
0.176	400.00	EAST				
FRONT-1	RM-1		0.750	59.98	0.075	340.02
0.176	400.00	SOUTH				
LEFT-1	RM-1		0.750	59.98	0.075	164.02
0.256	224.00	WEST				

Window Library (quick_lib_double.out)

-W A L L + W I N D O W S- SURFACE	SPACE		- - - W I N D O W S - - - U-VALUE (BTU/HR-SQFT-F)	AREA (SQFT)	- - - - W A L L - - - - U-VALUE (BTU/HR-SQFT-F)	AREA (SQFT)
BACK-1	RM-1		0.751	59.98	0.075	340.02
0.176	400.00	NORTH				
RIGHT-1	RM-1		0.751	59.98	0.075	340.02
0.176	400.00	EAST				
FRONT-1	RM-1		0.751	59.98	0.075	340.02
0.176	400.00	SOUTH				
LEFT-1	RM-1		0.751	59.98	0.075	164.02
0.256	224.00	WEST				

3.3 Low-3 Double Pane

Input of Low-e Double Pane:

Shading Coefficient (quick_sc_lowe.inp)

```
W-1 = GLASS-TYPE
          SHADING-COEF = .35                    $(0 TO 1)
          PANES = 2                             $MIN=1,MAX=3
          GLASS-CONDUCTANCE = .4579             $(BTU/HR.FT^2.F)
          VIS-TRANS = .407                      $DOE-2 DEFAULT = 0.9(0 TO 1)
          FRAME-CONDUCTANCE = 3.037             $DOE-2 DEFAULT = 0.434(BTU/HR.FT^2.F)
          FRAME-ABS = 0.9                       $DOE-2 DEFAULT = 0.7(0 TO 1)
                     ..                         $END OF GLASS-TYPE COMMAND


W-F-1 =
             WIDTH = 11.53                    $(FT)
             HEIGHT = 4.53                    $(FT)
             X = P-BUILDINGLENGTH TIMES 0.4
             Y = 1                            $COORDINATES
             SETBACK = 0.0                    $(FT)
             GLASS-TYPE = W-1
             FRAME-WIDTH = .2344              $EXPLANATION IN THE PARAMETER SECTION
             SKY-FORM-FACTOR = P-VIEWFACTORF  $ARBITRARY VALUE(0 TO 1)
             GND-FORM-FACTOR = 0.5            $ARBITRARY VALUE(0 TO 1)
             SHADING-DIVISIONS = 10           $DOE-2 DEFAULT, (0 TO 40)UNITS
                      ..                      $END OF WINDOW COMMAND
```

Window Library (quick_lib_lowe.inp)

```
W-1 = GLASS-TYPE
          GLASS-TYPE-CODE = 2666
          FRAME-CONDUCTANCE = 3.037             $DOE-2 DEFAULT = 0.434(BTU/HR.FT^2.F)
          FRAME-ABS = 0.9                       $DOE-2 DEFAULT = 0.7(0 TO 1)
                     ..                         $END OF GLASS-TYPE COMMAND

W-F-1 = WINDOW
             WIDTH = 11.53                    $(FT)
             HEIGHT = 4.53                    $(FT)
             X = P-BUILDINGLENGTH TIMES 0.4
             Y = 1                            $COORDINATES
             SETBACK = 0.0                    $(FT)
             GLASS-TYPE = W-1
             FRAME-WIDTH = .2344              $EXPLANATION IN THE PARAMETER SECTION
             SKY-FORM-FACTOR = P-VIEWFACTORF  $ARBITRARY VALUE(0 TO 1)
             GND-FORM-FACTOR = 0.5            $ARBITRARY VALUE(0 TO 1)
             SHADING-DIVISIONS = 10           $DOE-2 DEFAULT, (0 TO 40)UNITS
                      ..                      $END OF WINDOW COMMAND
```

Table 7. Window Library for Low-e.

									LAY1		GAP1		LAY2	
ID	U-SI	U-IP	SC	SHGC	Tsol	Rfsol	Tvis	Rfvis	ID	WID	GAS	WID	ID	WID
2666	2.41	.42	.35	.31	.21	.14	.41	.08	550	6.0	Air	6.3	3	6.0

Uall = 1/(1/Ucenter - .197) = 1/(1/.42 - .197) = .4579

DOE Output for Glazing (Low-e Double Pane):

REPORT- LV-C

Shading Coefficient (quick_sc_lowe.out)

EXTERIOR WINDOWS (U-VALUE INCLUDES OUTSIDE AIR FILM)

GLASS HEIGHT (FT)	CENTER-OF-GLASS WINDOW	U-VALUE (BTU/HR-SQFT-F)	VISIBLE MULTIPLIER TRANS	GLASS AREA (SQFT)	GLASS SHADING COEFF	NUMBER OF PANES	GLASS TYPE CODE	SET-BACK (FT)	GLASS WIDTH (FT)
4.53	W-F-1	0.420	1.0 0.407	52.23	0.35	2	1	0.00	11.53
4.53	W-R-1	0.420	1.0 0.407	52.23	0.35	2	1	0.00	11.53
4.53	W-B-1	0.420	1.0 0.407	52.23	0.35	2	1	0.00	11.53
4.53	W-L-1	0.420	1.0 0.407	52.23	0.35	2	1	0.00	11.53

Window Library (quick_lib_lowe.out)

EXTERIOR WINDOWS (U-VALUE INCLUDES OUTSIDE AIR FILM)

GLASS HEIGHT (FT)	CENTER-OF-GLASS WINDOW	U-VALUE (BTU/HR-SQFT-F)	VISIBLE MULTIPLIER TRANS	GLASS AREA (SQFT)	GLASS SHADING COEFF	NUMBER OF PANES	GLASS TYPE CODE	SET-BACK (FT)	GLASS WIDTH (FT)
4.53	W-F-1	0.420	1.0 0.407	52.23	0.35	2	2666	0.00	11.53
4.53	W-R-1	0.420	1.0 0.407	52.23	0.35	2	2666	0.00	11.53
4.53	W-B-1	0.420	1.0 0.407	52.23	0.35	2	2666	0.00	11.53
4.53	W-L-1	0.420	1.0 0.407	52.23	0.35	2	2666	0.00	11.53

DOE Output for Glazing (Low-e Double Pane):

REPORT- LV-D

Shading Coefficient (quick_sc_lowe.out)

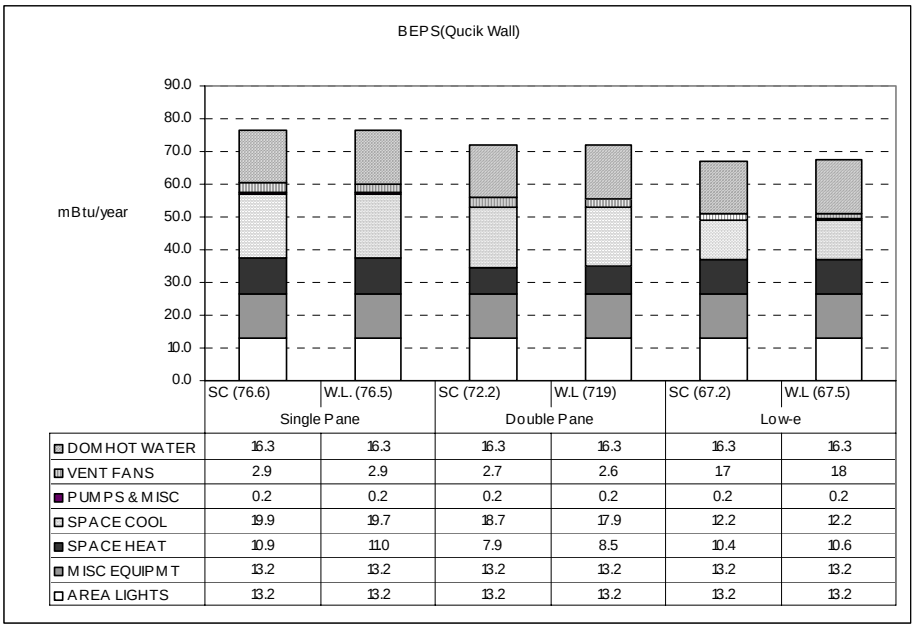
-W A L L + W I N D O W S- SURFACE	SPACE		- - - W I N D O W S - - - U-VALUE	AREA	- - - - W A L L - - - - U-VALUE	AREA
U-VALUE	AREA	AZIMUTH	(BTU/HR-SQFT-F)	(SQFT)	(BTU/HR-SQFT-F)	(SQFT)
(BTU/HR-SQFT-F)	(SQFT)					
BACK-1	RM-1		0.612	59.98	0.075	340.02
0.155	400.00	NORTH				
RIGHT-1	RM-1		0.612	59.98	0.075	340.02
0.155	400.00	EAST				
FRONT-1	RM-1		0.612	59.98	0.075	340.02
0.155	400.00	SOUTH				
LEFT-1	RM-1		0.612	59.98	0.075	164.02
0.219	224.00	WEST				

Window Library (quick_lib_lowe.out)

-W A L L + W I N D O W S- SURFACE	SPACE		- - - W I N D O W S - - - U-VALUE	AREA	- - - - W A L L - - - - U-VALUE	AREA
U-VALUE	AREA	AZIMUTH	(BTU/HR-SQFT-F)	(SQFT)	(BTU/HR-SQFT-F)	(SQFT)
(BTU/HR-SQFT-F)	(SQFT)					
BACK-1	RM-1		0.612	59.98	0.075	340.02
0.155	400.00	NORTH				
RIGHT-1	RM-1		0.612	59.98	0.075	340.02
0.155	400.00	EAST				
FRONT-1	RM-1		0.612	59.98	0.075	340.02
0.155	400.00	SOUTH				
LEFT-1	RM-1		0.612	59.98	0.075	164.02
0.219	224.00	WEST				

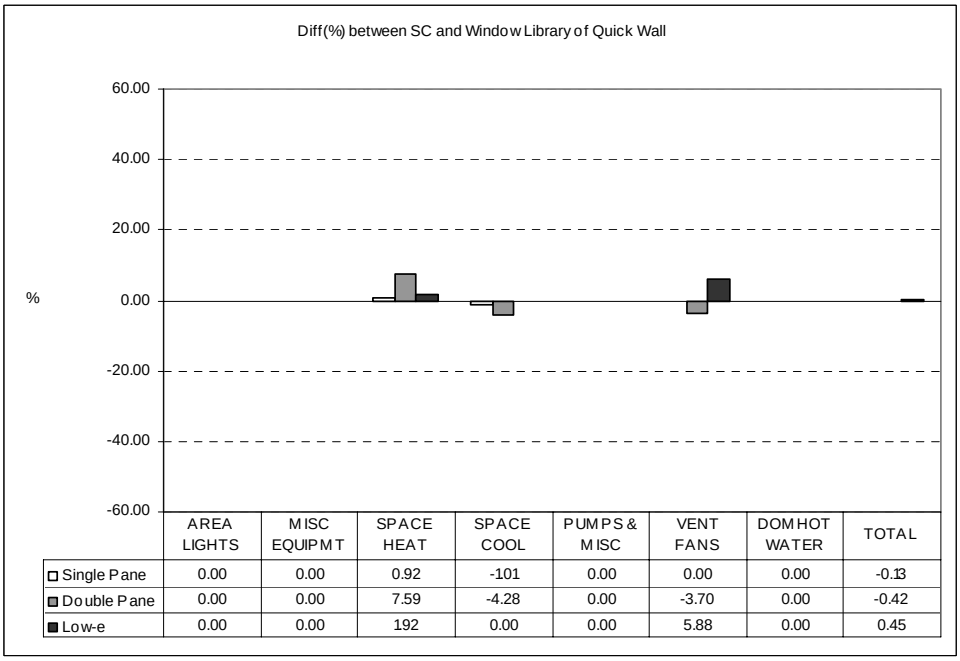
BEPS Report

The results show all annual energy consumption (Shading Coefficient and Window Library Method) on single-pane, double-pane and low-e glass of quick wall.



	SC (76.6)	W.L. (76.5)	SC (72.2)	W.L (719)	SC (67.2)	W.L (67.5)
	Single Pane		Double Pane		Low-e	
DOM HOT WATER	16.3	16.3	16.3	16.3	16.3	16.3
VENT FANS	2.9	2.9	2.7	2.6	1.7	1.8
PUMPS & MISC	0.2	0.2	0.2	0.2	0.2	0.2
SPACE COOL	19.9	19.7	18.7	17.9	12.2	12.2
SPACE HEAT	10.9	11.0	7.9	8.5	10.4	10.6
MISC EQUIPMT	13.2	13.2	13.2	13.2	13.2	13.2
AREA LIGHTS	13.2	13.2	13.2	13.2	13.2	13.2

Figure 2. Annual BEPS of Quick Wall.

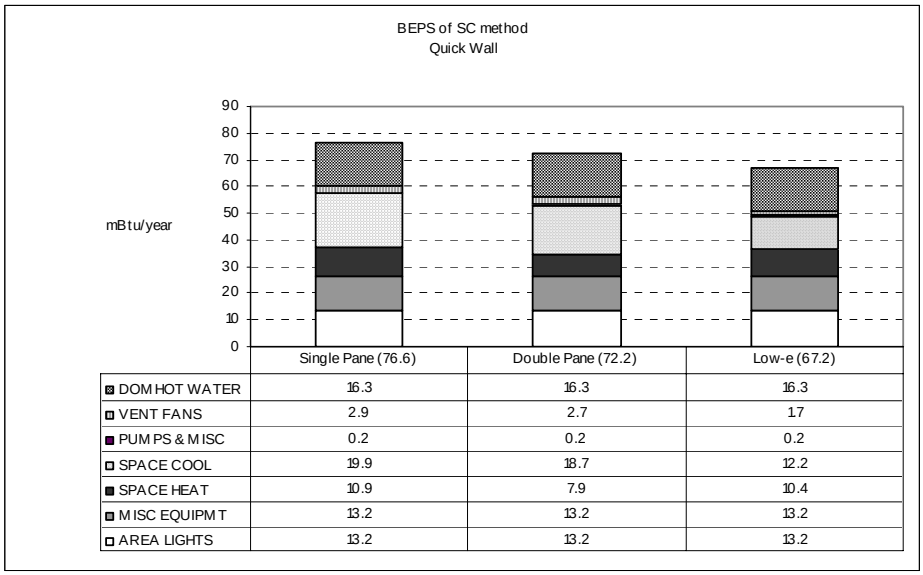


	AREA LIGHTS	MISC EQUIPMT	SPACE HEAT	SPACE COOL	PUMPS & MISC	VENT FANS	DOM HOT WATER	TOTAL
Single Pane	0.00	0.00	0.92	-1.01	0.00	0.00	0.00	-0.13
Double Pane	0.00	0.00	7.59	-4.28	0.00	-3.70	0.00	-0.42
Low-e	0.00	0.00	1.92	0.00	0.00	5.88	0.00	0.45

Figure 3. Difference (%) between Shading Coefficient and Window Library.

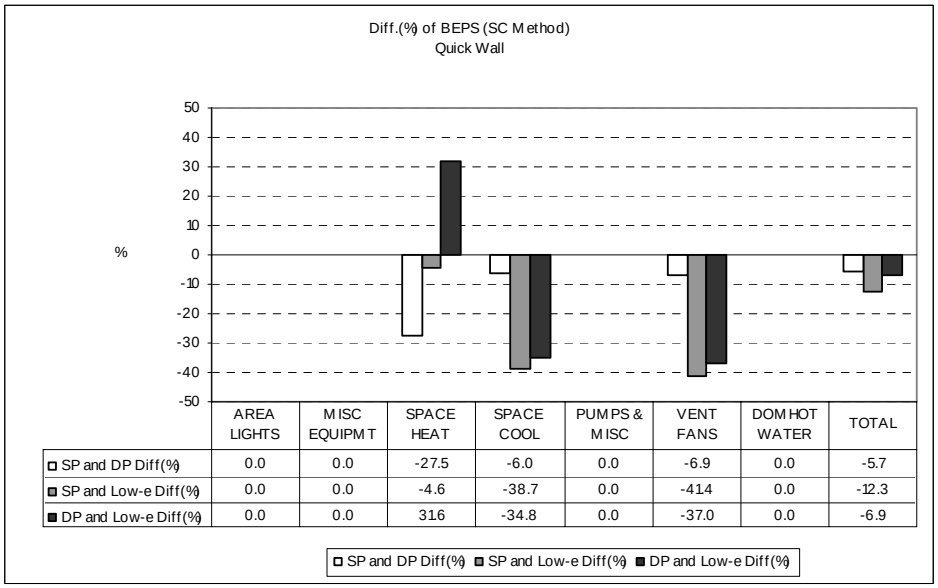
BEPS of Shading Coefficient Method (Quick Wall):

The plots show annual energy consumption of the Shading Coefficient Method of quick wall according to the types of glass (single-pane, double-pane, and low-e glass).



	Single Pane (76.6)	Double Pane (72.2)	Low-e (67.2)
DOM HOT WATER	16.3	16.3	16.3
VENT FANS	2.9	2.7	1.7
PUMPS & MISC	0.2	0.2	0.2
SPACE COOL	19.9	18.7	12.2
SPACE HEAT	10.9	7.9	10.4
MISC EQUIPMT	13.2	13.2	13.2
AREA LIGHTS	13.2	13.2	13.2

Figure 4. Annual BEPS of Shading Coefficient Method (Quick Wall).

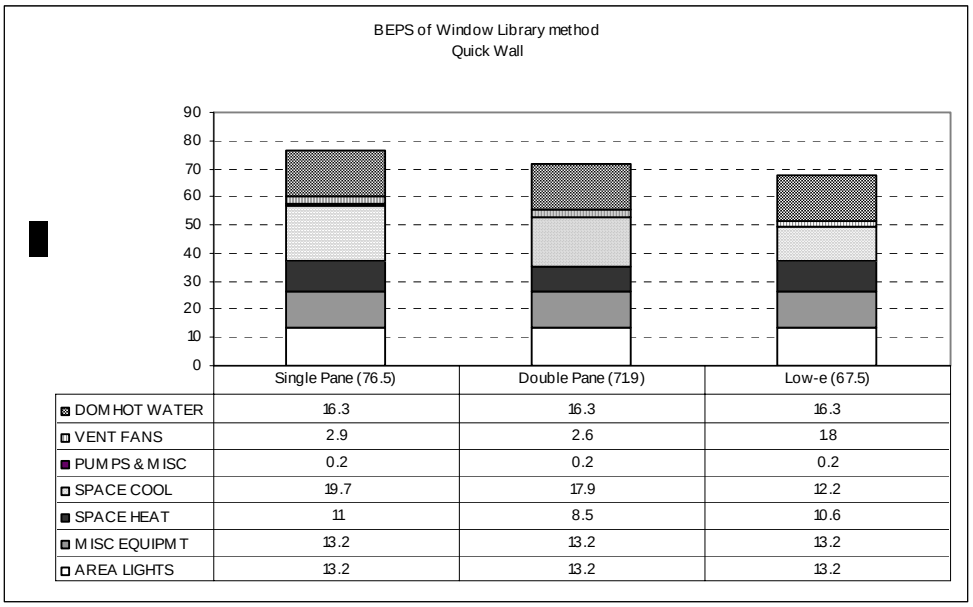


	AREA LIGHTS	MISC EQUIPMT	SPACE HEAT	SPACE COOL	PUMPS & MISC	VENT FANS	DOM HOT WATER	TOTAL
SP and DP Diff(%)	0.0	0.0	-27.5	-6.0	0.0	-6.9	0.0	-5.7
SP and Low-e Diff(%)	0.0	0.0	-4.6	-38.7	0.0	-41.4	0.0	-12.3
DP and Low-e Diff(%)	0.0	0.0	31.6	-34.8	0.0	-37.0	0.0	-6.9

Figure 5. Difference (%) of BEPS (Shading Coefficient Method).

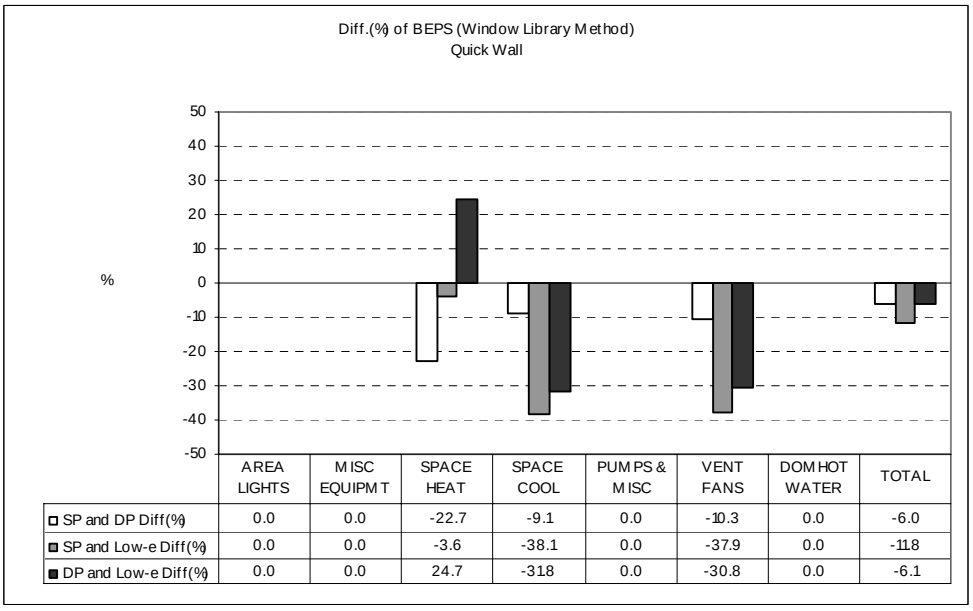
BEPS of Window Library Method (Quick Wall):

The plots show annual energy consumption of the Window Library Method of quick wall according to the types of glass (single-pane, double-pane, and low-e glass).



	Single Pane (76.5)	Double Pane (71.9)	Low-e (67.5)
DOM HOT WATER	16.3	16.3	16.3
VENT FANS	2.9	2.6	1.8
PUMPS & MISC	0.2	0.2	0.2
SPACE COOL	19.7	17.9	12.2
SPACE HEAT	11	8.5	10.6
MISC EQUIPMT	13.2	13.2	13.2
AREA LIGHTS	13.2	13.2	13.2

Figure 6. BEPS of Window Library Method (Quick Wall).

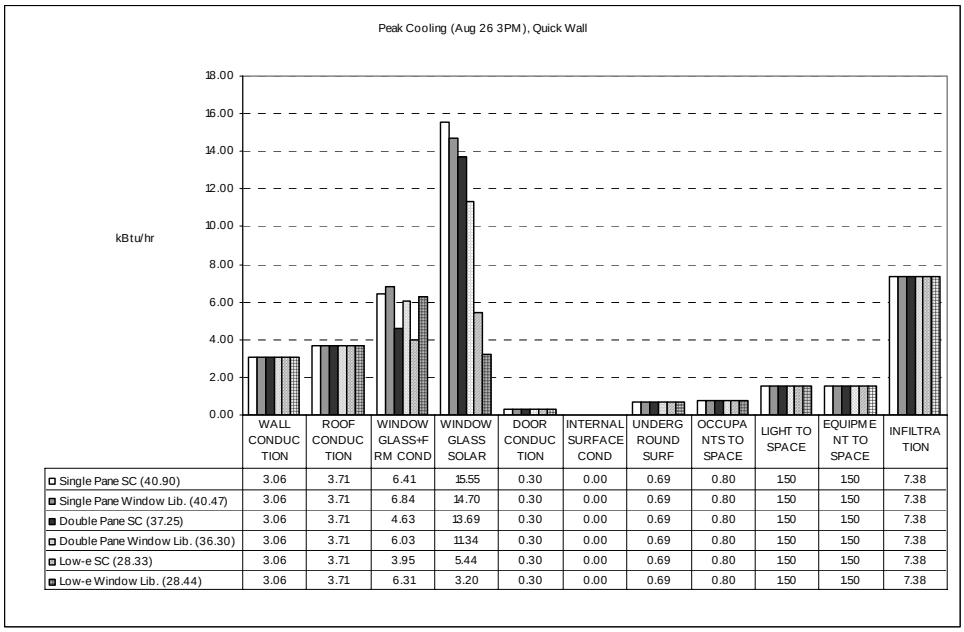


	AREA LIGHTS	MISC EQUIPMT	SPACE HEAT	SPACE COOL	PUMPS & MISC	VENT FANS	DOM HOT WATER	TOTAL
SP and DP Diff(%)	0.0	0.0	-22.7	-9.1	0.0	-10.3	0.0	-6.0
SP and Low-e Diff(%)	0.0	0.0	-3.6	-38.1	0.0	-37.9	0.0	-11.8
DP and Low-e Diff(%)	0.0	0.0	24.7	-31.8	0.0	-30.8	0.0	-6.1

Figure 7. Difference (%) of BEPS (Window Library Method) Quick Wall.

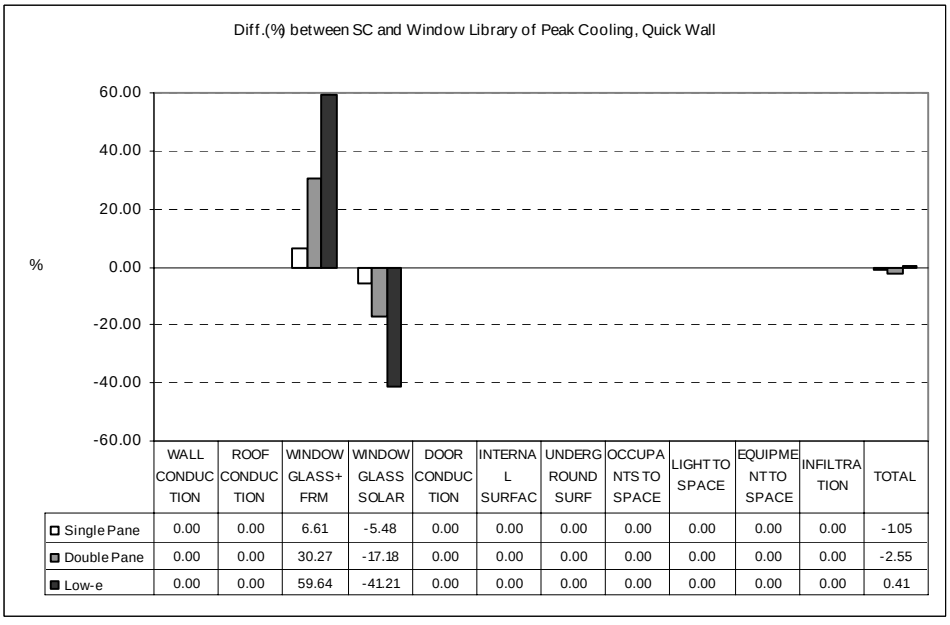
Hourly Peak Cooling Load (kBtu/hr, Quick Wall):

The plots show the hourly peak cooling load of quick wall. The date of peak day is from Aug 25, 3PM, which is the peak day of thermal mass wall with low-e glass.



	WALL CONDUCTION	ROOF CONDUCTION	WINDOW GLASS+FRM COND	WINDOW GLASS SOLAR	DOOR CONDUCTION	INTERNAL SURFACE COND	UNDERGROUND SURF	OCCUPANTS TO SPACE	LIGHT TO SPACE	EQUIPMENT TO SPACE	INFILTRATION
Single Pane SC (40.90)	3.06	3.71	6.41	15.55	0.30	0.00	0.69	0.80	1.50	1.50	7.38
Single Pane Window Lib. (40.47)	3.06	3.71	6.84	14.70	0.30	0.00	0.69	0.80	1.50	1.50	7.38
Double Pane SC (37.25)	3.06	3.71	4.63	13.69	0.30	0.00	0.69	0.80	1.50	1.50	7.38
Double Pane Window Lib. (36.30)	3.06	3.71	6.03	11.34	0.30	0.00	0.69	0.80	1.50	1.50	7.38
Low-e SC (28.33)	3.06	3.71	3.95	5.44	0.30	0.00	0.69	0.80	1.50	1.50	7.38
Low-e Window Lib. (28.44)	3.06	3.71	6.31	3.20	0.30	0.00	0.69	0.80	1.50	1.50	7.38

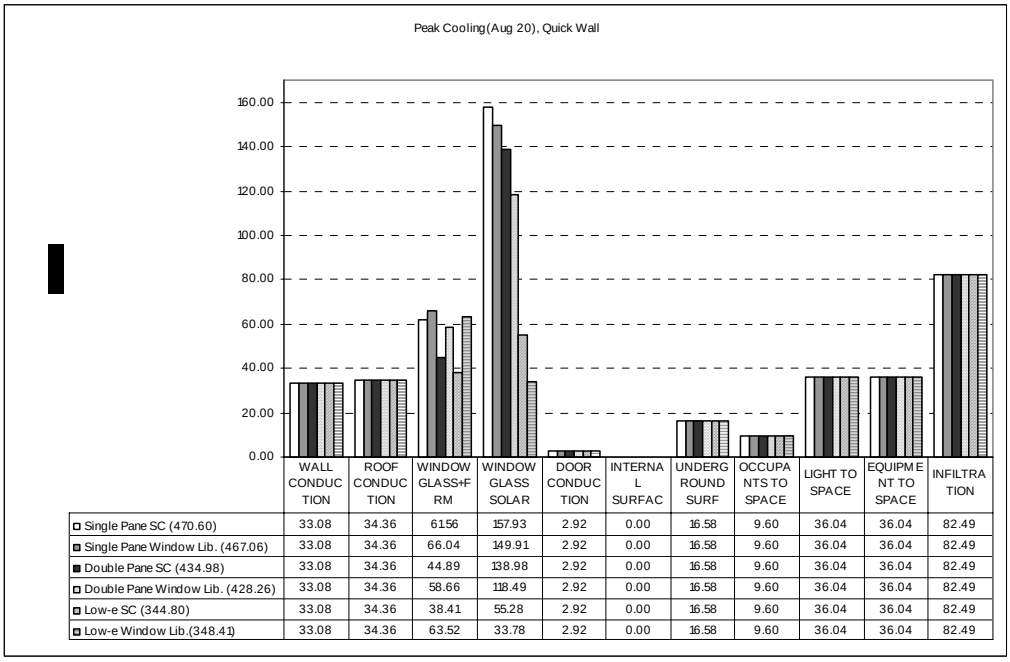
Figure 8. Hourly Peak Cooling of Quick Wall.



	WALL CONDUCTION	ROOF CONDUCTION	WINDOW GLASS+FRM	WINDOW GLASS SOLAR	DOOR CONDUCTION	INTERNAL SURFAC	UNDERGROUND SURF	OCCUPANTS TO SPACE	LIGHT TO SPACE	EQUIPMENT TO SPACE	INFILTRATION	TOTAL
Single Pane	0.00	0.00	6.61	-5.48	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-1.05
Double Pane	0.00	0.00	30.27	-17.18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-2.55
Low-e	0.00	0.00	59.64	-41.21	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.41

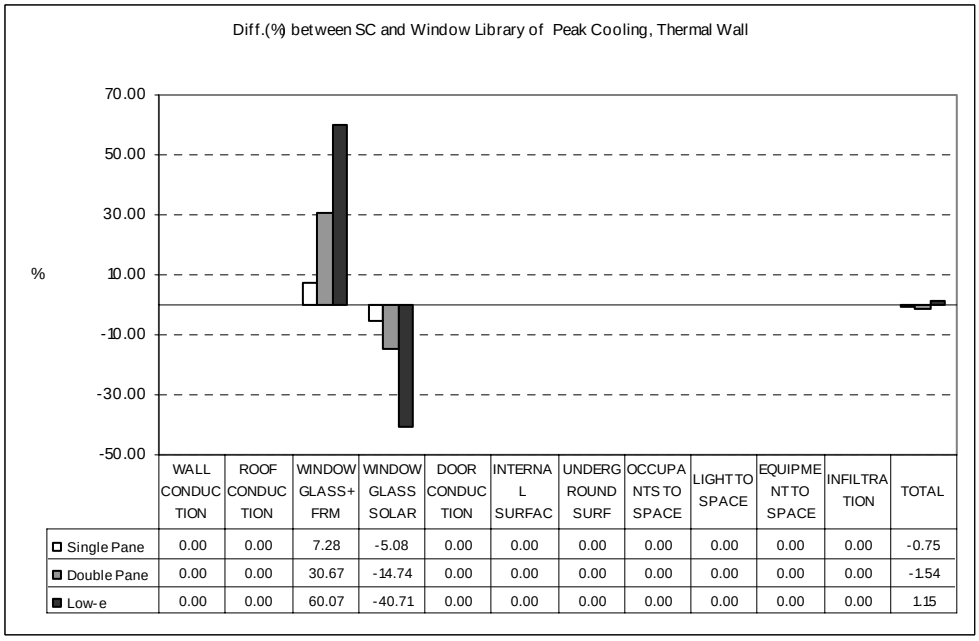
Figure 9. Difference (%) between Shading Coefficient and Window Library of Peak Cooling.

Daily Peak Cooling Load (kBtu/day, Quick Wall):



	WALL CONDUCTION	ROOF CONDUCTION	WINDOW GLASS+FRM	WINDOW GLASS SOLAR	DOOR CONDUCTION	INTERNAL SURFAC	UNDERGROUND SURF	OCCUPANTS TO SPACE	LIGHT TO SPACE	EQUIPMENT TO SPACE	INFILTRATION
Single Pane SC (470.60)	33.08	34.36	61.56	157.93	2.92	0.00	16.58	9.60	36.04	36.04	82.49
Single Pane Window Lib. (467.06)	33.08	34.36	66.04	149.91	2.92	0.00	16.58	9.60	36.04	36.04	82.49
Double Pane SC (434.98)	33.08	34.36	44.89	138.98	2.92	0.00	16.58	9.60	36.04	36.04	82.49
Double Pane Window Lib. (428.26)	33.08	34.36	58.66	118.49	2.92	0.00	16.58	9.60	36.04	36.04	82.49
Low-e SC (344.80)	33.08	34.36	38.41	55.28	2.92	0.00	16.58	9.60	36.04	36.04	82.49
Low-e Window Lib.(348.41)	33.08	34.36	63.52	33.78	2.92	0.00	16.58	9.60	36.04	36.04	82.49

Figure 10. Daily Peak Cooling of Quick Wall.

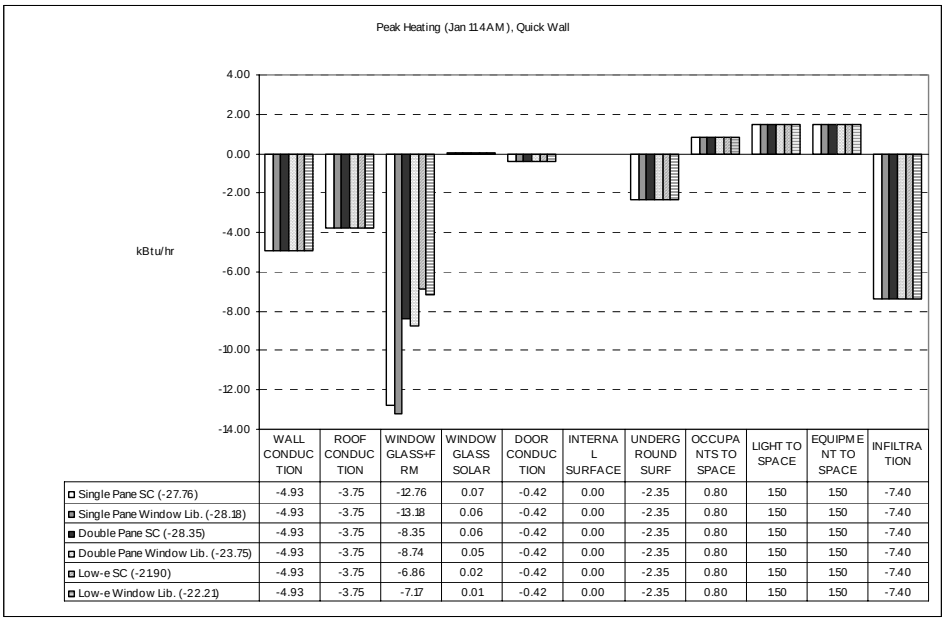


	WALL CONDUCTION	ROOF CONDUCTION	WINDOW GLASS+FRM	WINDOW GLASS SOLAR	DOOR CONDUCTION	INTERNAL SURFAC	UNDERGROUND SURF	OCCUPANTS TO SPACE	LIGHT TO SPACE	EQUIPMENT TO SPACE	INFILTRATION	TOTAL
Single Pane	0.00	0.00	7.28	-5.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.75
Double Pane	0.00	0.00	30.67	-14.74	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-1.54
Low-e	0.00	0.00	60.07	-40.71	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.15

Figure 11. Difference (%) between Shading Coefficient and Window Library of Peak Cooling.

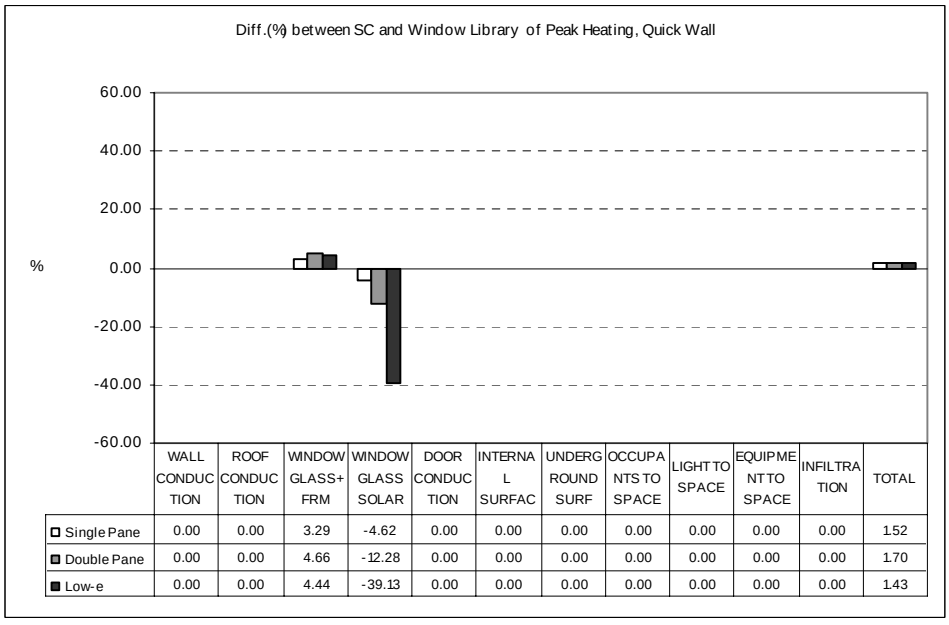
Hourly Peak Heating Load (kBtu/hr, Quick Wall)

The plots show the hourly peak heating load of quick wall. The date of peak day is from Jan 11, 4AM, which is the peak day of thermal mass wall with low-e glass.



	WALL CONDUCTION	ROOF CONDUCTION	WINDOW GLASS+FRM	WINDOW GLASS SOLAR	DOOR CONDUCTION	INTERNAL SURFACE	UNDERGROUND SURF	OCCUPANTS TO SPACE	LIGHT TO SPACE	EQUIPMENT TO SPACE	INFILTRATION
Single Pane SC (-27.76)	-4.93	-3.75	-12.76	0.07	-0.42	0.00	-2.35	0.80	1.50	1.50	-7.40
Single Pane Window Lib. (-28.18)	-4.93	-3.75	-13.18	0.06	-0.42	0.00	-2.35	0.80	1.50	1.50	-7.40
Double Pane SC (-28.35)	-4.93	-3.75	-8.35	0.06	-0.42	0.00	-2.35	0.80	1.50	1.50	-7.40
Double Pane Window Lib. (-23.75)	-4.93	-3.75	-8.74	0.05	-0.42	0.00	-2.35	0.80	1.50	1.50	-7.40
Low-e SC (-21.90)	-4.93	-3.75	-6.86	0.02	-0.42	0.00	-2.35	0.80	1.50	1.50	-7.40
Low-e Window Lib. (-22.21)	-4.93	-3.75	-7.17	0.01	-0.42	0.00	-2.35	0.80	1.50	1.50	-7.40

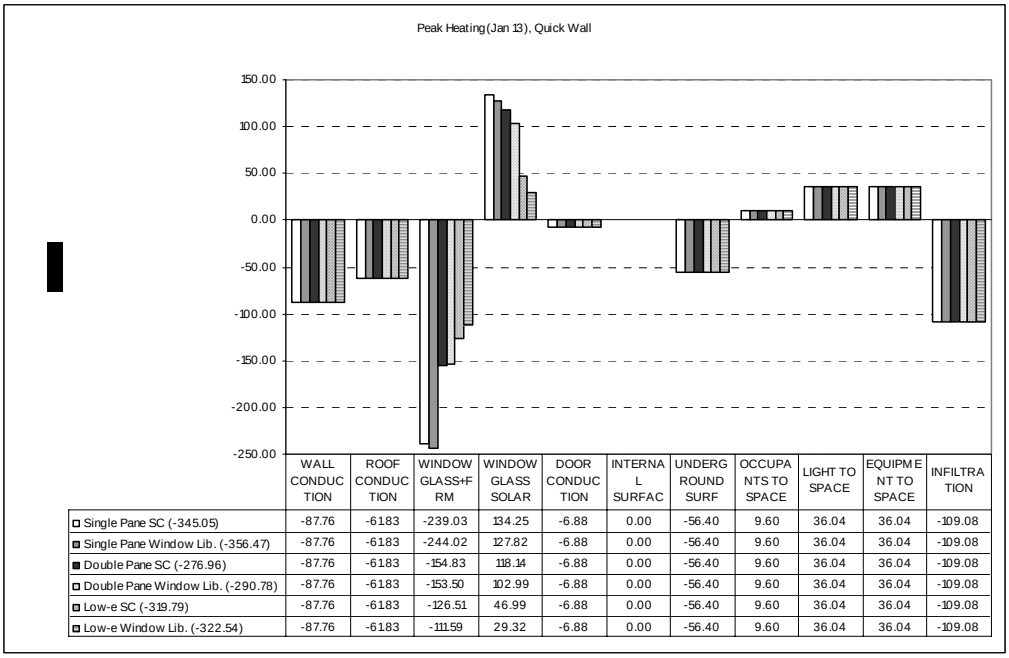
Figure 12. Hourly Peak Heating Load of Quick Wall.



	WALL CONDUCTION	ROOF CONDUCTION	WINDOW GLASS+FRM	WINDOW GLASS SOLAR	DOOR CONDUCTION	INTERNAL SURFAC	UNDERGROUND SURF	OCCUPANTS TO SPACE	LIGHT TO SPACE	EQUIPMENT TO SPACE	INFILTRATION	TOTAL
Single Pane	0.00	0.00	3.29	-4.62	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.52
Double Pane	0.00	0.00	4.66	-12.28	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.70
Low-e	0.00	0.00	4.44	-39.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.43

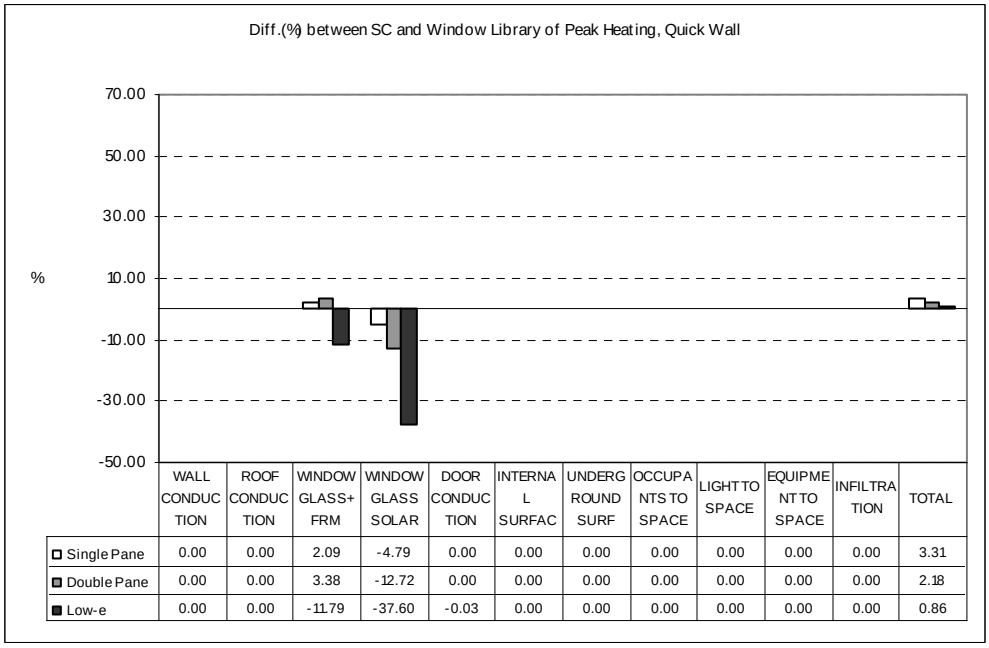
Figure 13. Difference (%) between Shading Coefficient and Window Library of Peak Heating.

Daily Peak Heating Load (kBtu/day, Quick Wall):



	WALL CONDUCTION	ROOF CONDUCTION	WINDOW GLASS+FRM	WINDOW GLASS SOLAR	DOOR CONDUCTION	INTERNAL SURFAC	UNDERGROUND SURF	OCCUPANTS TO SPACE	LIGHT TO SPACE	EQUIPMENT TO SPACE	INFILTRATION
Single Pane SC (-345.05)	-87.76	-61.83	-239.03	134.25	-6.88	0.00	-56.40	9.60	36.04	36.04	-109.08
Single Pane Window Lib. (-356.47)	-87.76	-61.83	-244.02	127.82	-6.88	0.00	-56.40	9.60	36.04	36.04	-109.08
Double Pane SC (-276.96)	-87.76	-61.83	-154.83	118.14	-6.88	0.00	-56.40	9.60	36.04	36.04	-109.08
Double Pane Window Lib. (-290.78)	-87.76	-61.83	-153.50	102.99	-6.88	0.00	-56.40	9.60	36.04	36.04	-109.08
Low-e SC (-319.79)	-87.76	-61.83	-126.51	46.99	-6.88	0.00	-56.40	9.60	36.04	36.04	-109.08
Low-e Window Lib. (-322.54)	-87.76	-61.83	-111.59	29.32	-6.88	0.00	-56.40	9.60	36.04	36.04	-109.08

Figure 14. Daily Peak Heating Load of Quick Wall.

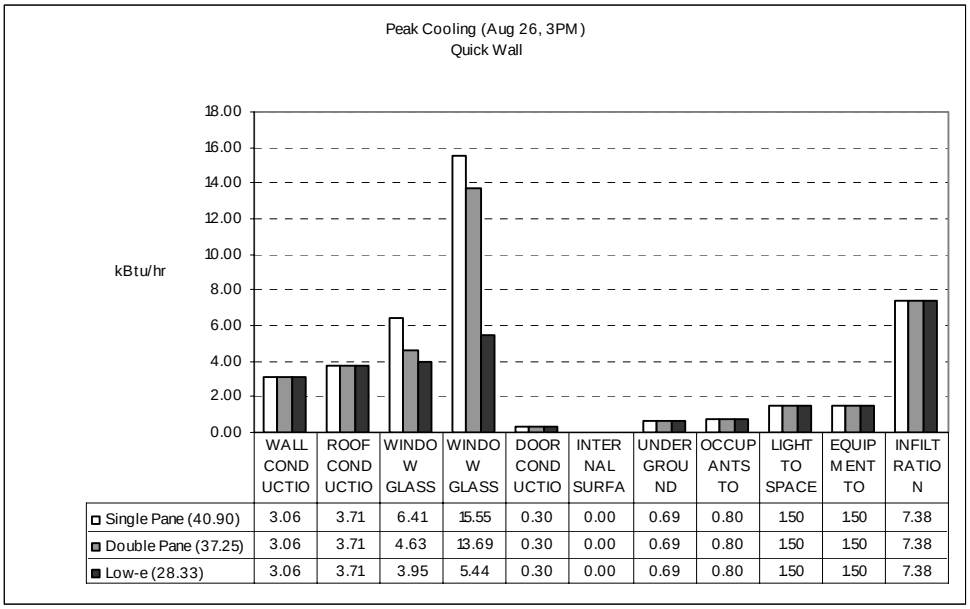


	WALL CONDUCTION	ROOF CONDUCTION	WINDOW GLASS+FRM	WINDOW GLASS SOLAR	DOOR CONDUCTION	INTERNAL SURFAC	UNDERGROUND SURF	OCCUPANTS TO SPACE	LIGHT TO SPACE	EQUIPMENT TO SPACE	INFILTRATION	TOTAL
Single Pane	0.00	0.00	2.09	-4.79	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.31
Double Pane	0.00	0.00	3.38	-12.72	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.18
Low-e	0.00	0.00	-11.79	-37.60	-0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.86

Figure 15. Difference (%) between Shading Coefficient and Window Library.

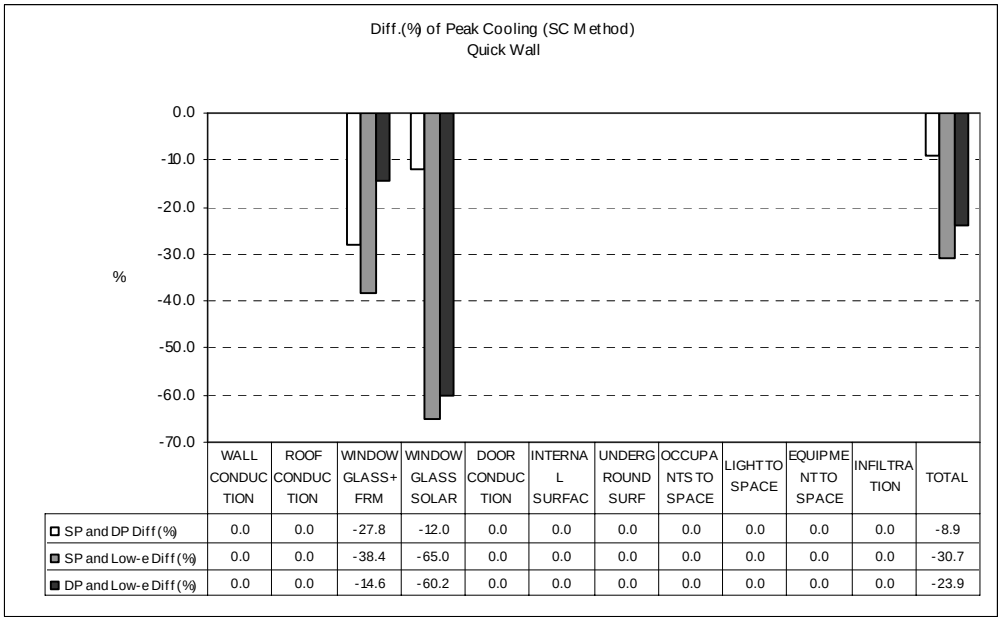
Comparison of Single-pane, Double-pane and Low-e Glass (Shading Coefficient Method / Quick Wall):

Hourly Peak Cooling (kBtu/hr):



	WALL CONDUCTIO	ROOF CONDUCTIO	WINDOW GLASS	WINDOW GLASS	DOOR CONDUCTIO	INTERNAL SURFA	UNDERGROUND	OCCUPANTS TO	LIGHT TO SPACE	EQUIPMENT TO	INFILTRATION
Single Pane (40.90)	3.06	3.71	6.41	15.55	0.30	0.00	0.69	0.80	1.50	1.50	7.38
Double Pane (37.25)	3.06	3.71	4.63	13.69	0.30	0.00	0.69	0.80	1.50	1.50	7.38
Low-e (28.33)	3.06	3.71	3.95	5.44	0.30	0.00	0.69	0.80	1.50	1.50	7.38

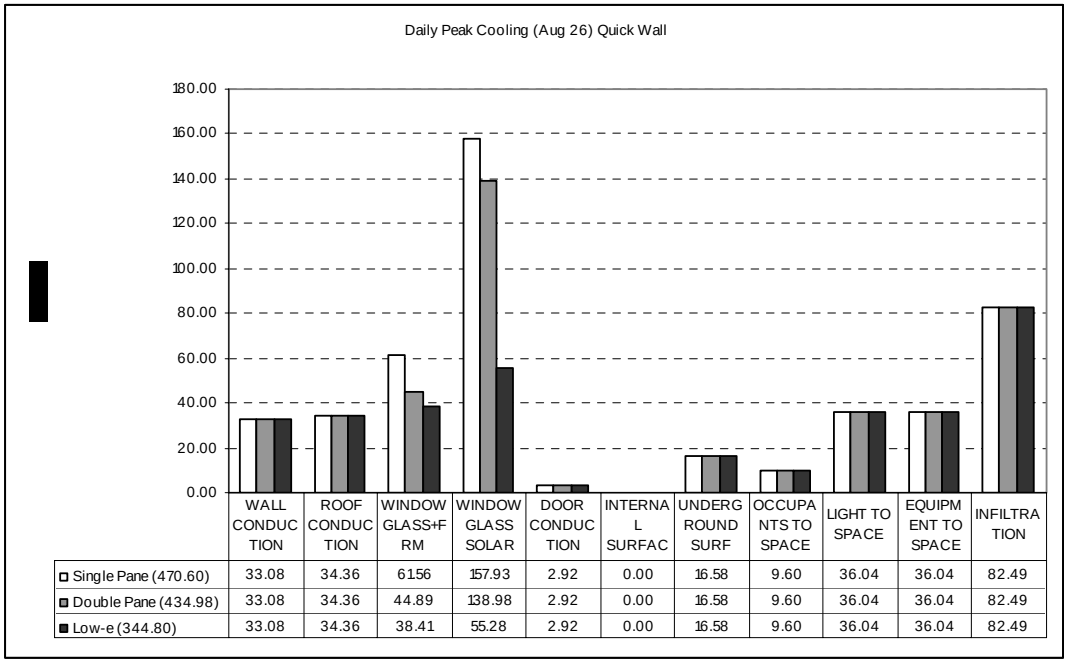
Figure 16. Comparison of hourly peak cooling of Single-pane, Double-pane and Low-e Glass (Shading Coefficient Method / Quick Wall).



	WALL CONDUCTION	ROOF CONDUCTION	WINDOW GLASS+FRM	WINDOW GLASS SOLAR	DOOR CONDUCTION	INTERNAL SURFAC	UNDERGROUND SURF	OCCUPANTS TO SPACE	LIGHT TO SPACE	EQUIPMENT TO SPACE	INFILTRATION	TOTAL
SP and DP Diff (%)	0.0	0.0	-27.8	-12.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-8.9
SP and Low-e Diff (%)	0.0	0.0	-38.4	-65.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-30.7
DP and Low-e Diff (%)	0.0	0.0	-14.6	-60.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-23.9

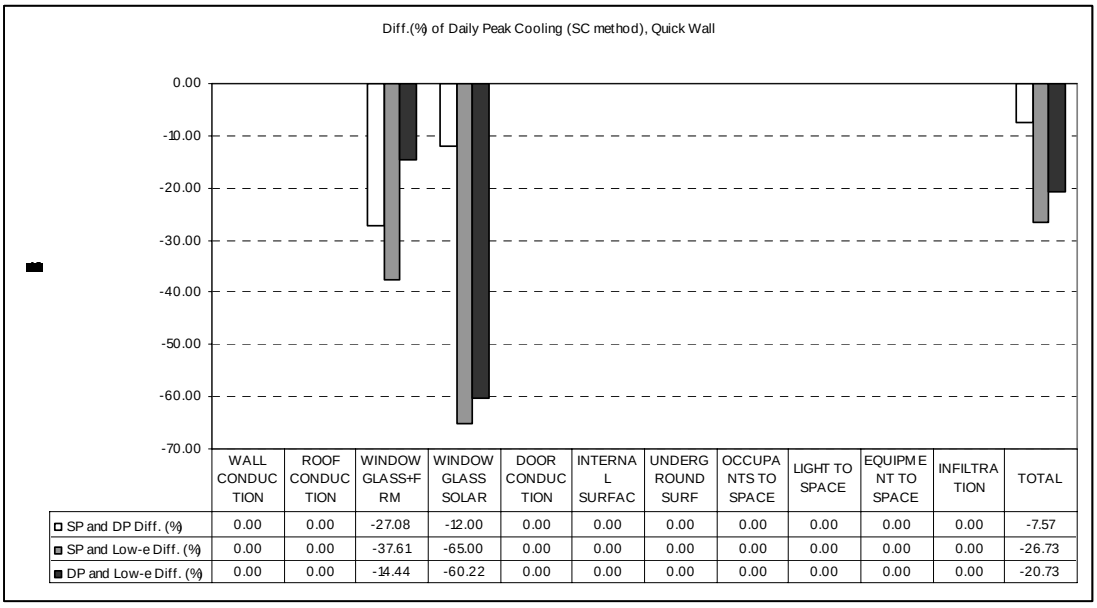
Figure 17. Difference (%) of Peak Cooling (Shading Coefficient Method / Quick Wall).

Daily Peak Cooling (kBtu/day):



	WALL CONDUCTION	ROOF CONDUCTION	WINDOW GLASS+FRM	WINDOW GLASS SOLAR	DOOR CONDUCTION	INTERNAL SURFAC	UNDERGROUND SURF	OCCUPANTS TO SPACE	LIGHT TO SPACE	EQUIPMENT TO SPACE	INFILTRATION
Single Pane (470.60)	33.08	34.36	61.56	157.93	2.92	0.00	16.58	9.60	36.04	36.04	82.49
Double Pane (434.98)	33.08	34.36	44.89	138.98	2.92	0.00	16.58	9.60	36.04	36.04	82.49
Low-e (344.80)	33.08	34.36	38.41	55.28	2.92	0.00	16.58	9.60	36.04	36.04	82.49

Figure 18. Comparison of daily peak cooling of Single-pane, Double-pane and Low-e Glass (Shading Coefficient Method / Quick Wall).

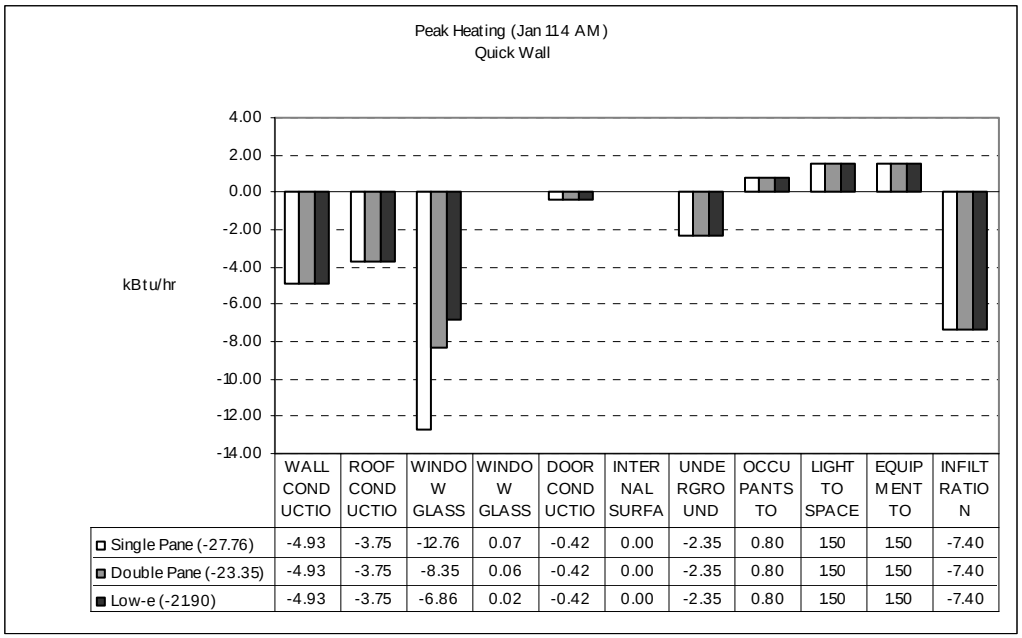


	WALL CONDUCTION	ROOF CONDUCTION	WINDOW GLASS+FRM	WINDOW GLASS SOLAR	DOOR CONDUCTION	INTERNAL SURFAC	UNDERGROUND SURF	OCCUPANTS TO SPACE	LIGHT TO SPACE	EQUIPMENT TO SPACE	INFILTRATION	TOTAL
SP and DP Diff. (%)	0.00	0.00	-27.08	-12.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-7.57
SP and Low-e Diff. (%)	0.00	0.00	-37.61	-65.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-26.73
DP and Low-e Diff. (%)	0.00	0.00	-14.44	-60.22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-20.73

Figure 19. Difference (%) of Daily Peak Cooling.

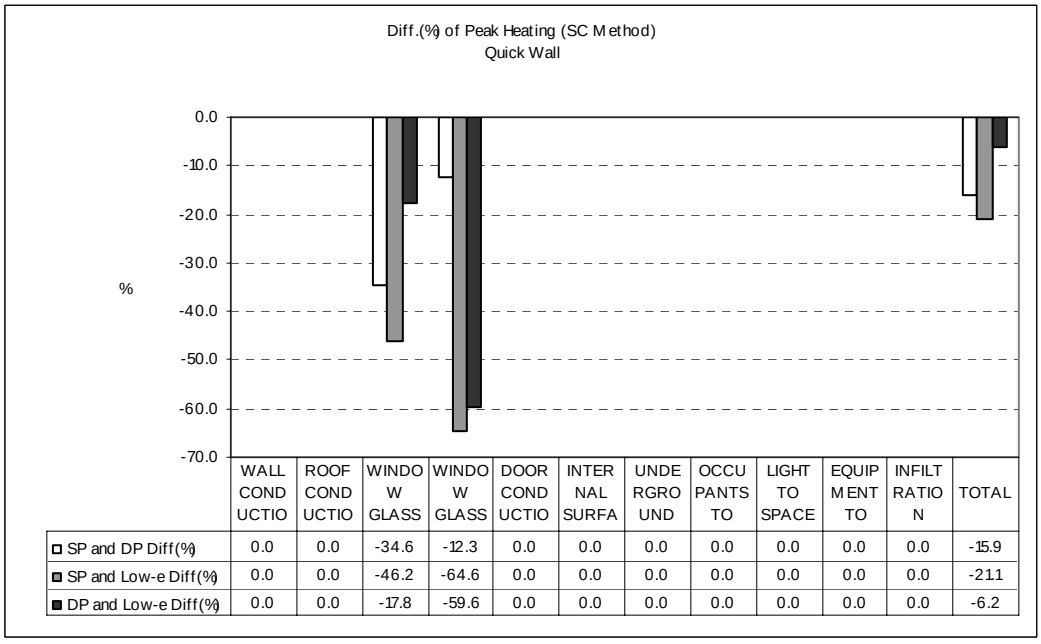
Comparison of Single-pane, Double-pane and Low-e Glass (Shading Coefficient Method / Quick Wall):

Hourly Peak Heating (kBtu/hr):



	WALL CONDUCTIO	ROOF CONDUCTIO	WINDOW GLASS	WINDOW GLASS	DOOR CONDUCTIO	INTERNAL SURFA	UNDERGROUND	OCCUPANTS TO	LIGHT TO SPACE	EQUIPMENT TO	INFILTRATION
Single Pane (-27.76)	-4.93	-3.75	-12.76	0.07	-0.42	0.00	-2.35	0.80	1.50	1.50	-7.40
Double Pane (-23.35)	-4.93	-3.75	-8.35	0.06	-0.42	0.00	-2.35	0.80	1.50	1.50	-7.40
Low-e (-21.90)	-4.93	-3.75	-6.86	0.02	-0.42	0.00	-2.35	0.80	1.50	1.50	-7.40

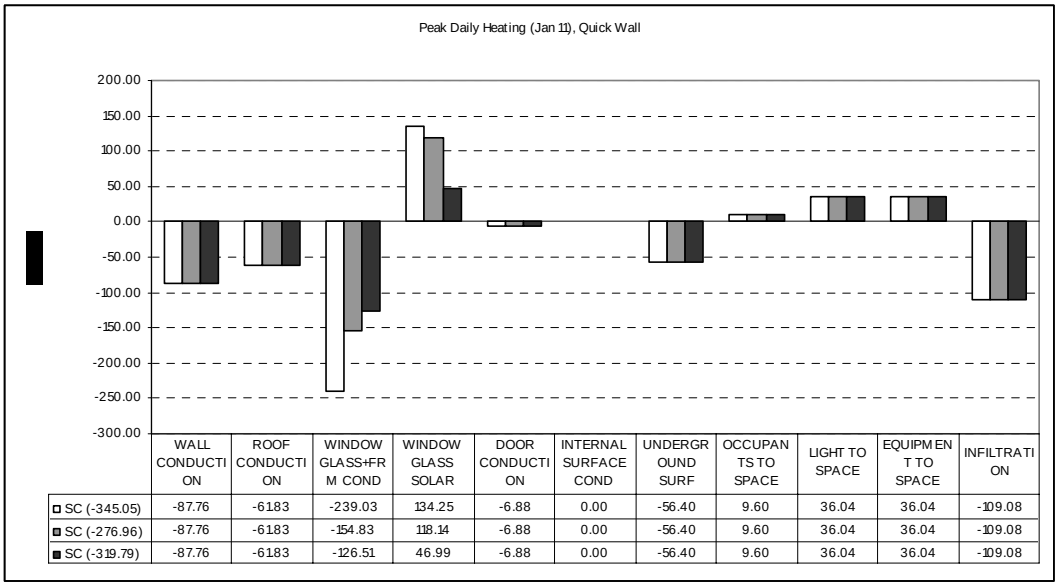
Figure 20. Comparison of hourly peak heating of Single-pane, Double-pane and Low-e Glass (Shading Coefficient Method / Quick Wall).



	WALL CONDUCTIO	ROOF CONDUCTIO	WINDOW GLASS	WINDOW GLASS	DOOR CONDUCTIO	INTERNAL SURFA	UNDERGROUND	OCCUPANTS TO	LIGHT TO SPACE	EQUIPMENT TO	INFILTRATION	TOTAL
SP and DP Diff(%)	0.0	0.0	-34.6	-12.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-15.9
SP and Low-e Diff(%)	0.0	0.0	-46.2	-64.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-21.1
DP and Low-e Diff(%)	0.0	0.0	-17.8	-59.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-6.2

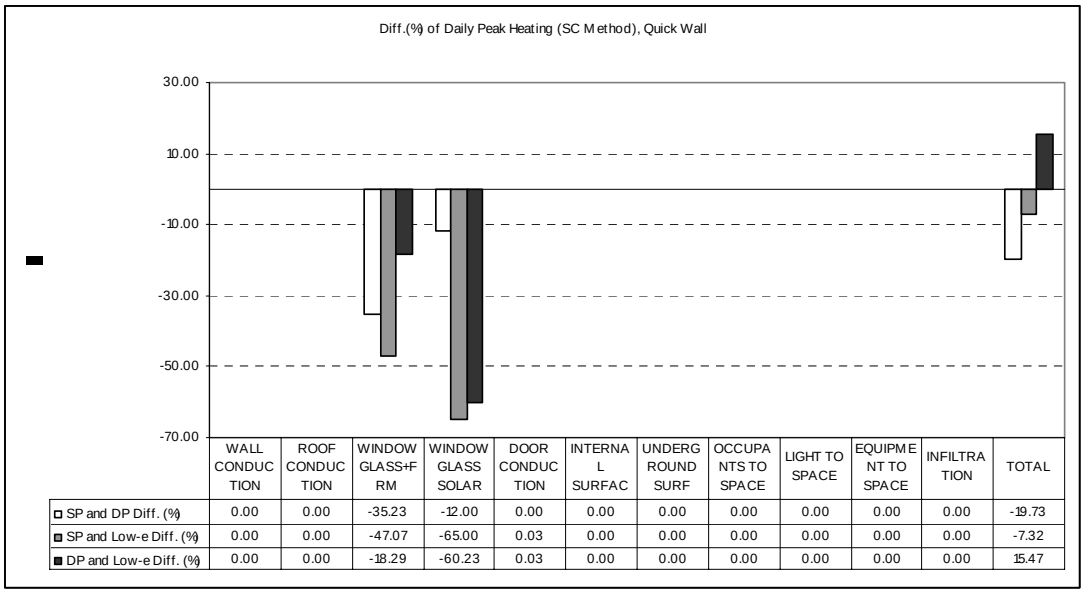
Figure 21. Difference (%) of hourly peak heating.

Daily Peak Heating (kBtu/day):



	WALL CONDUCTION	ROOF CONDUCTION	WINDOW GLASS+FRM COND	WINDOW GLASS SOLAR	DOOR CONDUCTION	INTERNAL SURFACE COND	UNDERGROUND SURF	OCCUPANTS TO SPACE	LIGHT TO SPACE	EQUIPMENT TO SPACE	INFILTRATION
SC (-345.05)	-87.76	-61.83	-239.03	134.25	-6.88	0.00	-56.40	9.60	36.04	36.04	-109.08
SC (-276.96)	-87.76	-61.83	-154.83	118.14	-6.88	0.00	-56.40	9.60	36.04	36.04	-109.08
SC (-319.79)	-87.76	-61.83	-126.51	46.99	-6.88	0.00	-56.40	9.60	36.04	36.04	-109.08

Figure 22. Comparison of daily peak heating among Single-pane, Double-pane and Low-e Glass (Shading Coefficient Method / Quick Wall).

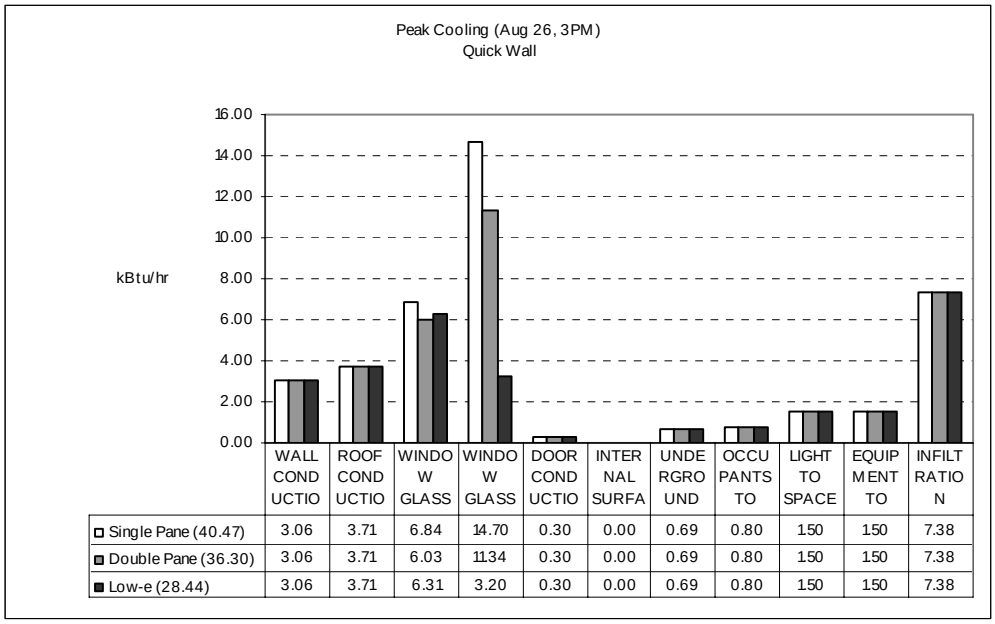


	WALL CONDUCTION	ROOF CONDUCTION	WINDOW GLASS+FRM	WINDOW GLASS SOLAR	DOOR CONDUCTION	INTERNAL SURFAC	UNDERGROUND SURF	OCCUPANTS TO SPACE	LIGHT TO SPACE	EQUIPMENT TO SPACE	INFILTRATION	TOTAL
SP and DP Diff. (%)	0.00	0.00	-35.23	-12.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-19.73
SP and Low-e Diff. (%)	0.00	0.00	-47.07	-65.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	-7.32
DP and Low-e Diff. (%)	0.00	0.00	-18.29	-60.23	0.03	0.00	0.00	0.00	0.00	0.00	0.00	15.47

Figure 23. Difference (%) of daily peak heating.

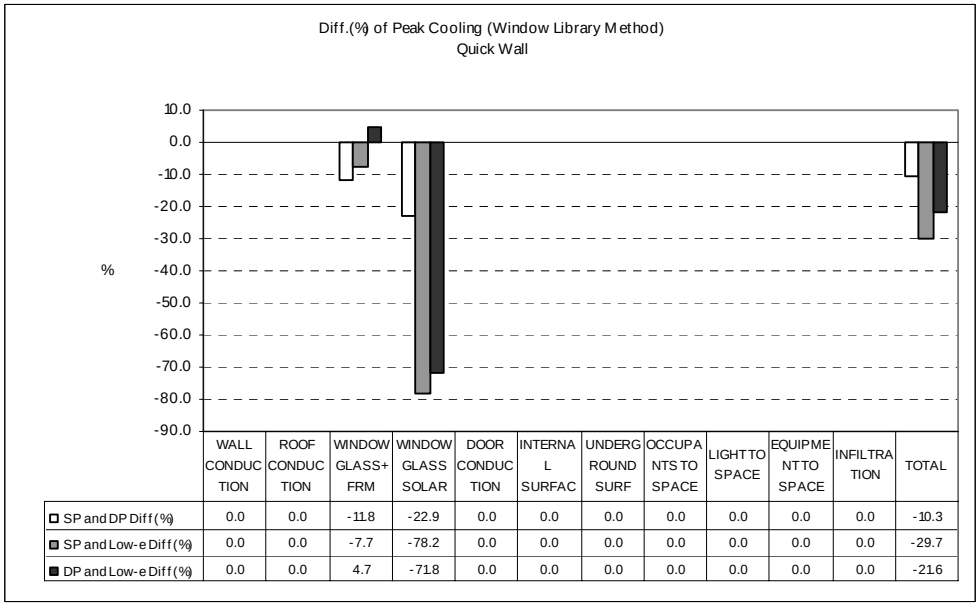
Comparison of Single-pane, Double-pane and Low-e Glass (Window Library Method / Quick Wall):

Hourly Peak Cooling (kBtu/hr):



	WALL CONDUCTIO	ROOF CONDUCTIO	WINDOW GLASS	WINDOW GLASS	DOOR CONDUCTIO	INTERNAL SURFA	UNDERGROUND	OCCUPANTS TO	LIGHT TO SPACE	EQUIPMENT TO	INFILTRATION
Single Pane (40.47)	3.06	3.71	6.84	14.70	0.30	0.00	0.69	0.80	1.50	1.50	7.38
Double Pane (36.30)	3.06	3.71	6.03	11.34	0.30	0.00	0.69	0.80	1.50	1.50	7.38
Low-e (28.44)	3.06	3.71	6.31	3.20	0.30	0.00	0.69	0.80	1.50	1.50	7.38

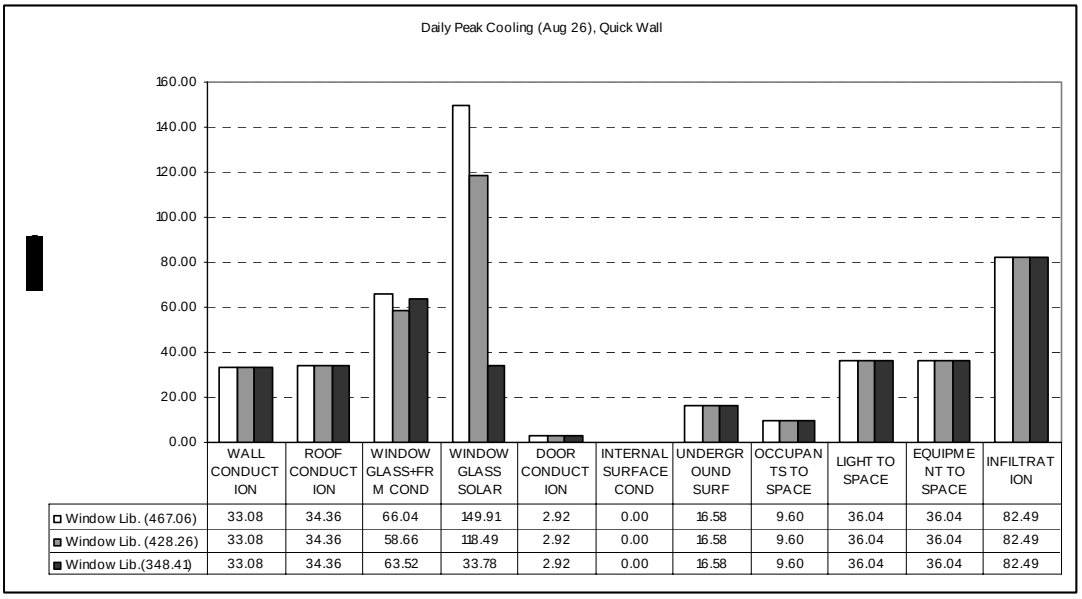
Figure 24 Comparison of hourly peak cooling of Single-pane, Double-pane and Low-e Glass (Window Library Method / Quick Wall).



	WALL CONDUCTION	ROOF CONDUCTION	WINDOW GLASS+FRM	WINDOW GLASS SOLAR	DOOR CONDUCTION	INTERNAL SURFAC	UNDERGROUND SURF	OCCUPANTS TO SPACE	LIGHT TO SPACE	EQUIPMENT TO SPACE	INFILTRATION	TOTAL
SP and DP Diff (%)	0.0	0.0	-11.8	-22.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-10.3
SP and Low-e Diff (%)	0.0	0.0	-7.7	-78.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-29.7
DP and Low-e Diff (%)	0.0	0.0	4.7	-71.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-21.6

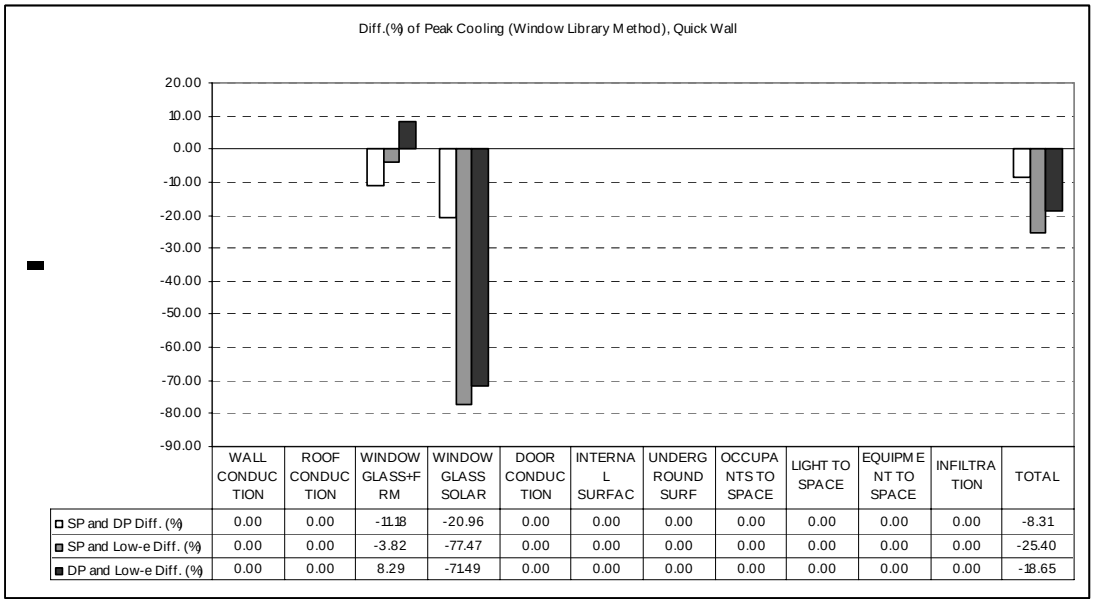
Figure 25. Difference (%) of peak cooling.

Daily Peak Cooling (kBtu/day):



	WALL CONDUCTION	ROOF CONDUCTION	WINDOW GLASS+FRM COND	WINDOW GLASS SOLAR	DOOR CONDUCTION	INTERNAL SURFACE COND	UNDERGROUND SURF	OCCUPANTS TO SPACE	LIGHT TO SPACE	EQUIPMENT TO SPACE	INFILTRATION
Window Lib. (467.06)	33.08	34.36	66.04	149.91	2.92	0.00	16.58	9.60	36.04	36.04	82.49
Window Lib. (428.26)	33.08	34.36	58.66	118.49	2.92	0.00	16.58	9.60	36.04	36.04	82.49
Window Lib.(348.41)	33.08	34.36	63.52	33.78	2.92	0.00	16.58	9.60	36.04	36.04	82.49

Figure 26. Comparison of daily peak cooling of Single-pane, Double-pane and Low-e Glass (Window Library Method / Quick Wall).

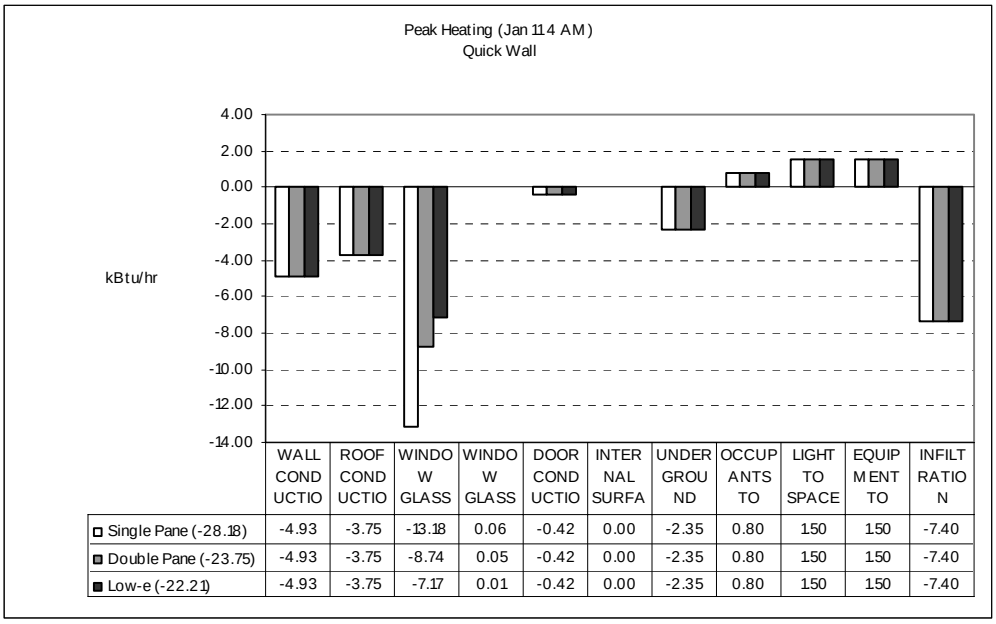


	WALL CONDUCTION	ROOF CONDUCTION	WINDOW GLASS+FRM	WINDOW GLASS SOLAR	DOOR CONDUCTION	INTERNAL SURFAC	UNDERGROUND SURF	OCCUPANTS TO SPACE	LIGHT TO SPACE	EQUIPMENT TO SPACE	INFILTRATION	TOTAL
SP and DP Diff. (%)	0.00	0.00	-11.18	-20.96	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-8.31
SP and Low-e Diff. (%)	0.00	0.00	-3.82	-77.47	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-25.40
DP and Low-e Diff. (%)	0.00	0.00	8.29	-71.49	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-18.65

Figure 27. Difference (%) of peak cooling.

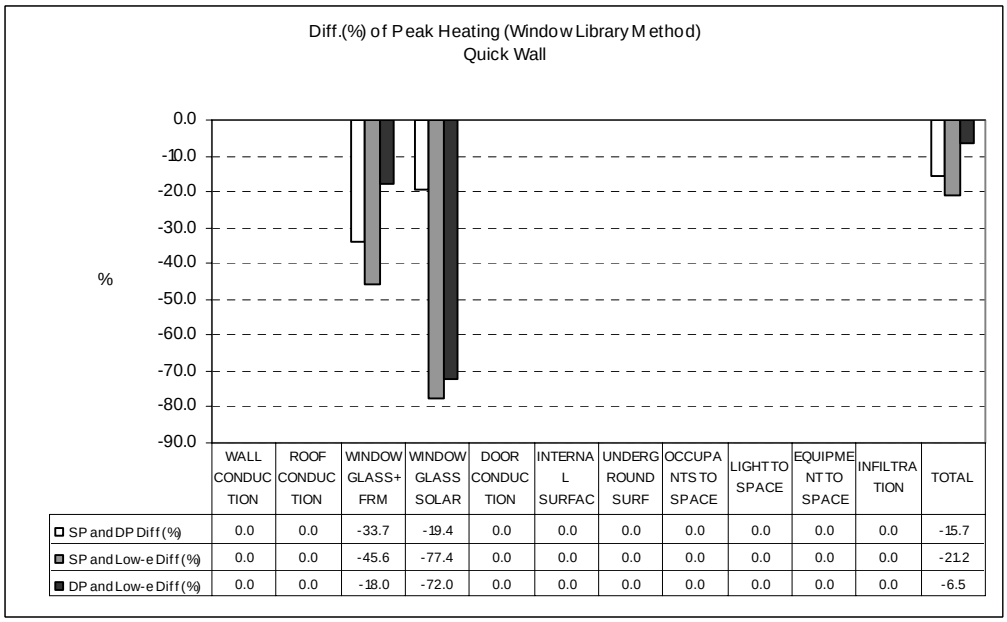
Comparison of Single-pane, Double-pane and Low-e Glass (Window Library Method / Quick Wall):

Hourly Peak Heating (kBtu/hr):



	WALL CONDUCTIO	ROOF CONDUCTIO	WINDOW GLASS	WINDOW GLASS	DOOR CONDUCTIO	INTERNAL SURFA	UNDER GROUND	OCCUPANTS TO	LIGHT TO SPACE	EQUIPMENT TO	INFILTRATION
Single Pane (-28.18)	-4.93	-3.75	-13.18	0.06	-0.42	0.00	-2.35	0.80	1.50	1.50	-7.40
Double Pane (-23.75)	-4.93	-3.75	-8.74	0.05	-0.42	0.00	-2.35	0.80	1.50	1.50	-7.40
Low-e (-22.21)	-4.93	-3.75	-7.17	0.01	-0.42	0.00	-2.35	0.80	1.50	1.50	-7.40

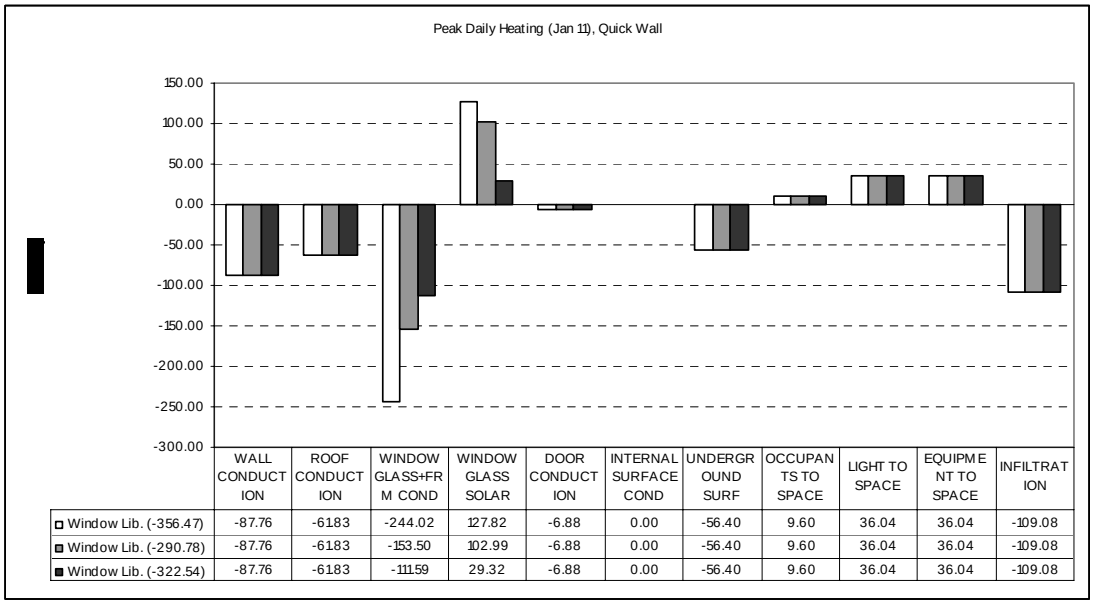
Figure 28. Comparison of hourly peak heating of Single-pane, Double-pane and Low-e Glass (Window Library Method / Quick Wall).



	WALL CONDUCTION	ROOF CONDUCTION	WINDOW GLASS+FRM	WINDOW GLASS SOLAR	DOOR CONDUCTION	INTERNAL SURFAC	UNDERGROUND SURF	OCCUPANTS TO SPACE	LIGHT TO SPACE	EQUIPMENT TO SPACE	INFILTRATION	TOTAL
SP and DP Diff (%)	0.0	0.0	-33.7	-19.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-15.7
SP and Low-e Diff (%)	0.0	0.0	-45.6	-77.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-21.2
DP and Low-e Diff (%)	0.0	0.0	-18.0	-72.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-6.5

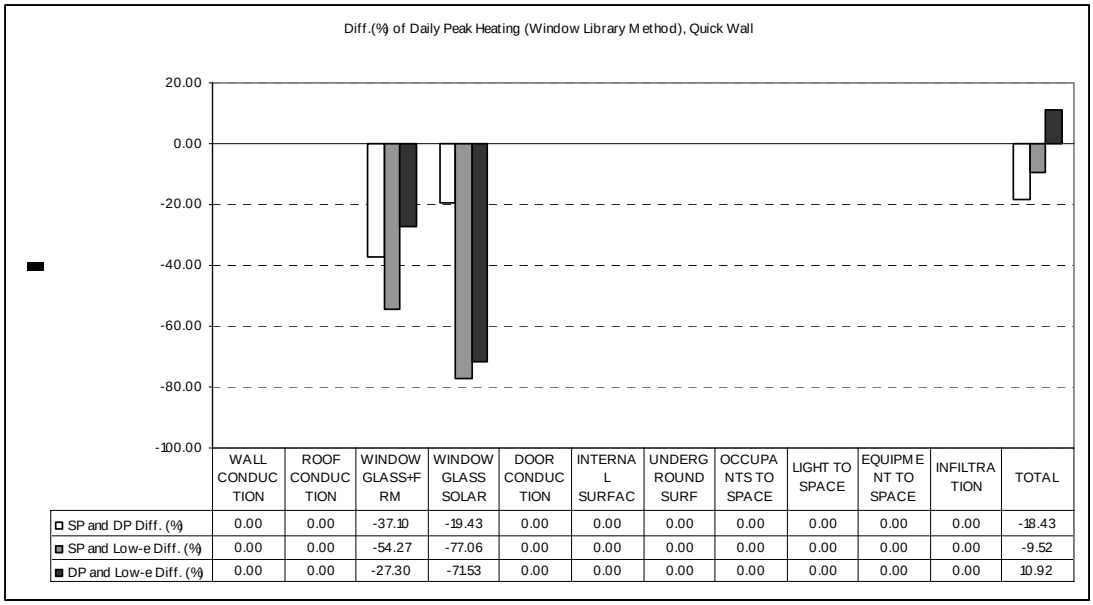
Figure 29. Difference (%) of peak heating.

Daily Peak Heating (kBtu/day):



	WALL CONDUCTION	ROOF CONDUCTION	WINDOW GLASS+FRM COND	WINDOW GLASS SOLAR	DOOR CONDUCTION	INTERNAL SURFACE COND	UNDERGROUND SURF	OCCUPANTS TO SPACE	LIGHT TO SPACE	EQUIPMENT TO SPACE	INFILTRATION
Window Lib. (-356.47)	-87.76	-61.83	-244.02	127.82	-6.88	0.00	-56.40	9.60	36.04	36.04	-109.08
Window Lib. (-290.78)	-87.76	-61.83	-153.50	102.99	-6.88	0.00	-56.40	9.60	36.04	36.04	-109.08
Window Lib. (-322.54)	-87.76	-61.83	-111.59	29.32	-6.88	0.00	-56.40	9.60	36.04	36.04	-109.08

Figure 30. Comparison of daily peak heating of Single-pane, Double-pane and Low-e Glass (Window Library Method / Quick Wall).



	WALL CONDUCTION	ROOF CONDUCTION	WINDOW GLASS+FRM	WINDOW GLASS SOLAR	DOOR CONDUCTION	INTERNAL SURFAC	UNDERGROUND SURF	OCCUPANTS TO SPACE	LIGHT TO SPACE	EQUIPMENT TO SPACE	INFILTRATION	TOTAL
SP and DP Diff. (%)	0.00	0.00	-37.10	-19.43	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-18.43
SP and Low-e Diff. (%)	0.00	0.00	-54.27	-77.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-9.52
DP and Low-e Diff. (%)	0.00	0.00	-27.30	-71.53	0.00	0.00	0.00	0.00	0.00	0.00	0.00	10.92

Figure 31. Difference (%) of daily peak heating.

Solar Gain of Quick Wall:

- QSOLG + QABSG: Transmitted plus reconducted solar heat gain through window (glass plus frame)
- QCON + QCONFR: Conduction heat gain through window (glass plus frame)

Single Pane / Quick Wall:

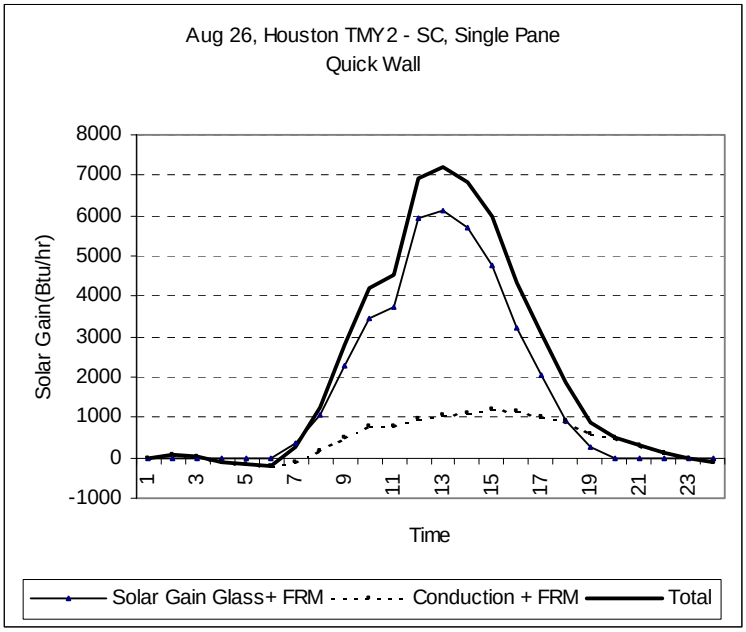


Figure 32. Solar Gain of Single Pane / Shading Coefficient, Quick Wall.

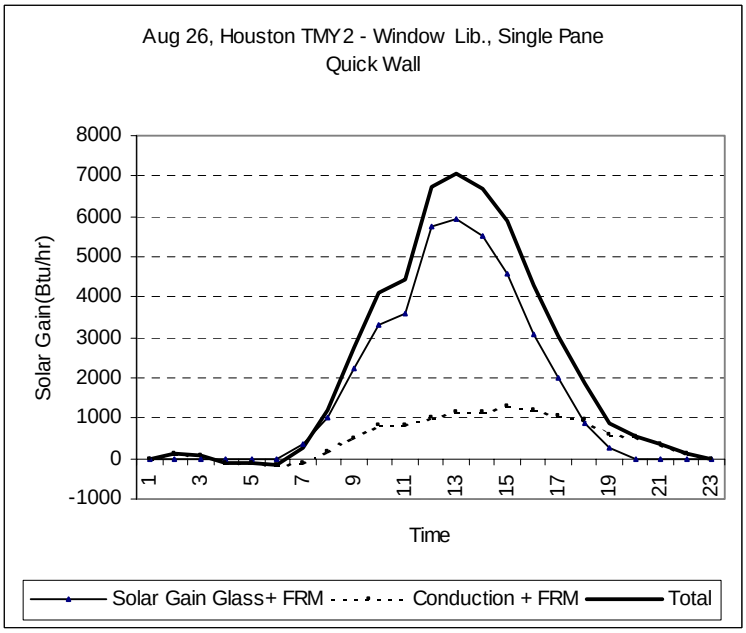


Figure 33. Solar Gain of Single Pane / Window Library, Quick Wall.

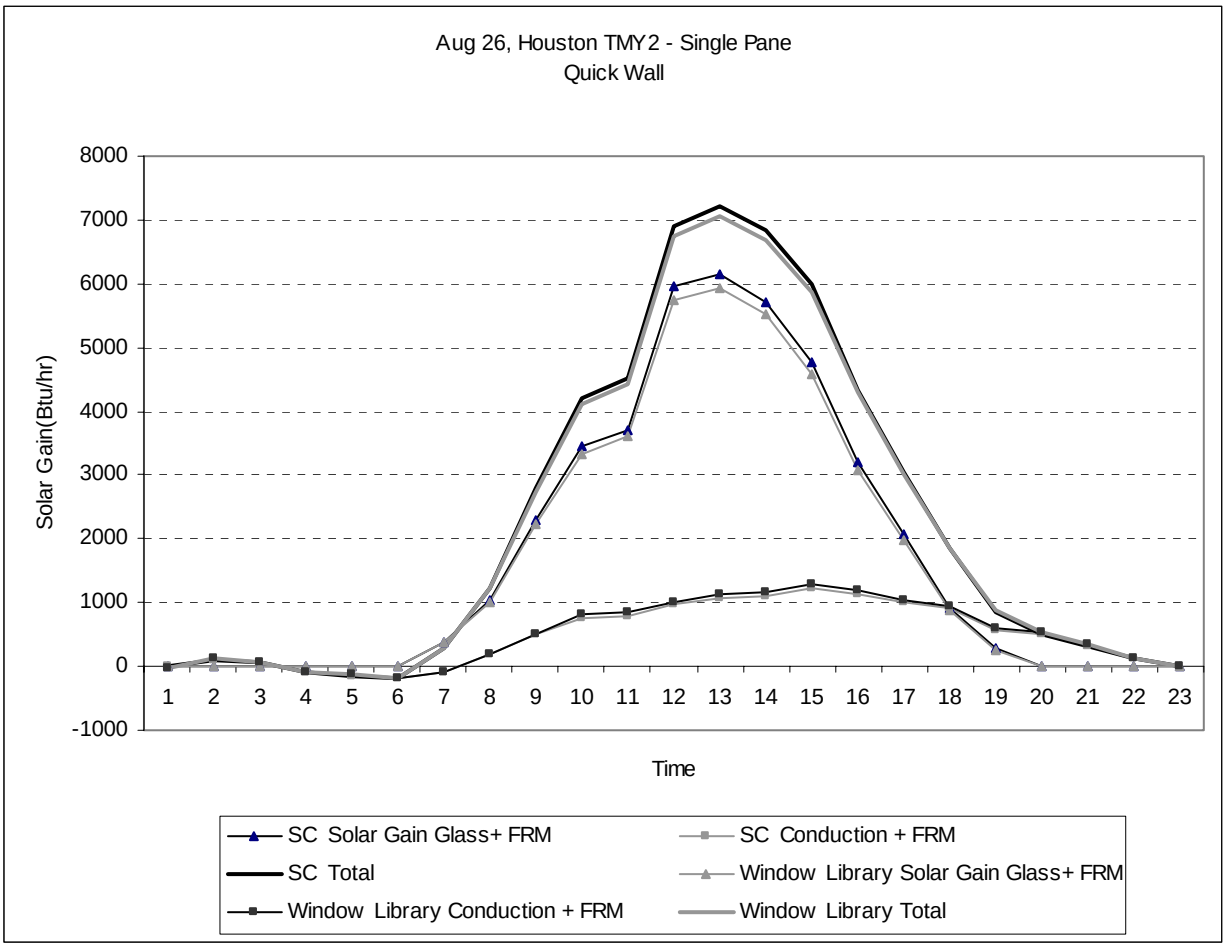


Figure 34. Solar Gain of Single Pane / Shading Coefficient and Window Library, Quick Wall.

Double Pane / Quick Wall:

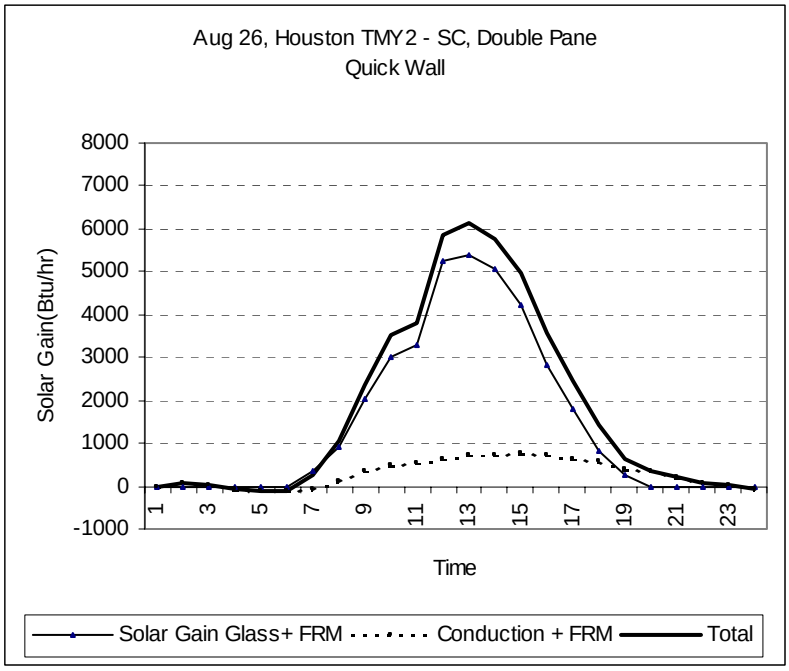


Figure 35. Solar Gain of Double Pane / Shading Coefficient, Quick Wall.

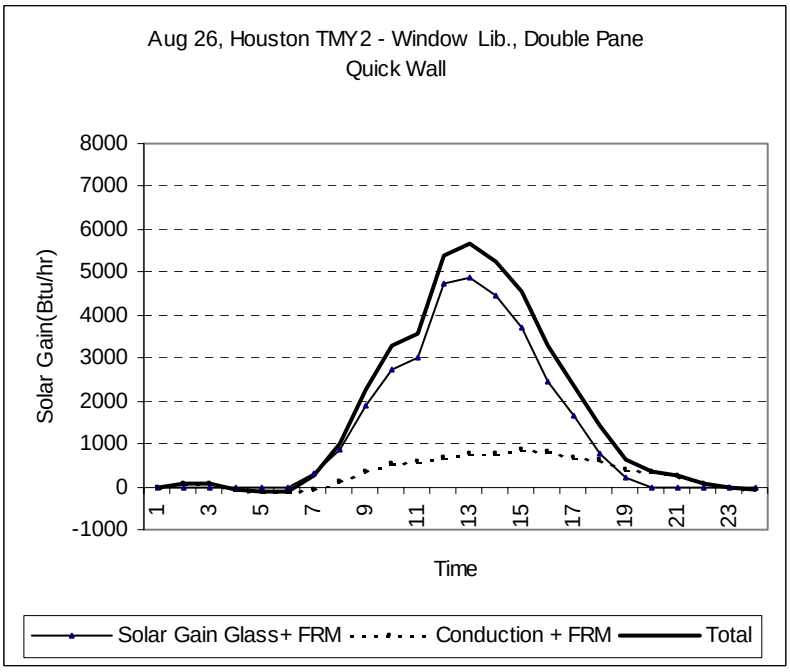


Figure 36. Solar Gain of Double Pane / Window Library, Quick Wall.

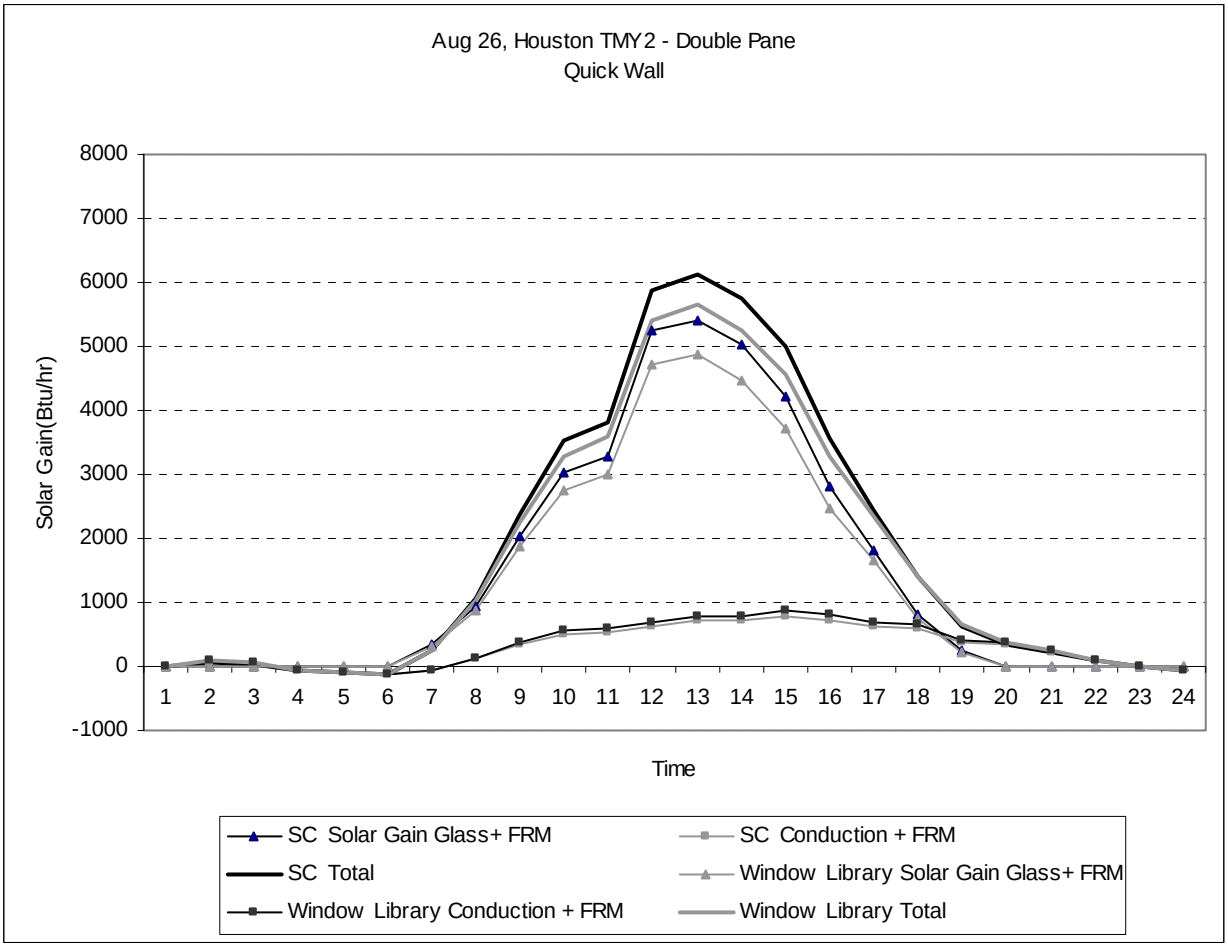


Figure 37. Solar Gain of Double Pane / Shading Coefficient and Window Library, Quick Wall.

Low-e / Quick Wall:

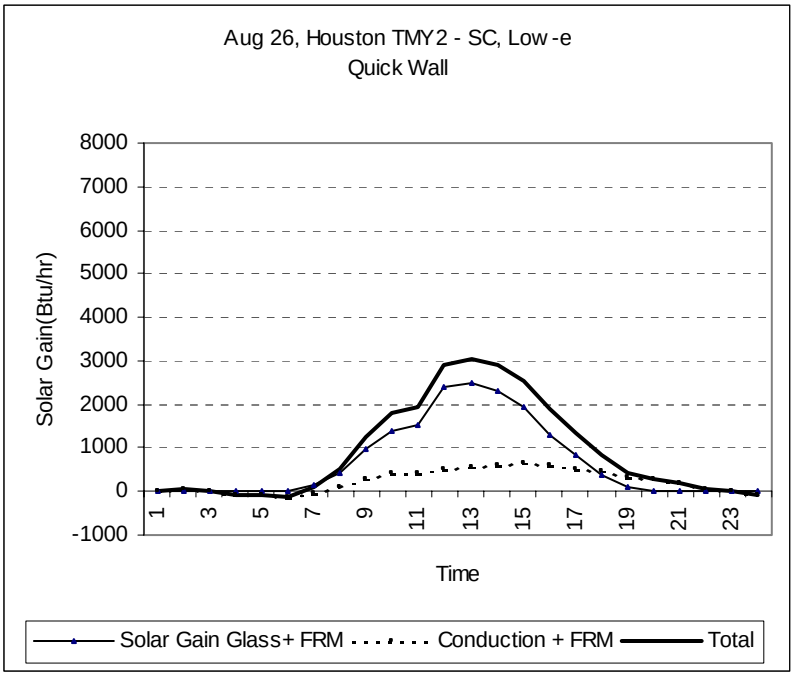


Figure 38. Solar Gain of Low-e/ Shading Coefficient, Quick Wall.

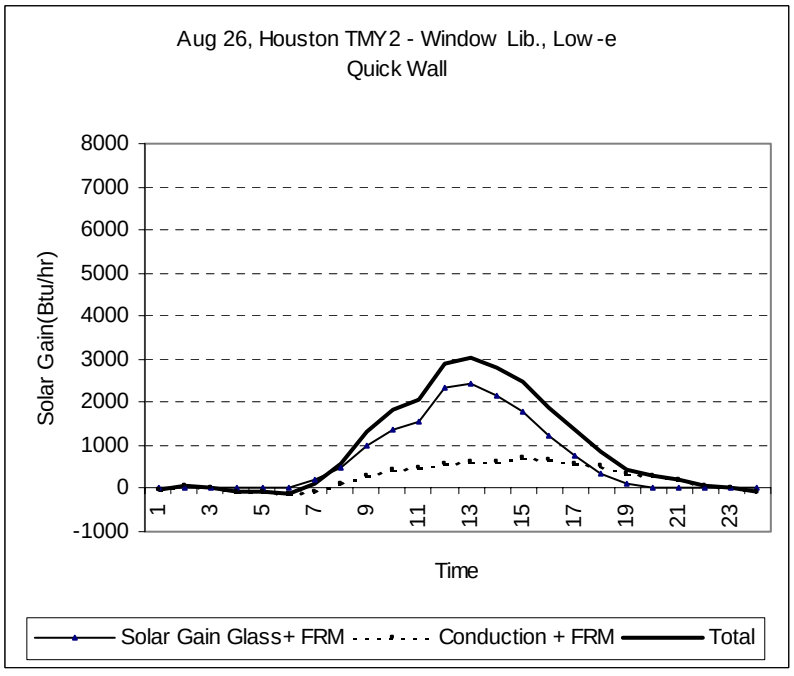


Figure 39. Solar Gain of Low-e/ Window Library, Quick Wall.

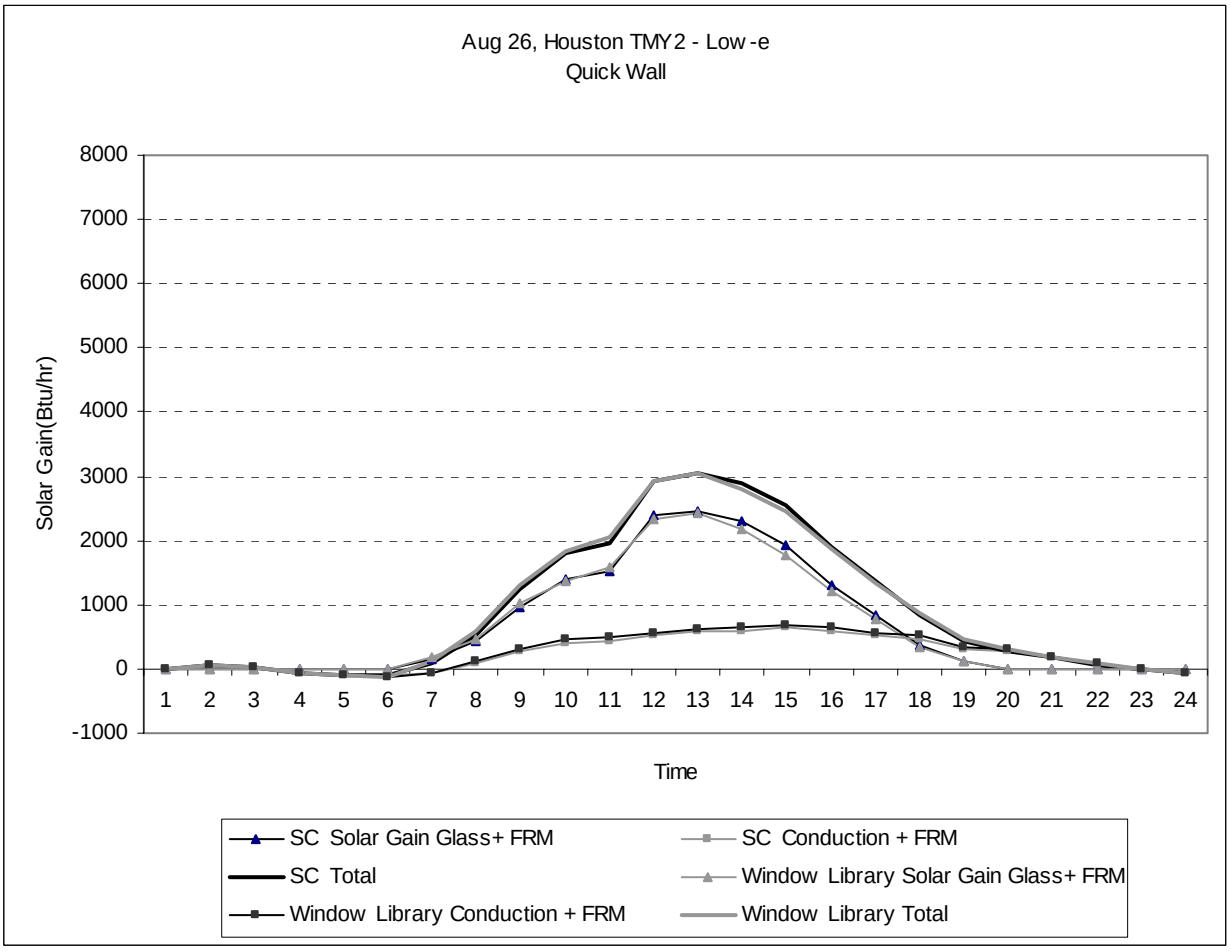


Figure 40. Solar Gain of Low-e Glass / Shading Coefficient and Window Library, Quick Wall.

Total Solar Gain of Quick Wall:

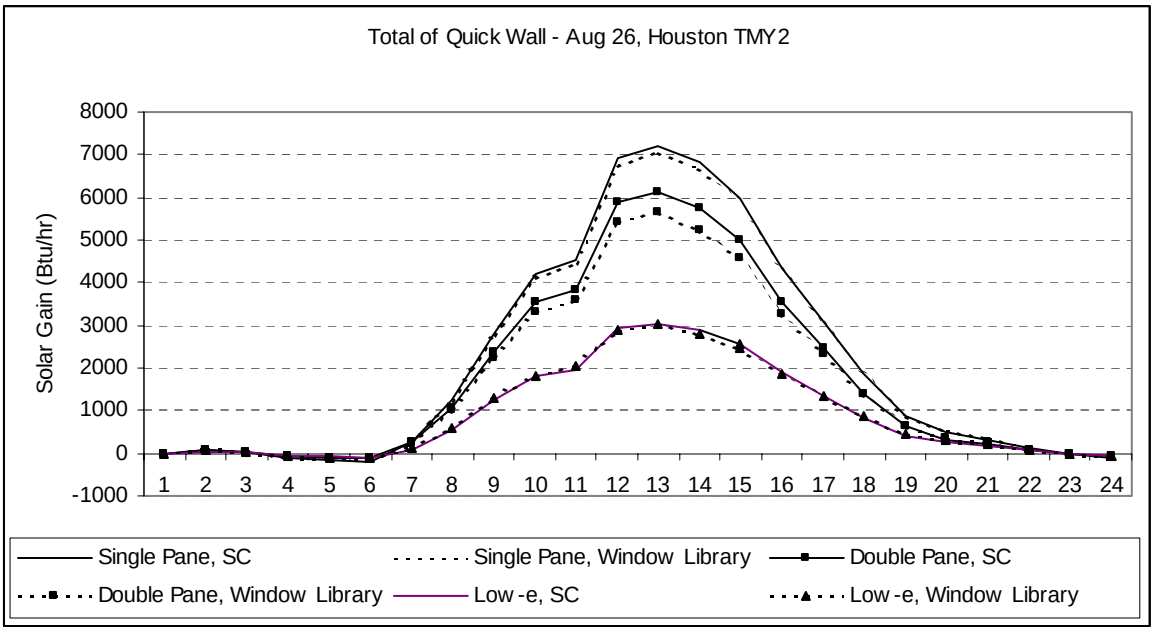


Figure 41. Total Solar Gain of Quick Wall Simulations.

4 Thermal Wall

The following are DOE input files of single-pane, double-pane and low-e glass with Shading Coefficient and Window Library Method on thermal wall and the DOE output file from those input files.

4.1 Single Pane Simulation

Input of Single Pane:

Shading Coefficient (thermal_sc_single.inp)

```
W-1 = GLASS-TYPE
          SHADING-COEF = 1                        $(0 TO 1)
          PANES = 1                               $MIN=1,MAX=3
          GLASS-CONDUCTANCE = 1.434               $(BTU/HR.FT^2.F)
          VIS-TRANS = .898                        $DOE-2 DEFAULT = 0.9(0 TO 1)
          FRAME-CONDUCTANCE = 3.037               $DOE-2 DEFAULT = 0.434(BTU/HR.FT^2.F)
          FRAME-ABS = 0.9                         $DOE-2 DEFAULT = 0.7(0 TO 1)
                     ..                           $END OF GLASS-TYPE COMMAND

W-F-1 = WINDOW
             WIDTH = 11.53                    $(FT)
             HEIGHT = 4.53                    $(FT)
             X = 20
             Y = 1                            $COORDINATES
             SETBACK = 0.0                    $(FT)
        GLASS-TYPE = W-1
             FRAME-WIDTH = 0.2344             $EXPLANATION IN THE PARAMETER SECTION
             SKY-FORM-FACTOR = P-VIEWFACTORF  $ARBITRARY VALUE(0 TO 1)
             GND-FORM-FACTOR = 0.5            $ARBITRARY VALUE(0 TO 1)
             SHADING-DIVISIONS = 10           $DOE-2 DEFAULT, (0 TO 40)UNITS
                       ..                     $END OF WINDOW COMMAND
```

Window Library (thermal_lib_single.inp)

```
W-1 = GLASS-TYPE
          GLASS-TYPE-CODE = 1000
          FRAME-CONDUCTANCE = 3.037           $DOE-2 DEFAULT = 0.434(BTU/HR.FT^2.F)
          FRAME-ABS = 0.9                     $DOE-2 DEFAULT = 0.7(0 TO 1)
                     ..                       $END OF GLASS-TYPE COMMAND

W-F-1 = WINDOW
             WIDTH = 11.53                    $(FT)
             HEIGHT = 4.53                    $(FT)
             X = 20
             Y = 1                            $COORDINATES
             SETBACK = 0.0                    $(FT)
             GLASS-TYPE = W-1
             FRAME-WIDTH = 0.2344             $EXPLANATION IN THE PARAMETER SECTION
             SKY-FORM-FACTOR = P-VIEWFACTORF  $ARBITRARY VALUE(0 TO 1)
             GND-FORM-FACTOR = 0.5            $ARBITRARY VALUE(0 TO 1)
             SHADING-DIVISIONS = 10           $DOE-2 DEFAULT, (0 TO 40)UNITS
                       ..                     $END OF WINDOW COMMAND
```

Table 8. Window Library for Single Pane.

									LAY1		GAP1		LAY2	
ID	U-SI	U-IP	SC	SHGC	Tsol	Rfsol	Tvis	Rfvis	ID	WID	GAS	ID	U-SI	U-IP
1000	6.31	**1.118**	**1.00**	.86	.84	.08	.90	.08	2	3.0				

Uall = 1/(1/Ucenter - .197) = 1/(1/1.118 - .197) = **1.434**

DOE Output for Glazing (Single Pane):

REPORT- LV-C

Shading Coefficient (thermal_sc_single.out)

EXTERIOR WINDOWS (U-VALUE INCLUDES OUTSIDE AIR FILM)

GLASS HEIGHT (FT)	CENTER-OF-GLASS U-VALUE (BTU/HR-SQFT-F)	GLASS VISIBLE TRANS	GLASS AREA (SQFT)	GLASS SHADING COEFF	NUMBER OF PANES	GLASS TYPE CODE	SET-BACK (FT)	GLASS WIDTH (FT)
W-F-1		1.0	52.25	1.00	1	1	0.00	11.53
4.53	1.120	0.898						
W-R-1		1.0	52.25	1.00	1	1	0.00	11.53
4.53	1.120	0.898						
W-B-1		1.0	52.25	1.00	1	1	0.00	11.53
4.53	1.120	0.898						
W-L-1		1.0	52.25	1.00	1	1	0.00	11.53
4.53	1.120	0.898						

Window Library (thermal_lib_single.out)

EXTERIOR WINDOWS (U-VALUE INCLUDES OUTSIDE AIR FILM)

GLASS HEIGHT (FT)	CENTER-OF-GLASS U-VALUE (BTU/HR-SQFT-F)	GLASS VISIBLE TRANS	GLASS AREA (SQFT)	GLASS SHADING COEFF	NUMBER OF PANES	GLASS TYPE CODE	SET-BACK (FT)	GLASS WIDTH (FT)
W-F-1		1.0	52.25	1.00	1	1000	0.00	11.53
4.53	1.118	0.898						
W-R-1		1.0	52.25	1.00	1	1000	0.00	11.53
4.53	1.118	0.898						
W-B-1		1.0	52.25	1.00	1	1000	0.00	11.53
4.53	1.118	0.898						
W-L-1		1.0	52.25	1.00	1	1000	0.00	11.53
4.53	1.118	0.898						

DOE Output for Glazing (Single Pane):

REPORT- LV-D

Shading Coefficient (thermal_sc_single.out)

-W A L L + W I N D O W S- SURFACE	SPACE		- - - W I N D O W S - - - U-VALUE (BTU/HR-SQFT-F)	AREA (SQFT)	- - - - W A L L - - - - U-VALUE (BTU/HR-SQFT-F)	AREA (SQFT)
U-VALUE	AREA	AZIMUTH				
BACK-1_1	RM-1		1.221	60.00	0.058	290.00
0.258	350.00	NORTH				
BACK-1_2	RM-1		0.000	0.00	0.139	50.00
0.139	50.00	NORTH				
RIGHT-1_2	RM-1		0.000	0.00	0.139	50.00
0.139	50.00	EAST				
RIGHT-1_1	RM-1		1.221	60.00	0.058	290.00
0.258	350.00	EAST				
FRONT-1_2	RM-1		0.000	0.00	0.139	50.00
0.139	50.00	SOUTH				
FRONT-1_1	RM-1		1.221	60.00	0.058	290.00
0.258	350.00	SOUTH				
LEFT-1_1	RM-1		1.221	60.00	0.058	136.00
0.414	196.00	WEST				
LEFT-1_2	RM-1		0.000	0.00	0.139	28.00
0.139	28.00	WEST				

Window Library (thermal_lib_single.out)

BACK-1_1	RM-1		1.220	60.00	0.058	290.00
0.257	350.00	NORTH				
BACK-1_2	RM-1		0.000	0.00	0.139	50.00
0.139	50.00	NORTH				
RIGHT-1_2	RM-1		0.000	0.00	0.139	50.00
0.139	50.00	EAST				
RIGHT-1_1	RM-1		1.220	60.00	0.058	290.00
0.257	350.00	EAST				
FRONT-1_2	RM-1		0.000	0.00	0.139	50.00
0.139	50.00	SOUTH				
FRONT-1_1	RM-1		1.220	60.00	0.058	290.00
0.257	350.00	SOUTH				
LEFT-1_1	RM-1		1.220	60.00	0.058	136.00
0.414	196.00	WEST				
LEFT-1_2	RM-1		0.000	0.00	0.139	28.00
0.139	28.00	WEST				

4.2 Double Pane Simulation

Input of Double Pane:

Shading Coefficient (thermal_sc_double.inp)

```
W-1 = GLASS-TYPE
          SHADING-COEF = .88                    $(0 TO 1)
          PANES = 2                             $MIN=1,MAX=3
          GLASS-CONDUCTANCE = .653              $(BTU/HR.FT^2.F)
          VIS-TRANS = .812                      $DOE-2 DEFAULT = 0.9(0 TO 1)
          FRAME-CONDUCTANCE = 3.037             $DOE-2 DEFAULT = 0.434(BTU/HR.FT^2.F)
          FRAME-ABS = 0.9                       $DOE-2 DEFAULT = 0.7(0 TO 1)
                    ..                          $END OF GLASS-TYPE COMMAND

W-F-1 = WINDOW
             WIDTH = 11.53                    $(FT)
             HEIGHT = 4.53                    $(FT)
             X = 20
             Y = 1                            $COORDINATES
             SETBACK = 0.0                    $(FT)
             GLASS-TYPE = W-1
             FRAME-WIDTH = 0.2344             $EXPLANATION IN THE PARAMETER SECTION
             SKY-FORM-FACTOR = P-VIEWFACTORF  $ARBITRARY VALUE(0 TO 1)
             GND-FORM-FACTOR = 0.5            $ARBITRARY VALUE(0 TO 1)
             SHADING-DIVISIONS = 10           $DOE-2 DEFAULT, (0 TO 40)UNITS
                      ..                      $END OF WINDOW COMMAND
```

Window Library (thermal_lib_double.inp)

```
W-1 = GLASS-TYPE
          GLASS-TYPE-CODE = 2000
          FRAME-CONDUCTANCE = 3.037             $DOE-2 DEFAULT = 0.434(BTU/HR.FT^2.F)
          FRAME-ABS = 0.9                       $DOE-2 DEFAULT = 0.7(0 TO 1)
                    ..                          $END OF GLASS-TYPE COMMAND

W-F-1 = WINDOW
             WIDTH = 11.53                    $(FT)
             HEIGHT = 4.53                    $(FT)
             X = 20
             Y = 1                            $COORDINATES
             SETBACK = 0.0                    $(FT)
             GLASS-TYPE = W-1
             FRAME-WIDTH = 0.2344             $EXPLANATION IN THE PARAMETER SECTION
             SKY-FORM-FACTOR = P-VIEWFACTORF  $ARBITRARY VALUE(0 TO 1)
             GND-FORM-FACTOR = 0.5            $ARBITRARY VALUE(0 TO 1)
             SHADING-DIVISIONS = 10           $DOE-2 DEFAULT, (0 TO 40)UNITS
                      ..                      $END OF WINDOW COMMAND
```

Table 9. Window Library for Double Pane.

									LAY1		GAP1		LAY2	
ID	U-SI	U-IP	SC	SHGC	Tsol	Rfsol	Tvis	Rfvis	ID	WID	GAS	WID	ID	WID
2000	3.23	**.579**	**.88**	.76	.70	.13	.81	.15	2	3.0	Air	6.3	2	3.0

Uall = 1/(1/Ucenter - .197) = 1/(1/.579 - .197) = **.653**

DOE Output for Glazing (Double Pane):

REPORT- LV-C

Shading Coefficient (thermal_sc_double.out)

EXTERIOR WINDOWS (U-VALUE INCLUDES OUTSIDE AIR FILM)

GLASS HEIGHT (FT)	CENTER-OF-GLASS WINDOW	GLASS U-VALUE (BTU/HR-SQFT-F)	VISIBLE MULTIPLIER TRANS	GLASS AREA (SQFT)	GLASS SHADING COEFF	NUMBER OF PANES	GLASS TYPE CODE	SET-BACK (FT)	GLASS WIDTH (FT)
4.53	W-F-1	0.579	1.0 0.812	52.25	0.88	2	1	0.00	11.53
4.53	W-R-1	0.579	1.0 0.812	52.25	0.88	2	1	0.00	11.53
4.53	W-B-1	0.579	1.0 0.812	52.25	0.88	2	1	0.00	11.53
4.53	W-L-1	0.579	1.0 0.812	52.25	0.88	2	1	0.00	11.53

Window Library (thermal_lib_double.out)

EXTERIOR WINDOWS (U-VALUE INCLUDES OUTSIDE AIR FILM)

GLASS HEIGHT (FT)	CENTER-OF-GLASS WINDOW	GLASS U-VALUE (BTU/HR-SQFT-F)	VISIBLE MULTIPLIER TRANS	GLASS AREA (SQFT)	GLASS SHADING COEFF	NUMBER OF PANES	GLASS TYPE CODE	SET-BACK (FT)	GLASS WIDTH (FT)
4.53	W-F-1	0.579	1.0 0.812	52.25	0.88	2	2000	0.00	11.53
4.53	W-R-1	0.579	1.0 0.812	52.25	0.88	2	2000	0.00	11.53
4.53	W-B-1	0.579	1.0 0.812	52.25	0.88	2	2000	0.00	11.53
4.53	W-L-1	0.579	1.0 0.812	52.25	0.88	2	2000	0.00	11.53

DOE Output for Glazing (Double Pane):

REPORT- LV-D

Shading Coefficient (thermal_sc_double.out)

-W A L L + W I N D O W S- SURFACE	SPACE	- - - W I N D O W S - - - U-VALUE (BTU/HR-SQFT-F)	AREA (SQFT)	- - - - W A L L - - - - U-VALUE (BTU/HR-SQFT-F)	AREA (SQFT)	U-VALUE	AREA	AZIMUTH
BACK-1_1	RM-1	0.750	60.00	0.058	290.00	0.177	350.00	NORTH
BACK-1_2	RM-1	0.000	0.00	0.139	50.00	0.139	50.00	NORTH
RIGHT-1_2	RM-1	0.000	0.00	0.139	50.00	0.139	50.00	EAST
RIGHT-1_1	RM-1	0.750	60.00	0.058	290.00	0.177	350.00	EAST
FRONT-1_2	RM-1	0.000	0.00	0.139	50.00	0.139	50.00	SOUTH
FRONT-1_1	RM-1	0.750	60.00	0.058	290.00	0.177	350.00	SOUTH
LEFT-1_1	RM-1	0.750	60.00	0.058	136.00	0.270	196.00	WEST
LEFT-1_2	RM-1	0.000	0.00	0.139	28.00	0.139	28.00	WEST

Window Library (thermal_lib_double.out)

BACK-1_1	RM-1	0.751	60.00	0.058	290.00	0.177	350.00	NORTH
BACK-1_2	RM-1	0.000	0.00	0.139	50.00	0.139	50.00	NORTH
RIGHT-1_2	RM-1	0.000	0.00	0.139	50.00	0.139	50.00	EAST
RIGHT-1_1	RM-1	0.751	60.00	0.058	290.00	0.177	350.00	EAST
FRONT-1_2	RM-1	0.000	0.00	0.139	50.00	0.139	50.00	SOUTH
FRONT-1_1	RM-1	0.751	60.00	0.058	290.00	0.177	350.00	SOUTH
LEFT-1_1	RM-1	0.751	60.00	0.058	136.00	0.270	196.00	WEST
LEFT-1_2	RM-1	0.000	0.00	0.139	28.00	0.139	28.00	WEST

Low-e Double Pane Simulation

Input of Low-e Double Pane:

Shading Coefficient (thermal_sc_lowe.inp)

```
W-1 = GLASS-TYPE
          SHADING-COEF = .35                    $(0 TO 1)
          PANES = 2                             $MIN=1,MAX=3
          GLASS-CONDUCTANCE = .4579             $(BTU/HR.FT^2.F)
          VIS-TRANS = .407                      $DOE-2 DEFAULT = 0.9(0 TO 1)
          FRAME-CONDUCTANCE = 3.037             $DOE-2 DEFAULT = 0.434(BTU/HR.FT^2.F)
          FRAME-ABS = 0.9                       $DOE-2 DEFAULT = 0.7(0 TO 1)
                     ..                         $END OF GLASS-TYPE COMMAND

W-F-1 = WINDOW
             WIDTH = 11.53                  $(FT)
             HEIGHT = 4.53                  $(FT)
             X = 20
             Y = 1                          $COORDINATES
             SETBACK = 0.0                  $(FT)
             GLASS-TYPE = W-1
             FRAME-WIDTH = 0.2344           $EXPLANATION IN THE PARAMETER SECTION
             SKY-FORM-FACTOR = P-VIEWFACTORF $ARBITRARY VALUE(0 TO 1)
             GND-FORM-FACTOR = 0.5          $ARBITRARY VALUE(0 TO 1)
             SHADING-DIVISIONS = 10         $DOE-2 DEFAULT, (0 TO 40)UNITS
                       ..                   $END OF WINDOW COMMAND
```

Window Library (thermal_lib_lowe.inp)

```
W-1 = GLASS-TYPE
          GLASS-TYPE-CODE = 2666
          FRAME-CONDUCTANCE = 3.037             $DOE-2 DEFAULT = 0.434(BTU/HR.FT^2.F)
          FRAME-ABS = 0.9                       $DOE-2 DEFAULT = 0.7(0 TO 1)
                     ..                         $END OF GLASS-TYPE COMMAND

W-F-1 = WINDOW
             WIDTH = 11.53                  $(FT)
             HEIGHT = 4.53                  $(FT)
             X = 20
             Y = 1                          $COORDINATES
             SETBACK = 0.0                  $(FT)
             GLASS-TYPE = W-1
             FRAME-WIDTH = 0.2344           $EXPLANATION IN THE PARAMETER SECTION
             SKY-FORM-FACTOR = P-VIEWFACTORF $ARBITRARY VALUE(0 TO 1)
             GND-FORM-FACTOR = 0.5          $ARBITRARY VALUE(0 TO 1)
             SHADING-DIVISIONS = 10         $DOE-2 DEFAULT, (0 TO 40)UNITS
                       ..                   $END OF WINDOW COMMAND
```

Table 10. Window Library for Low-e.

									LAY1		GAP1		LAY2	
ID	U-SI	U-IP	SC	SHGC	Tsol	Rfsol	Tvis	Rfvis	ID	WID	GAS	WID	ID	WID
2666	2.41	**.42**	**.35**	.31	.21	.14	.41	.08	550	6.0	Air	6.3	3	6.0

Uall = 1/(1/Ucenter - .197) = 1/(1/1.118 - .197) = **1.434**

DOE Output for Glazing (Low-e Double Pane):

REPORT- LV-C

Shading Coefficient (thermal_sc_lowe.out)

EXTERIOR WINDOWS (U-VALUE INCLUDES OUTSIDE AIR FILM)

GLASS HEIGHT (FT)	GLASS WINDOW (BTU/HR-SQFT-F) U-VALUE	CENTER-OF-GLASS VISIBLE MULTIPLIER TRANS	GLASS AREA (SQFT)	GLASS SHADING COEFF	NUMBER OF PANES	GLASS TYPE CODE	SET-BACK (FT)	GLASS WIDTH (FT)
W-F-1		1.0	52.25	0.35	2	1	0.00	11.53
4.53	0.420	0.407						
W-R-1		1.0	52.25	0.35	2	1	0.00	11.53
4.53	0.420	0.407						
W-B-1		1.0	52.25	0.35	2	1	0.00	11.53
4.53	0.420	0.407						
W-L-1		1.0	52.25	0.35	2	1	0.00	11.53
4.53	0.420	0.407						

Window Library (thermal_lib_lowe.out)

EXTERIOR WINDOWS (U-VALUE INCLUDES OUTSIDE AIR FILM)

GLASS HEIGHT (FT)	GLASS WINDOW (BTU/HR-SQFT-F) U-VALUE	CENTER-OF-GLASS VISIBLE MULTIPLIER TRANS	GLASS AREA (SQFT)	GLASS SHADING COEFF	NUMBER OF PANES	GLASS TYPE CODE	SET-BACK (FT)	GLASS WIDTH (FT)
W-F-1		1.0	52.25	0.35	2	2666	0.00	11.53
4.53	0.420	0.407						
W-R-1		1.0	52.25	0.35	2	2666	0.00	11.53
4.53	0.420	0.407						
W-B-1		1.0	52.25	0.35	2	2666	0.00	11.53
4.53	0.420	0.407						
W-L-1		1.0	52.25	0.35	2	2666	0.00	11.53
4.53	0.420	0.407						

DOE Output for Glazing (Low-e Double Pane):

REPORT- LV-D

Shading Coefficient (thermal_sc_lowe.out)

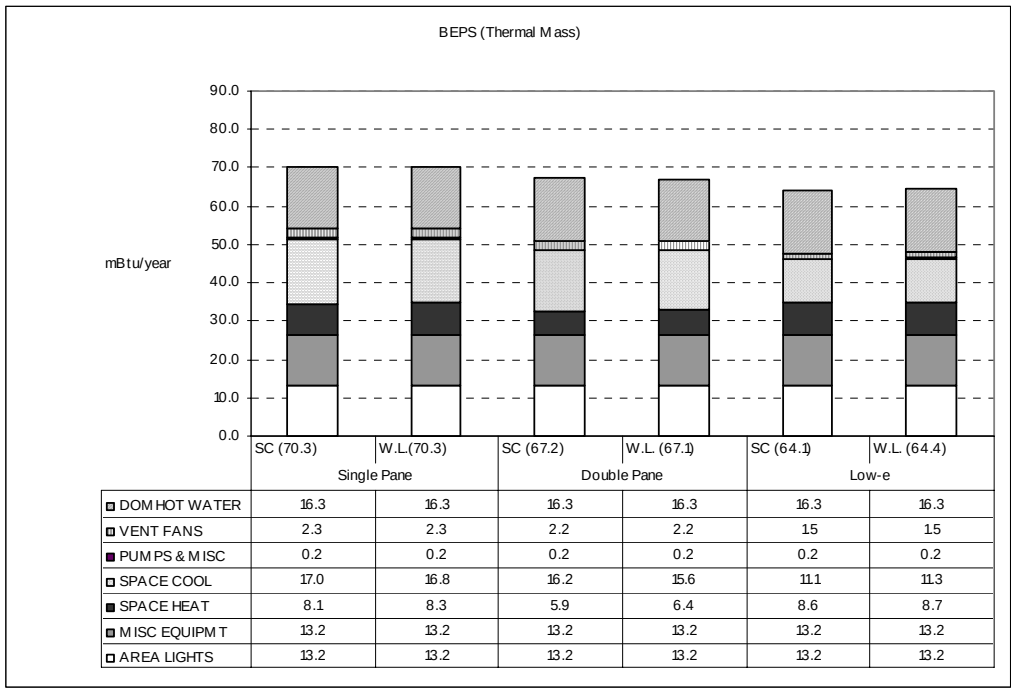
-W A L L + W I N D O W S- SURFACE		SPACE	- - - W I N D O W S - - - U-VALUE	AREA	- - - - W A L L - - - - U-VALUE	AREA
U-VALUE (BTU/HR-SQFT-F)	AREA (SQFT)	AZIMUTH	(BTU/HR-SQFT-F)	(SQFT)	(BTU/HR-SQFT-F)	(SQFT)
BACK-1_1	RM-1		0.612	60.00	0.058	290.00
0.153	350.00	NORTH				
BACK-1_2	RM-1		0.000	0.00	0.139	50.00
0.139	50.00	NORTH				
RIGHT-1_2	RM-1		0.000	0.00	0.139	50.00
0.139	50.00	EAST				
RIGHT-1_1	RM-1		0.612	60.00	0.058	290.00
0.153	350.00	EAST				
FRONT-1_2	RM-1		0.000	0.00	0.139	50.00
0.139	50.00	SOUTH				
FRONT-1_1	RM-1		0.612	60.00	0.058	290.00
0.153	350.00	SOUTH				
LEFT-1_1	RM-1		0.612	60.00	0.058	136.00
0.228	196.00	WEST				
LEFT-1_2	RM-1		0.000	0.00	0.139	28.00
0.139	28.00	WEST				

Window Library (thermal_lib_lowe.out)

BACK-1_1	RM-1		0.612	60.00	0.058	290.00
0.153	350.00	NORTH				
BACK-1_2	RM-1		0.000	0.00	0.139	50.00
0.139	50.00	NORTH				
RIGHT-1_2	RM-1		0.000	0.00	0.139	50.00
0.139	50.00	EAST				
RIGHT-1_1	RM-1		0.612	60.00	0.058	290.00
0.153	350.00	EAST				
FRONT-1_2	RM-1		0.000	0.00	0.139	50.00
0.139	50.00	SOUTH				
FRONT-1_1	RM-1		0.612	60.00	0.058	290.00
0.153	350.00	SOUTH				
LEFT-1_1	RM-1		0.612	60.00	0.058	136.00
0.228	196.00	WEST				
LEFT-1_2	RM-1		0.000	0.00	0.139	28.00
0.139	28.00	WEST				

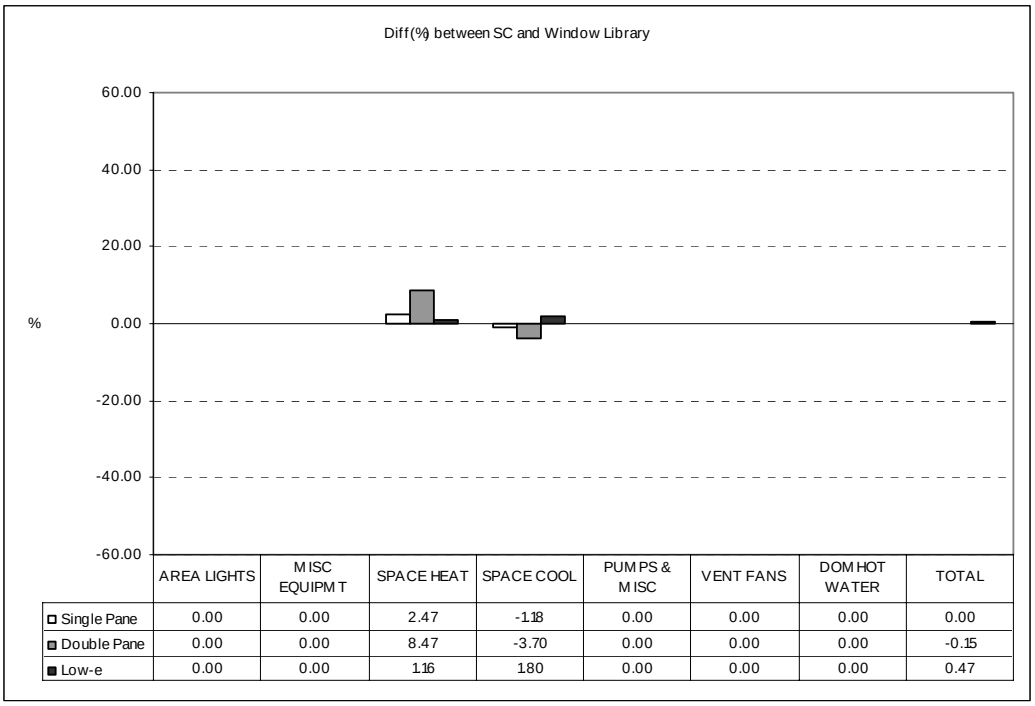
BEPS Report

The results show all annual energy consumption (Shading Coefficient and Window Library Method) on single-pane, double-pane and low-e glass of thermal wall.



	SC (70.3)	W.L.(70.3)	SC (67.2)	W.L. (67.1)	SC (64.1)	W.L. (64.4)
	Single Pane		Double Pane		Low-e	
DOM HOT WATER	16.3	16.3	16.3	16.3	16.3	16.3
VENT FANS	2.3	2.3	2.2	2.2	1.5	1.5
PUMPS & MISC	0.2	0.2	0.2	0.2	0.2	0.2
SPACE COOL	17.0	16.8	16.2	15.6	11.1	11.3
SPACE HEAT	8.1	8.3	5.9	6.4	8.6	8.7
MISC EQUIPMT	13.2	13.2	13.2	13.2	13.2	13.2
AREA LIGHTS	13.2	13.2	13.2	13.2	13.2	13.2

Figure 42. Annual BEPS of Thermal Wall.

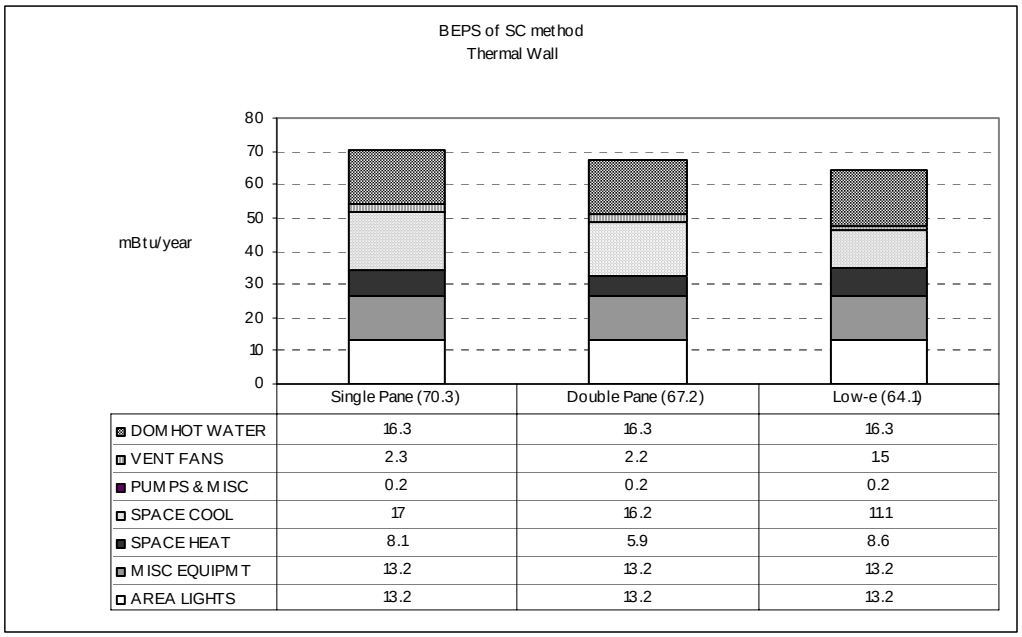


	AREA LIGHTS	MISC EQUIPMT	SPACE HEAT	SPACE COOL	PUMPS & MISC	VENT FANS	DOM HOT WATER	TOTAL
Single Pane	0.00	0.00	2.47	-1.18	0.00	0.00	0.00	0.00
Double Pane	0.00	0.00	8.47	-3.70	0.00	0.00	0.00	-0.15
Low-e	0.00	0.00	1.16	1.80	0.00	0.00	0.00	0.47

Figure 43. Difference (%) between Shading Coefficient and Window Library.

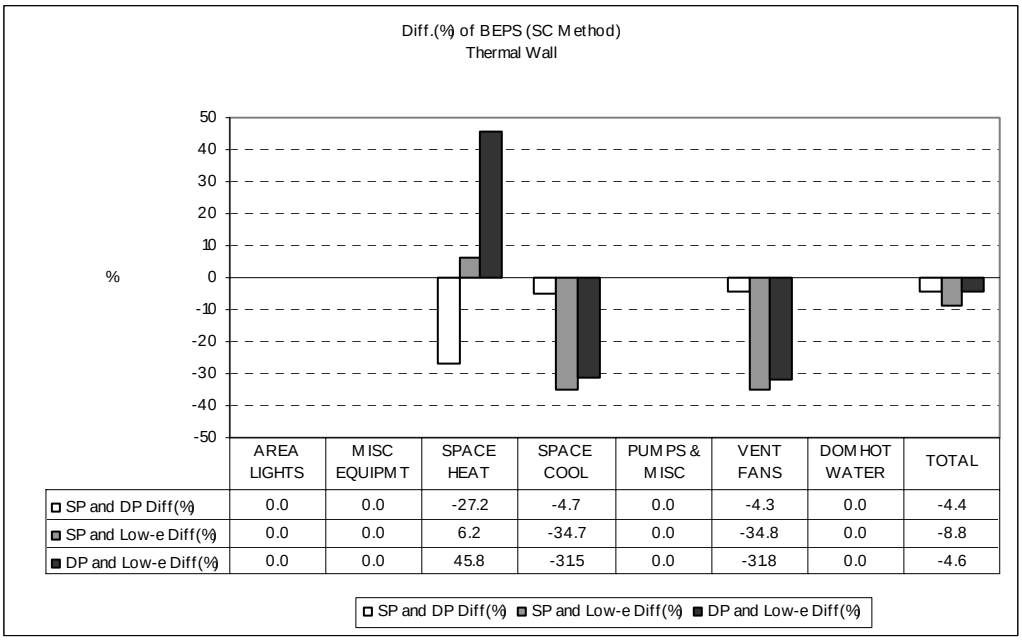
BEPS of Shading Coefficient Method (Thermal Wall):

The plots show annual energy consumption of the Shading Coefficient Method of thermal wall according to the types of glass (single-pane, double-pane, and low-e glass).



	Single Pane (70.3)	Double Pane (67.2)	Low-e (64.1)
DOM HOT WATER	16.3	16.3	16.3
VENT FANS	2.3	2.2	1.5
PUMPS & MISC	0.2	0.2	0.2
SPACE COOL	17	16.2	11.1
SPACE HEAT	8.1	5.9	8.6
MISC EQUIPMT	13.2	13.2	13.2
AREA LIGHTS	13.2	13.2	13.2

Figure 44. Annual BEPS of Shading Coefficient Method (Thermal Wall).

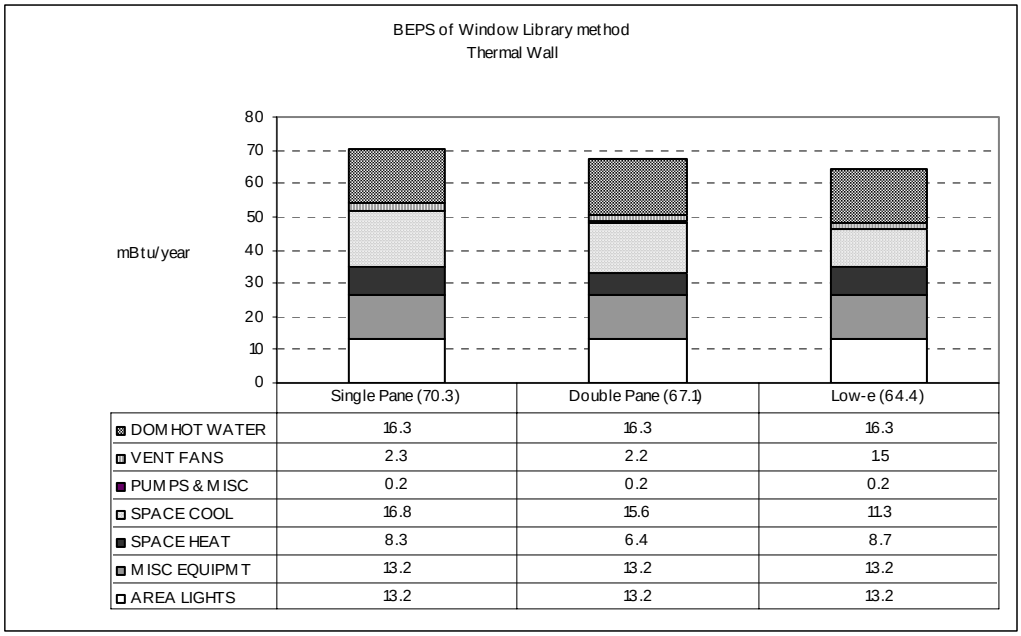


	AREA LIGHTS	MISC EQUIPMT	SPACE HEAT	SPACE COOL	PUMPS & MISC	VENT FANS	DOM HOT WATER	TOTAL
SP and DP Diff(%)	0.0	0.0	-27.2	-4.7	0.0	-4.3	0.0	-4.4
SP and Low-e Diff(%)	0.0	0.0	6.2	-34.7	0.0	-34.8	0.0	-8.8
DP and Low-e Diff(%)	0.0	0.0	45.8	-31.5	0.0	-31.8	0.0	-4.6

Figure 45. Difference (%) of BEPS (Shading Coefficient Method, Thermal Wall).

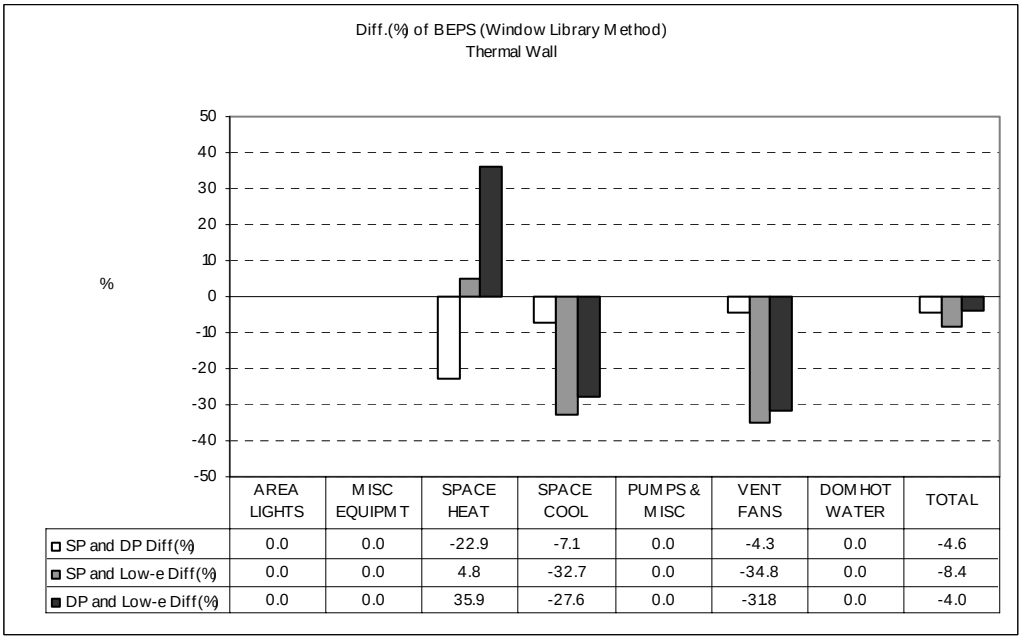
BEPS of Window Library Method (Thermal Wall):

The plots show annual energy consumption of the Window Library Method of thermal wall according to the types of glass (single-pane, double-pane, and low-e glass).



	Single Pane (70.3)	Double Pane (67.1)	Low-e (64.4)
DOM HOT WATER	16.3	16.3	16.3
VENT FANS	2.3	2.2	1.5
PUMPS & MISC	0.2	0.2	0.2
SPACE COOL	16.8	15.6	11.3
SPACE HEAT	8.3	6.4	8.7
MISC EQUIPMT	13.2	13.2	13.2
AREA LIGHTS	13.2	13.2	13.2

Figure 46. Annual BEPS of Window Library Method (Thermal Wall).

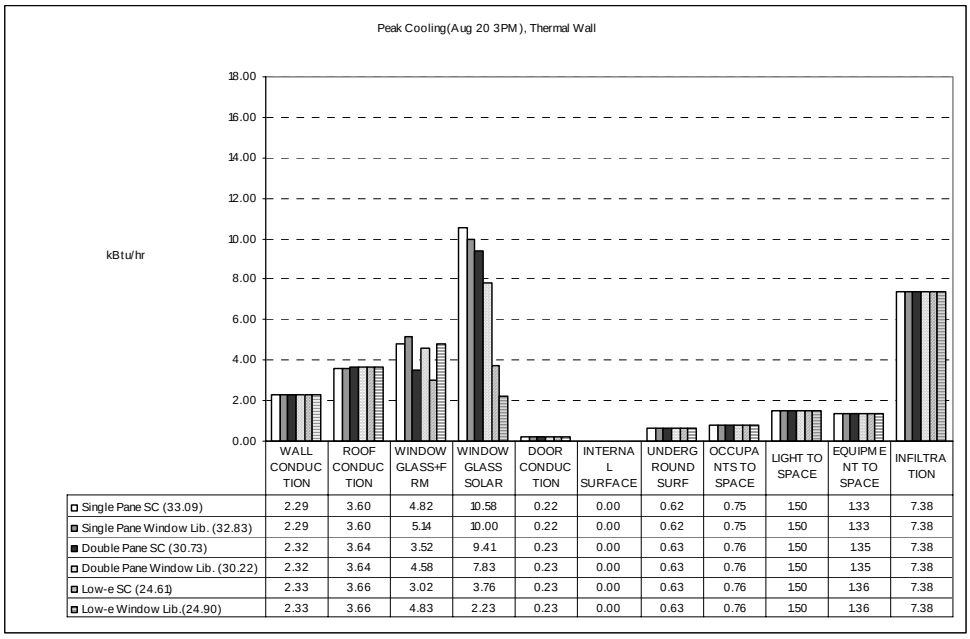


	AREA LIGHTS	MISC EQUIPMT	SPACE HEAT	SPACE COOL	PUMPS & MISC	VENT FANS	DOM HOT WATER	TOTAL
SP and DP Diff(%)	0.0	0.0	-22.9	-7.1	0.0	-4.3	0.0	-4.6
SP and Low-e Diff(%)	0.0	0.0	4.8	-32.7	0.0	-34.8	0.0	-8.4
DP and Low-e Diff(%)	0.0	0.0	35.9	-27.6	0.0	-31.8	0.0	-4.0

Figure 47. Difference (%) of BEPS (Window Library).

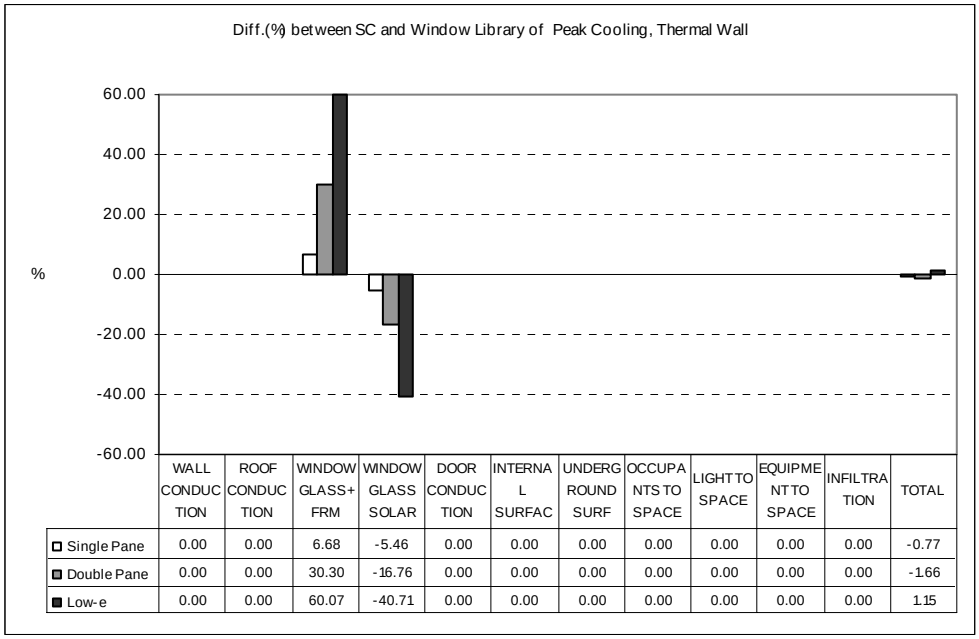
Hourly Peak Cooling Load (kBtu/hr, Thermal Wall)

The plots show the hourly peak cooling load of quick wall. The date of peak day is from Aug 26, 3PM, which is the peak day of thermal mass walls with low-e glass.



	WALL CONDUCTION	ROOF CONDUCTION	WINDOW GLASS+FRM	WINDOW GLASS SOLAR	DOOR CONDUCTION	INTERNAL SURFACE	UNDERGROUND SURF	OCCUPANTS TO SPACE	LIGHT TO SPACE	EQUIPMENT TO SPACE	INFILTRATION
Single Pane SC (33.09)	2.29	3.60	4.82	10.58	0.22	0.00	0.62	0.75	1.50	1.33	7.38
Single Pane Window Lib. (32.83)	2.29	3.60	5.14	10.00	0.22	0.00	0.62	0.75	1.50	1.33	7.38
Double Pane SC (30.73)	2.32	3.64	3.52	9.41	0.23	0.00	0.63	0.76	1.50	1.35	7.38
Double Pane Window Lib. (30.22)	2.32	3.64	4.58	7.83	0.23	0.00	0.63	0.76	1.50	1.35	7.38
Low-e SC (24.61)	2.33	3.66	3.02	3.76	0.23	0.00	0.63	0.76	1.50	1.36	7.38
Low-e Window Lib.(24.90)	2.33	3.66	4.83	2.23	0.23	0.00	0.63	0.76	1.50	1.36	7.38

Figure 48. Hourly Peak Cooling Load (Thermal Wall).

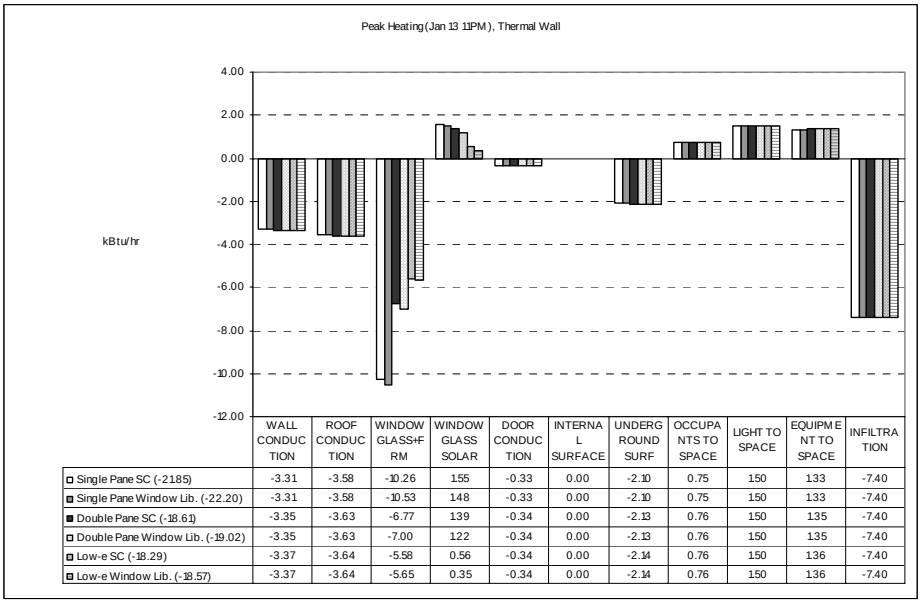


	WALL CONDUCTION	ROOF CONDUCTION	WINDOW GLASS+ FRM	WINDOW GLASS SOLAR	DOOR CONDUCTION	INTERNAL SURFAC	UNDERGROUND SURF	OCCUPANTS TO SPACE	LIGHT TO SPACE	EQUIPMENT TO SPACE	INFILTRATION	TOTAL
Single Pane	0.00	0.00	6.68	-5.46	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.77
Double Pane	0.00	0.00	30.30	-16.76	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-1.66
Low-e	0.00	0.00	60.07	-40.71	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.15

Figure 49. Difference (%) between Shading Coefficient and Window Library of Peak Cooling.

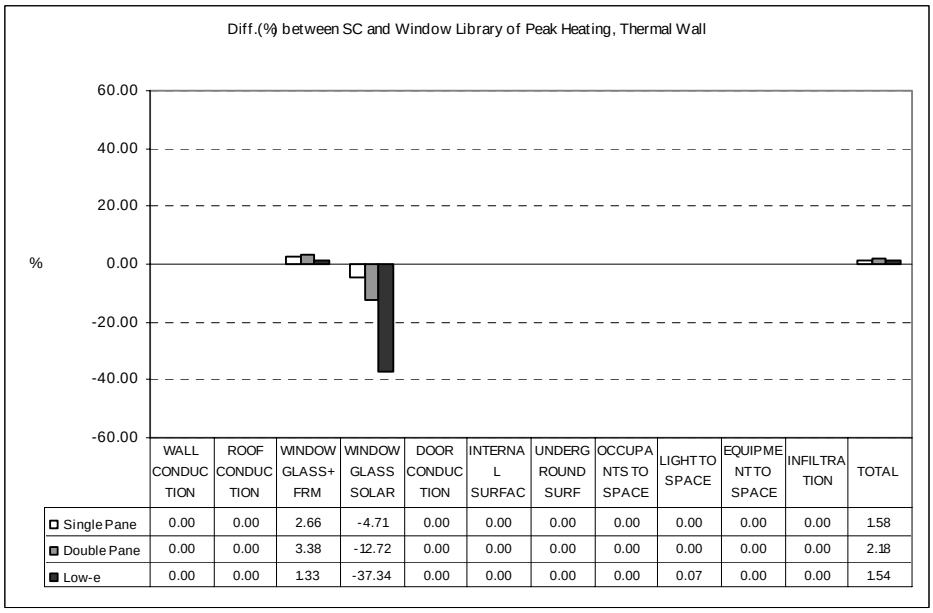
Hourly Peak Heating Load (kBtu/hr, Thermal Wall):

The plots show the hourly peak heating load of quick wall. The date of the peak day is from Jan 11, 4AM, which is the peak day of the thermal mass wall with low-e glass.



	WALL CONDUCTION	ROOF CONDUCTION	WINDOW GLASS+FRM	WINDOW GLASS SOLAR	DOOR CONDUCTION	INTERNAL SURFACE	UNDERGROUND SURF	OCCUPANTS TO SPACE	LIGHT TO SPACE	EQUIPMENT TO SPACE	INFILTRATION
Single Pane SC (-2185)	-3.31	-3.58	-10.26	1.55	-0.33	0.00	-2.10	0.75	1.50	1.33	-7.40
Single Pane Window Lib. (-22.20)	-3.31	-3.58	-10.53	1.48	-0.33	0.00	-2.10	0.75	1.50	1.33	-7.40
Double Pane SC (-18.61)	-3.35	-3.63	-6.77	1.39	-0.34	0.00	-2.13	0.76	1.50	1.35	-7.40
Double Pane Window Lib. (-19.02)	-3.35	-3.63	-7.00	1.22	-0.34	0.00	-2.13	0.76	1.50	1.35	-7.40
Low-e SC (-18.29)	-3.37	-3.64	-5.58	0.56	-0.34	0.00	-2.14	0.76	1.50	1.36	-7.40
Low-e Window Lib. (-18.57)	-3.37	-3.64	-5.65	0.35	-0.34	0.00	-2.14	0.76	1.50	1.36	-7.40

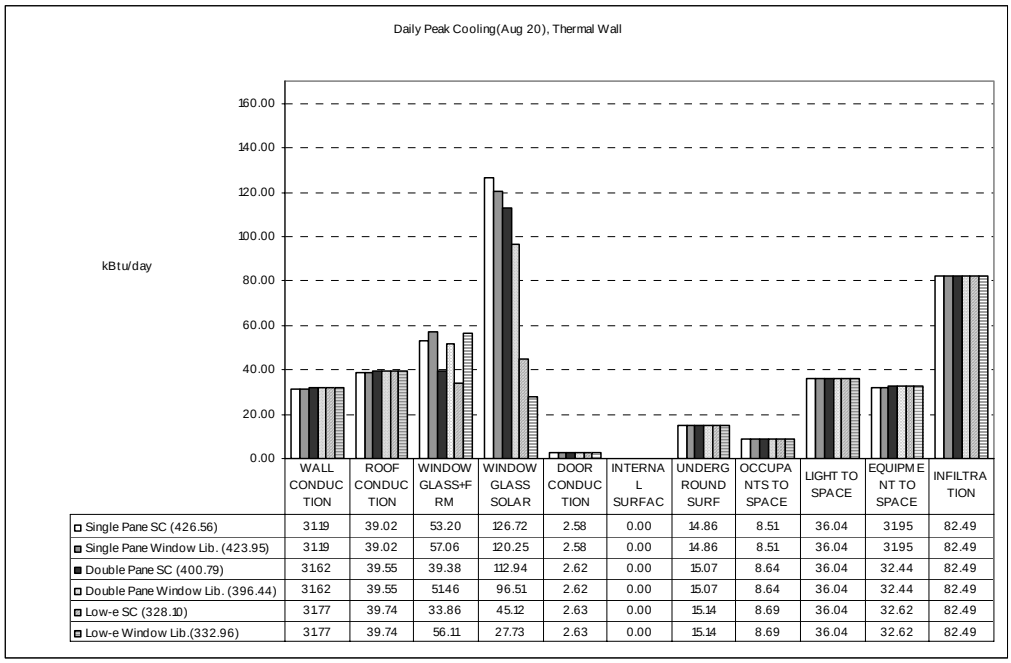
Figure 50. Hourly Peak Heating Load (Thermal Wall).



	WALL CONDUCTION	ROOF CONDUCTION	WINDOW GLASS+FRM	WINDOW GLASS SOLAR	DOOR CONDUCTION	INTERNAL SURFAC	UNDERGROUND SURF	OCCUPANTS TO SPACE	LIGHT TO SPACE	EQUIPMENT TO SPACE	INFILTRATION	TOTAL
Single Pane	0.00	0.00	2.66	-4.71	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.58
Double Pane	0.00	0.00	3.38	-12.72	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.18
Low-e	0.00	0.00	1.33	-37.34	0.00	0.00	0.00	0.00	0.07	0.00	0.00	1.54

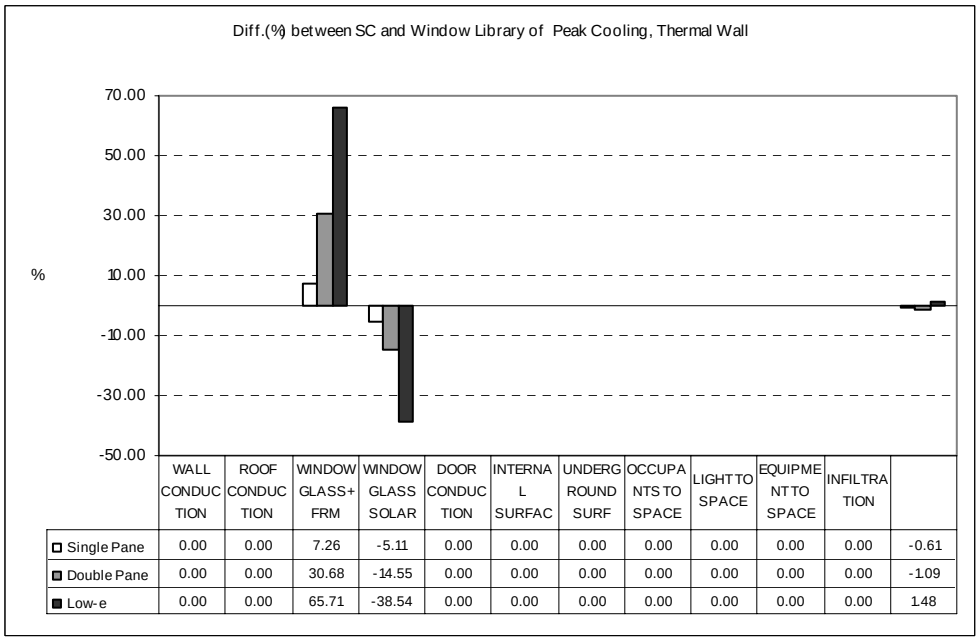
Figure 51. Difference (%) between Shading Coefficient and Window Library.

Daily Peak Heating Load (kBtu/day, Thermal Wall):



	WALL CONDUCTION	ROOF CONDUCTION	WINDOW GLASS+FRM	WINDOW GLASS SOLAR	DOOR CONDUCTION	INTERNAL SURFAC	UNDERGROUND SURF	OCCUPANTS TO SPACE	LIGHT TO SPACE	EQUIPMENT TO SPACE	INFILTRATION
Single Pane SC (426.56)	31.19	39.02	53.20	126.72	2.58	0.00	14.86	8.51	36.04	31.95	82.49
Single Pane Window Lib. (423.95)	31.19	39.02	57.06	120.25	2.58	0.00	14.86	8.51	36.04	31.95	82.49
Double Pane SC (400.79)	31.62	39.55	39.38	112.94	2.62	0.00	15.07	8.64	36.04	32.44	82.49
Double Pane Window Lib. (396.44)	31.62	39.55	51.46	96.51	2.62	0.00	15.07	8.64	36.04	32.44	82.49
Low-e SC (328.10)	31.77	39.74	33.86	45.12	2.63	0.00	15.14	8.69	36.04	32.62	82.49
Low-e Window Lib.(332.96)	31.77	39.74	56.11	27.73	2.63	0.00	15.14	8.69	36.04	32.62	82.49

Figure 52. Daily Peak Heating Load (Thermal Wall).

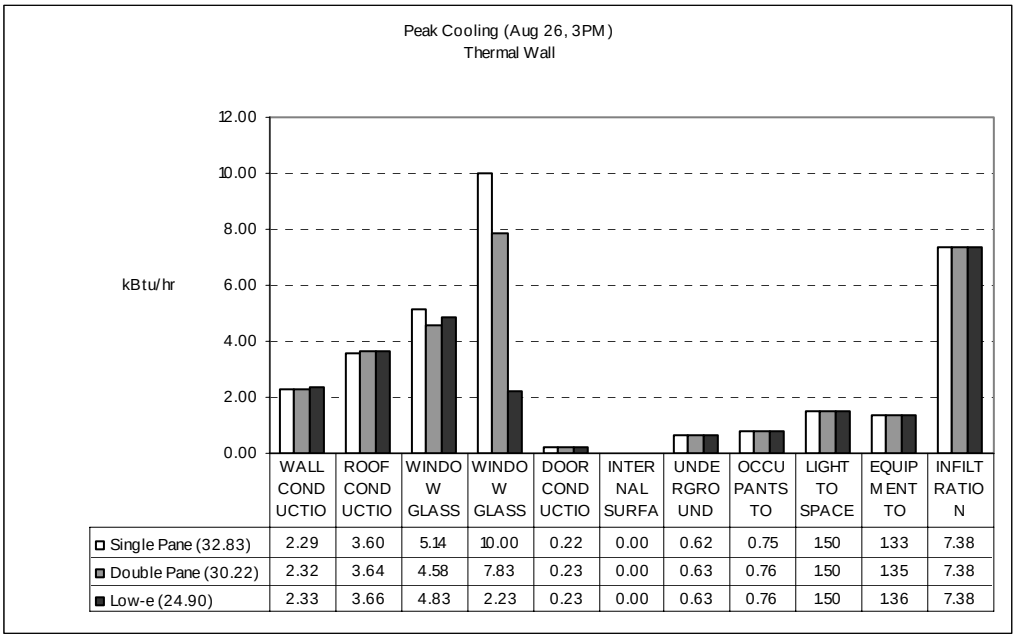


	WALL CONDUCTION	ROOF CONDUCTION	WINDOW GLASS+FRM	WINDOW GLASS SOLAR	DOOR CONDUCTION	INTERNAL SURFAC	UNDERGROUND SURF	OCCUPANTS TO SPACE	LIGHT TO SPACE	EQUIPMENT TO SPACE	INFILTRATION	
Single Pane	0.00	0.00	7.26	-5.11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.61
Double Pane	0.00	0.00	30.68	-14.55	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-1.09
Low-e	0.00	0.00	65.71	-38.54	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.48

Figure 53. Difference (%) between Shading Coefficient and Window Library.

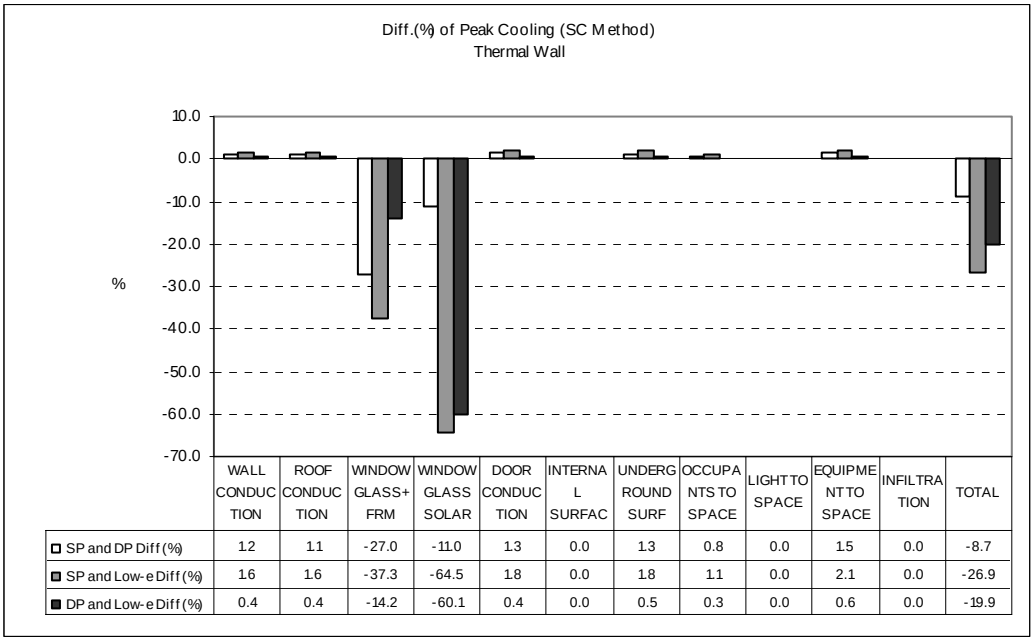
Comparison of single-pane, double-pane and low-e glass (Shading Coefficient Method / Thermal Wall):

Hourly Peak Cooling (kBtu/hr):



	WALL CONDUCTIO	ROOF CONDUCTIO	WINDOW GLASS	WINDOW GLASS	DOOR CONDUCTIO	INTERNAL SURFA	UNDERGROUND	OCCUPANTS TO	LIGHT TO SPACE	EQUIPMENT TO	INFILTRATION
Single Pane (32.83)	2.29	3.60	5.14	10.00	0.22	0.00	0.62	0.75	1.50	1.33	7.38
Double Pane (30.22)	2.32	3.64	4.58	7.83	0.23	0.00	0.63	0.76	1.50	1.35	7.38
Low-e (24.90)	2.33	3.66	4.83	2.23	0.23	0.00	0.63	0.76	1.50	1.36	7.38

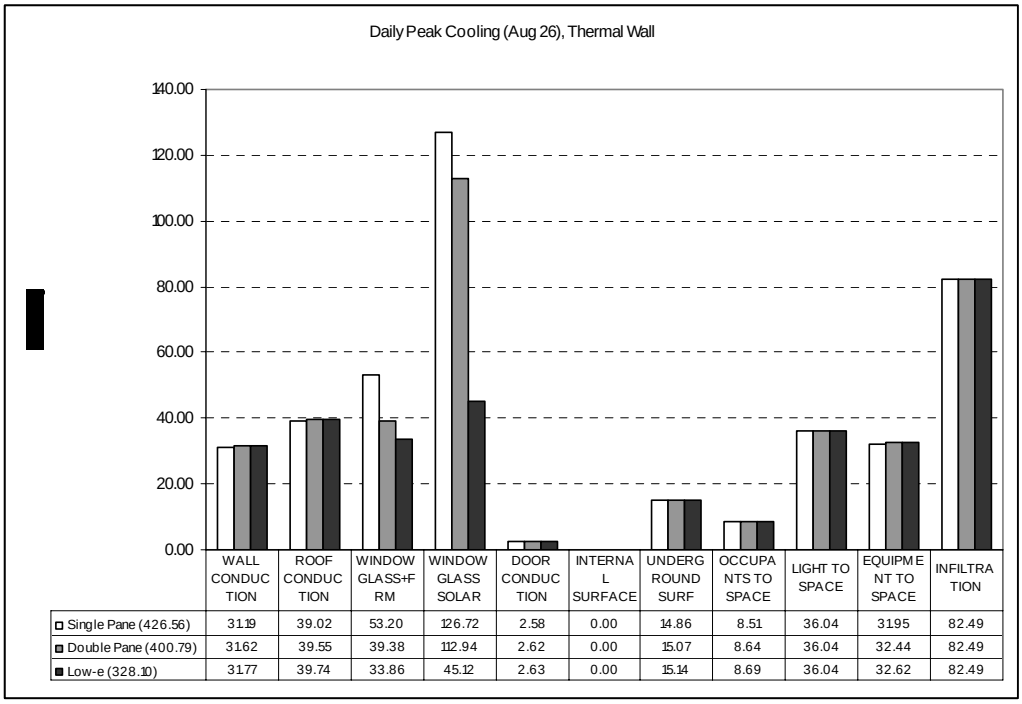
Figure 54. Comparison of hourly peak cooling among Single-pane, Double-pane and Low-e Glass (Shading Coefficient Method / Thermal Wall).



	WALL CONDUCTION	ROOF CONDUCTION	WINDOW GLASS+FRM	WINDOW GLASS SOLAR	DOOR CONDUCTION	INTERNAL SURFAC	UNDERGROUND SURF	OCCUPANTS TO SPACE	LIGHT TO SPACE	EQUIPMENT TO SPACE	INFILTRATION	TOTAL
SP and DP Diff (%)	1.2	1.1	-27.0	-11.0	1.3	0.0	1.3	0.8	0.0	1.5	0.0	-8.7
SP and Low-e Diff (%)	1.6	1.6	-37.3	-64.5	1.8	0.0	1.8	1.1	0.0	2.1	0.0	-26.9
DP and Low-e Diff (%)	0.4	0.4	-14.2	-60.1	0.4	0.0	0.5	0.3	0.0	0.6	0.0	-19.9

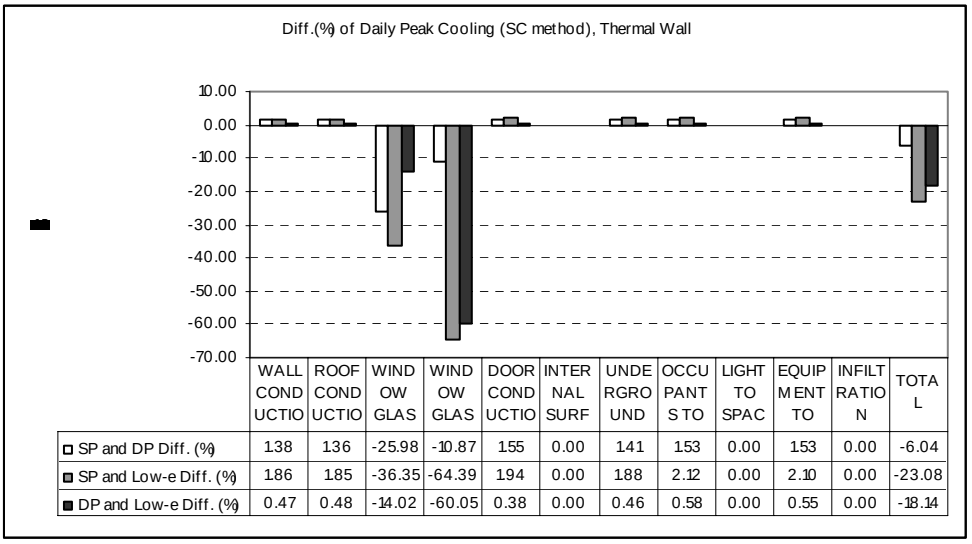
Figure 55. Difference (%) of peak cooling (Shading Coefficient Method).

Daily Peak Cooling (kBtu/day):



	WALL CONDUCTION	ROOF CONDUCTION	WINDOW GLASS+FRM	WINDOW GLASS SOLAR	DOOR CONDUCTION	INTERNAL SURFACE	UNDERGROUND SURF	OCCUPANTS TO SPACE	LIGHT TO SPACE	EQUIPMENT TO SPACE	INFILTRATION
Single Pane (426.56)	31.19	39.02	53.20	126.72	2.58	0.00	14.86	8.51	36.04	31.95	82.49
Double Pane (400.79)	31.62	39.55	39.38	112.94	2.62	0.00	15.07	8.64	36.04	32.44	82.49
Low-e (328.10)	31.77	39.74	33.86	45.12	2.63	0.00	15.14	8.69	36.04	32.62	82.49

Figure 56. Comparison of daily peak cooling among Single-pane, Double-pane and Low-e Glass (Shading Coefficient Method / Thermal Wall).

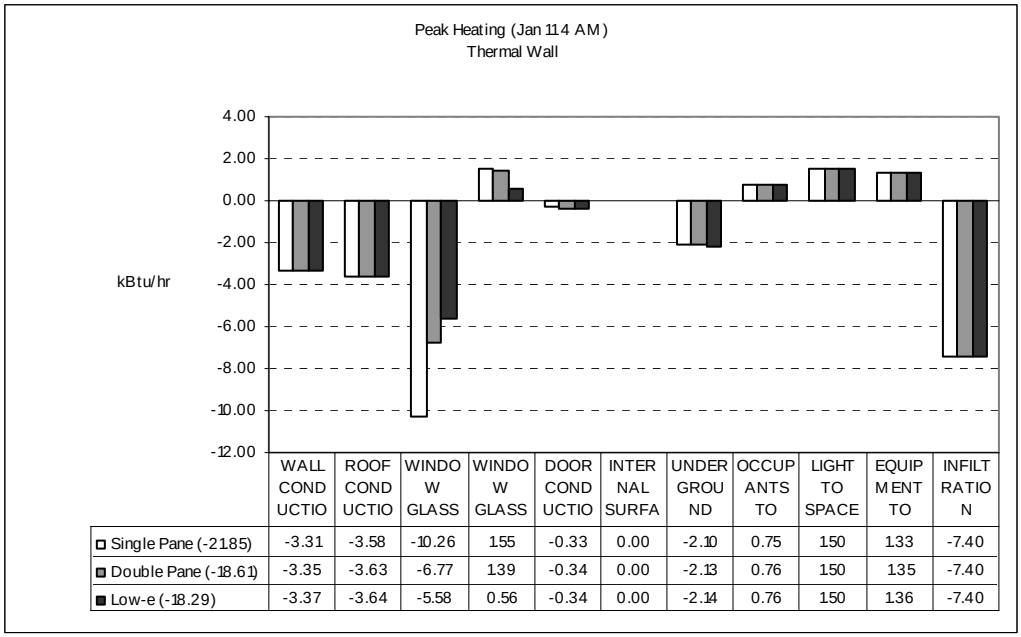


	WALL CONDUCTIO	ROOF CONDUCTIO	WINDOW GLAS	WINDOW GLAS	DOOR CONDUCTIO	INTERNAL SURF	UNDERGROUND	OCCUPANTS TO	LIGHT TO SPAC	EQUIPMENT TO	INFILTRATION	TOTAL
SP and DP Diff. (%)	1.38	1.36	-25.98	-10.87	1.55	0.00	1.41	1.53	0.00	1.53	0.00	-6.04
SP and Low-e Diff. (%)	1.86	1.85	-36.35	-64.39	1.94	0.00	1.88	2.12	0.00	2.10	0.00	-23.08
DP and Low-e Diff. (%)	0.47	0.48	-14.02	-60.05	0.38	0.00	0.46	0.58	0.00	0.55	0.00	-18.14

Figure 57. Difference (%) of daily peak cooling (Shading Coefficient Method).

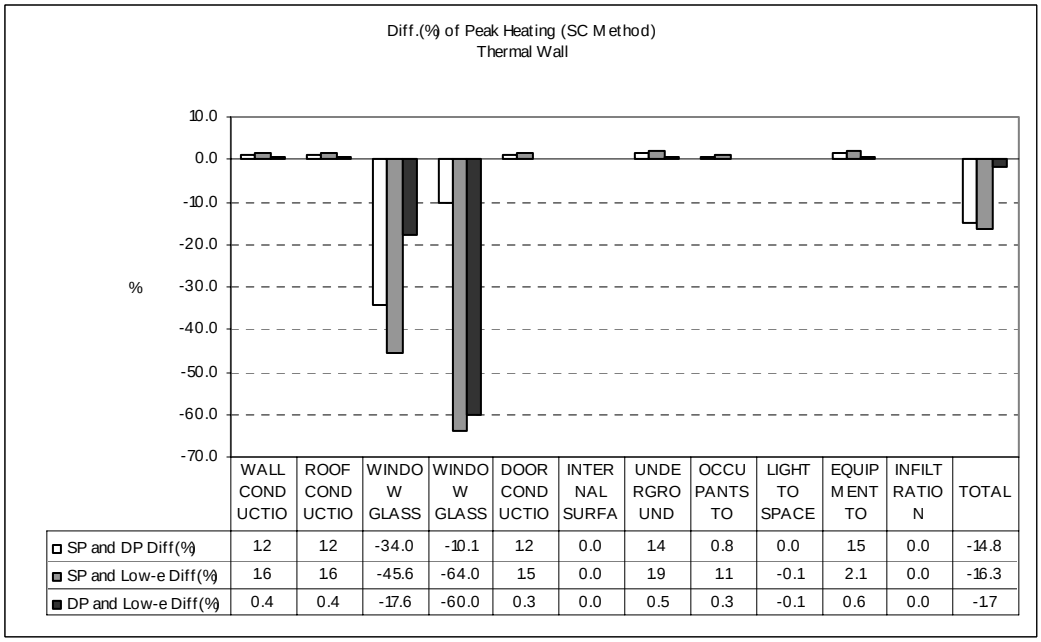
Comparison among single-pane, double-pane and low-e glass (SHADING COEFFICIENT Method / Thermal Wall):

Hourly Peak Heating (kBtu/hr):



	WALL CONDUCTIO	ROOF CONDUCTIO	WINDOW GLASS	WINDOW GLASS	DOOR CONDUCTIO	INTERNAL SURFA	UNDERGROUND	OCCUPANTS TO	LIGHT TO SPACE	EQUIPMENT TO	INFILTRATION
Single Pane (-2185)	-3.31	-3.58	-10.26	1.55	-0.33	0.00	-2.10	0.75	1.50	1.33	-7.40
Double Pane (-18.61)	-3.35	-3.63	-6.77	1.39	-0.34	0.00	-2.13	0.76	1.50	1.35	-7.40
Low-e (-18.29)	-3.37	-3.64	-5.58	0.56	-0.34	0.00	-2.14	0.76	1.50	1.36	-7.40

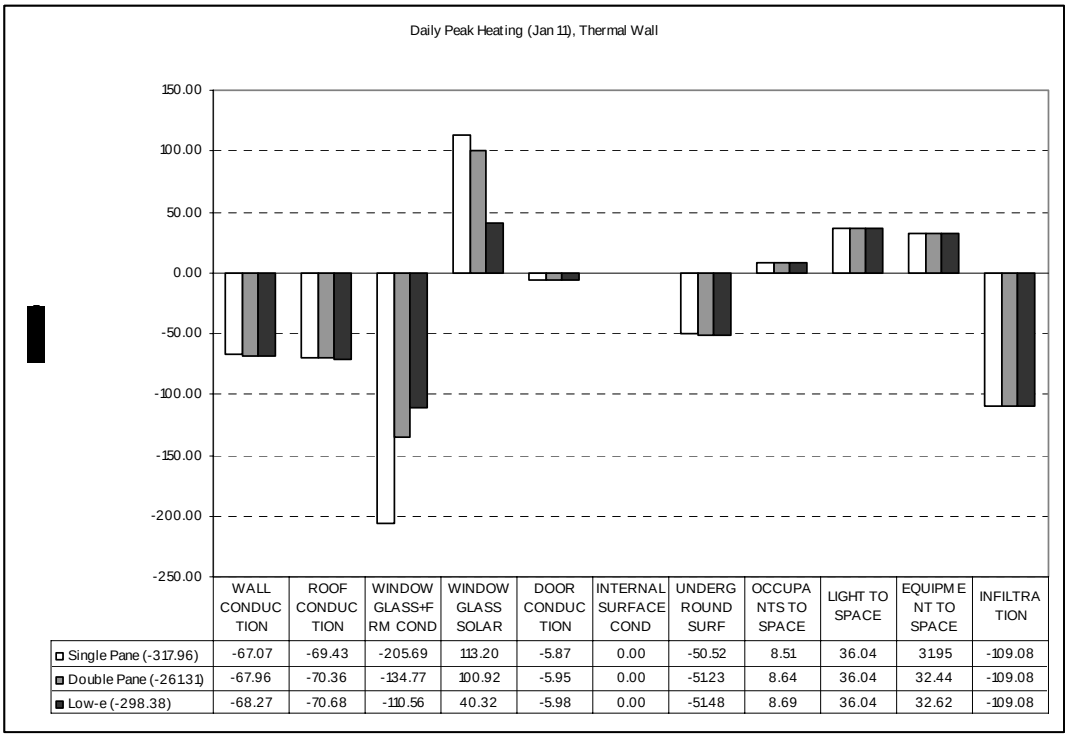
Figure 58. Comparison of hourly peak heating among Single-pane, Double-pane and Low-e Glass (Shading Coefficient Method / Thermal Wall).



	WALL CONDUCTIO	ROOF CONDUCTIO	WINDOW GLASS	WINDOW GLASS	DOOR CONDUCTIO	INTERNAL SURFA	UNDERGROUND	OCCUPANTS TO	LIGHT TO SPACE	EQUIPMENT TO	INFILTRATION	TOTAL
SP and DP Diff(%)	1.2	1.2	-34.0	-10.1	1.2	0.0	1.4	0.8	0.0	1.5	0.0	-14.8
SP and Low-e Diff(%)	1.6	1.6	-45.6	-64.0	1.5	0.0	1.9	1.1	-0.1	2.1	0.0	-16.3
DP and Low-e Diff(%)	0.4	0.4	-17.6	-60.0	0.3	0.0	0.5	0.3	-0.1	0.6	0.0	-1.7

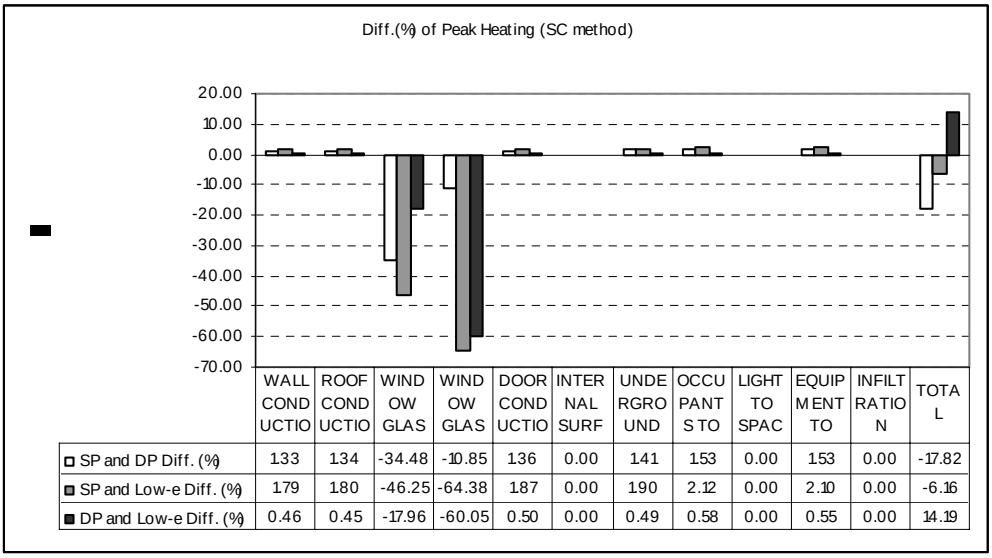
Figure 59. Difference (%) of peak heating (Shading Coefficient Method).

Daily Peak Heating (kBtu/day):



	WALL CONDUCTION	ROOF CONDUCTION	WINDOW GLASS+FRM COND	WINDOW GLASS SOLAR	DOOR CONDUCTION	INTERNAL SURFACE COND	UNDERGROUND SURF	OCCUPANTS TO SPACE	LIGHT TO SPACE	EQUIPMENT TO SPACE	INFILTRATION
Single Pane (-317.96)	-67.07	-69.43	-205.69	113.20	-5.87	0.00	-50.52	8.51	36.04	31.95	-109.08
Double Pane (-261.31)	-67.96	-70.36	-134.77	100.92	-5.95	0.00	-51.23	8.64	36.04	32.44	-109.08
Low-e (-298.38)	-68.27	-70.68	-110.56	40.32	-5.98	0.00	-51.48	8.69	36.04	32.62	-109.08

Figure 60. Comparison of daily peak heating among Single-Pane, Double-pane and Low-e Glass (Shading Coefficient Method / Thermal Wall).

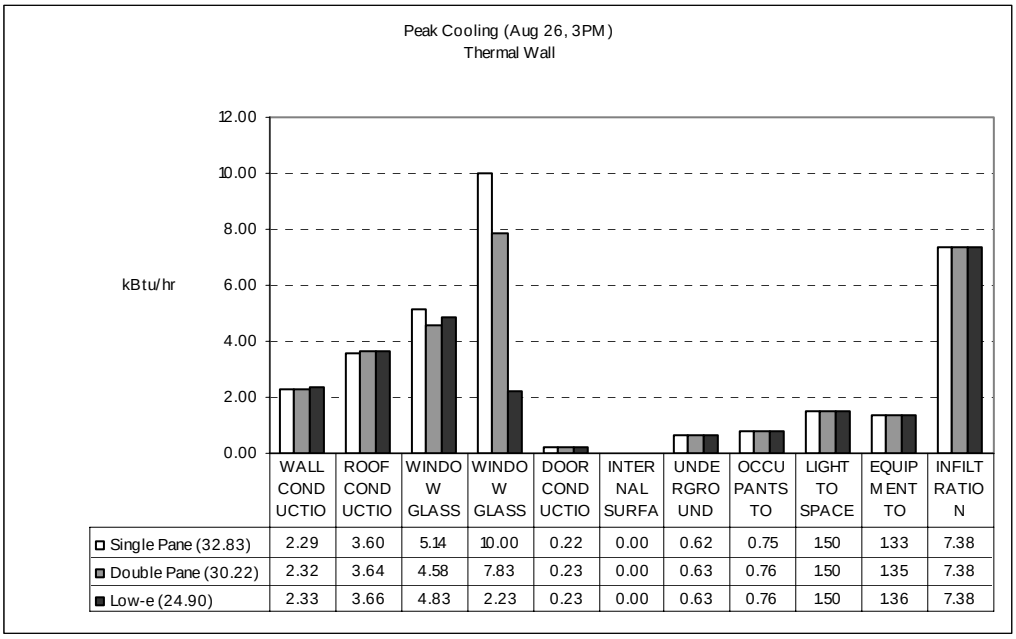


	WALL CONDUCTIO	ROOF CONDUCTIO	WINDOW GLAS	WINDOW GLAS	DOOR CONDUCTIO	INTERNAL SURF	UNDERGROUND	OCCUPANTS TO	LIGHT TO SPAC	EQUIPMENT TO	INFILTRATION	TOTAL
SP and DP Diff. (%)	1.33	1.34	-34.48	-10.85	1.36	0.00	1.41	1.53	0.00	1.53	0.00	-17.82
SP and Low-e Diff. (%)	1.79	1.80	-46.25	-64.38	1.87	0.00	1.90	2.12	0.00	2.10	0.00	-6.16
DP and Low-e Diff. (%)	0.46	0.45	-17.96	-60.05	0.50	0.00	0.49	0.58	0.00	0.55	0.00	14.19

Figure 61. Difference (%) of peak heating (Shading Coefficient Method).

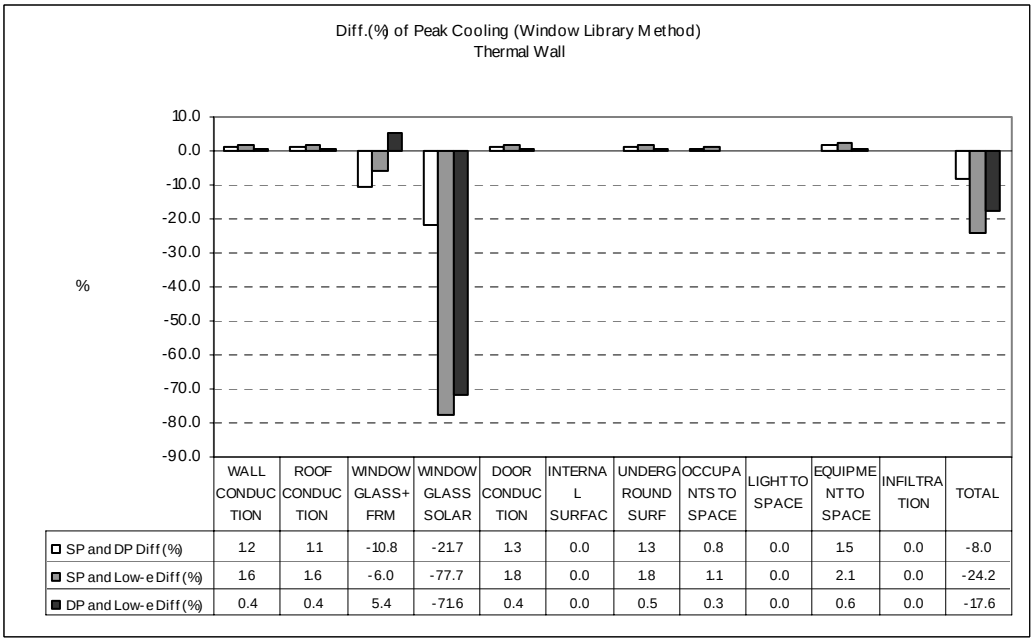
Comparison among single-pane, double-pane and low-e glass (Window Library / Thermal Wall):

Hourly Peak Cooling (kBtu/hr):



	WALL CONDUCTIO	ROOF CONDUCTIO	WINDOW GLASS	WINDOW GLASS	DOOR CONDUCTIO	INTERNAL SURFA	UNDERGROUND	OCCUPANTS TO	LIGHT TO SPACE	EQUIPMENT TO	INFILTRATION
Single Pane (32.83)	2.29	3.60	5.14	10.00	0.22	0.00	0.62	0.75	1.50	1.33	7.38
Double Pane (30.22)	2.32	3.64	4.58	7.83	0.23	0.00	0.63	0.76	1.50	1.35	7.38
Low-e (24.90)	2.33	3.66	4.83	2.23	0.23	0.00	0.63	0.76	1.50	1.36	7.38

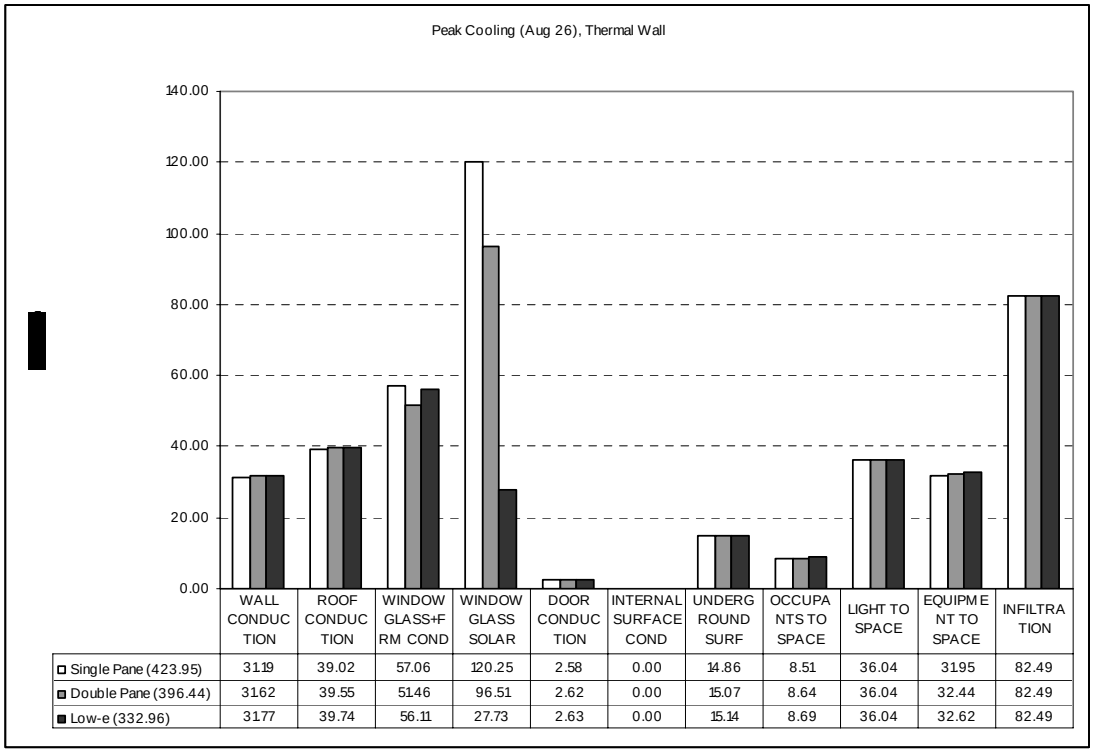
Figure 62. Comparison hourly peak cooling among Single-pane, Double-pane and Low-e Glass (Window Library / Thermal Wall).



	WALL CONDUCTION	ROOF CONDUCTION	WINDOW GLASS+FRM	WINDOW GLASS SOLAR	DOOR CONDUCTION	INTERNAL SURFAC	UNDERGROUND SURF	OCCUPANTS TO SPACE	LIGHT TO SPACE	EQUIPMENT TO SPACE	INFILTRATION	TOTAL
SP and DP Diff (%)	1.2	1.1	-10.8	-21.7	1.3	0.0	1.3	0.8	0.0	1.5	0.0	-8.0
SP and Low-e Diff (%)	1.6	1.6	-6.0	-77.7	1.8	0.0	1.8	1.1	0.0	2.1	0.0	-24.2
DP and Low-e Diff (%)	0.4	0.4	5.4	-71.6	0.4	0.0	0.5	0.3	0.0	0.6	0.0	-17.6

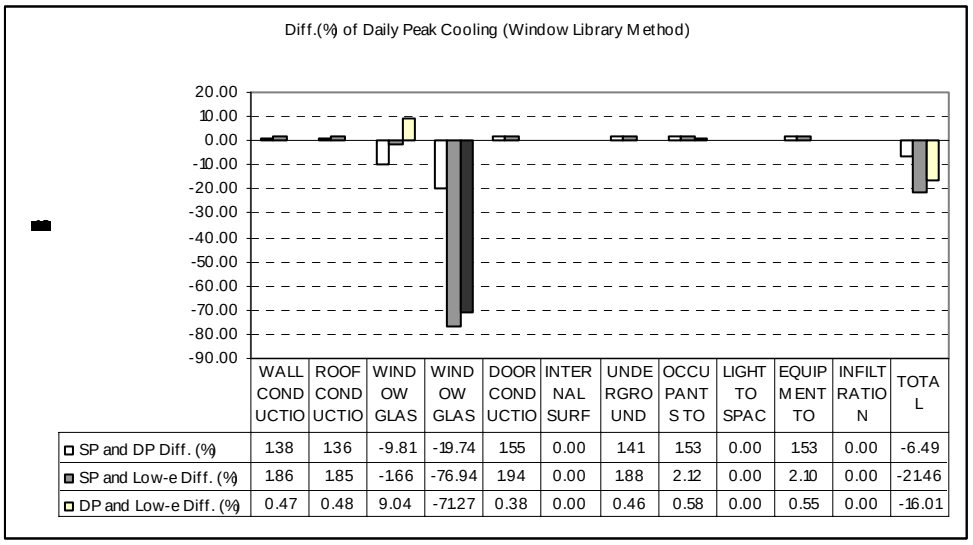
Figure 63. Difference (%) of peak cooling (Window Library Method).

Daily Peak Cooling (kBtu/day):



	WALL CONDUCTION	ROOF CONDUCTION	WINDOW GLASS+FRM COND	WINDOW GLASS SOLAR	DOOR CONDUCTION	INTERNAL SURFACE COND	UNDERGROUND SURF	OCCUPANTS TO SPACE	LIGHT TO SPACE	EQUIPMENT TO SPACE	INFILTRATION
Single Pane (423.95)	31.19	39.02	57.06	120.25	2.58	0.00	14.86	8.51	36.04	31.95	82.49
Double Pane (396.44)	31.62	39.55	51.46	96.51	2.62	0.00	15.07	8.64	36.04	32.44	82.49
Low-e (332.96)	31.77	39.74	56.11	27.73	2.63	0.00	15.14	8.69	36.04	32.62	82.49

Figure 64. Comparison of daily peak cooling among Single-pane, Double-pane and Low-e Glass (Window Library / Thermal Wall).

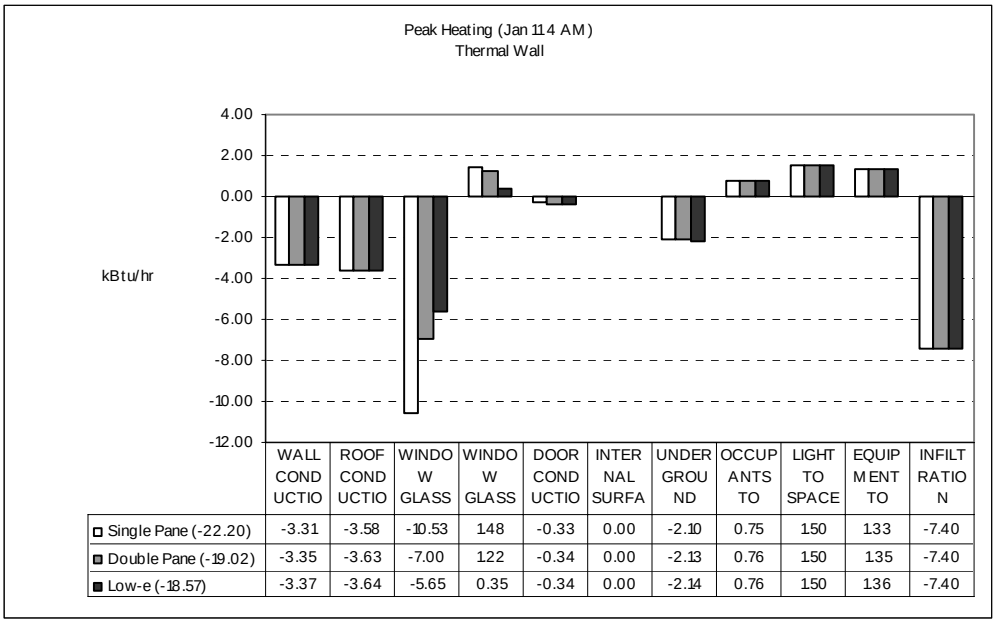


	WALL CONDUCTIO	ROOF CONDUCTIO	WINDOW GLAS	WINDOW GLAS	DOOR CONDUCTIO	INTERNAL SURF	UNDERGROUND	OCCUPANTS TO	LIGHT TO SPAC	EQUIPMENT TO	INFILTRATION	TOTAL
SP and DP Diff. (%)	1.38	1.36	-9.81	-19.74	1.55	0.00	1.41	1.53	0.00	1.53	0.00	-6.49
SP and Low-e Diff. (%)	1.86	1.85	-1.66	-76.94	1.94	0.00	1.88	2.12	0.00	2.10	0.00	-21.46
DP and Low-e Diff. (%)	0.47	0.48	9.04	-71.27	0.38	0.00	0.46	0.58	0.00	0.55	0.00	-16.01

Figure 65. Difference (%) of daily peak cooling (Window Library Method).

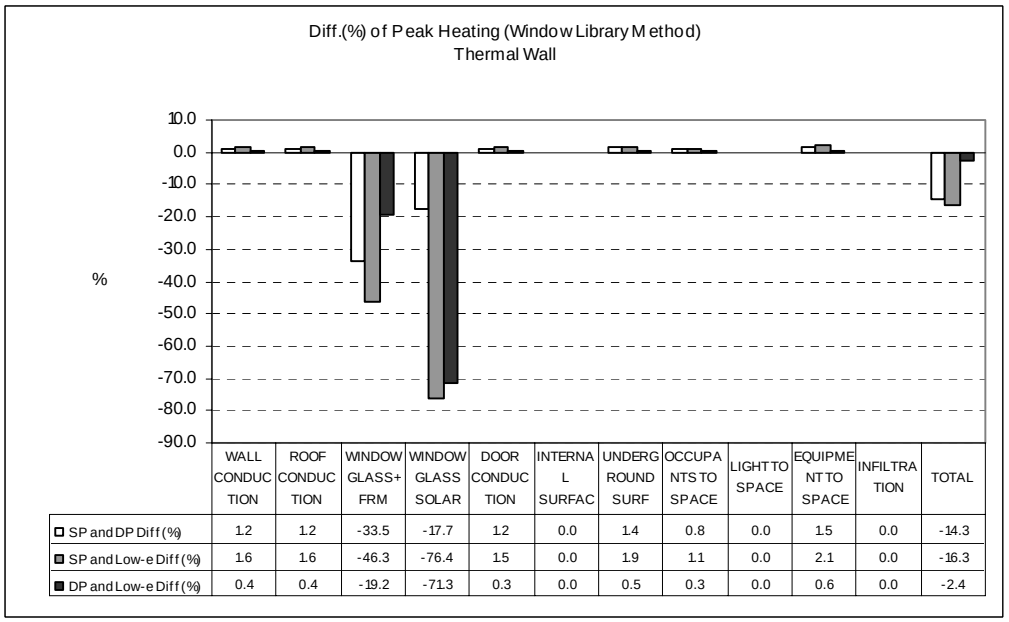
Comparison of single-pane, double-pane and low-e glass (Window Library / Thermal Wall):

Hourly Peak Heating (kBtu/hr):



	WALL CONDUCTIO	ROOF CONDUCTIO	WINDOW GLASS	WINDOW GLASS	DOOR CONDUCTIO	INTERNAL SURFA	UNDERGROUND	OCCUPANTS TO	LIGHT TO SPACE	EQUIPMENT TO	INFILTRATION
Single Pane (-22.20)	-3.31	-3.58	-10.53	1.48	-0.33	0.00	-2.10	0.75	1.50	1.33	-7.40
Double Pane (-19.02)	-3.35	-3.63	-7.00	1.22	-0.34	0.00	-2.13	0.76	1.50	1.35	-7.40
Low-e (-18.57)	-3.37	-3.64	-5.65	0.35	-0.34	0.00	-2.14	0.76	1.50	1.36	-7.40

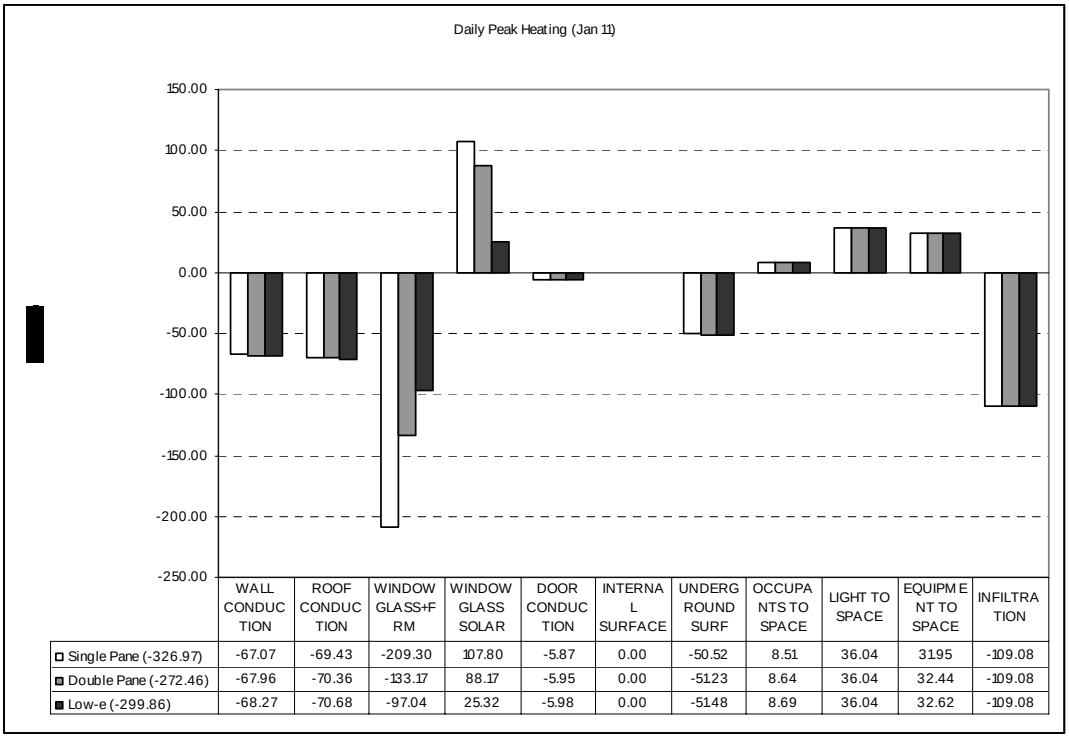
Figure 66. Comparison hourly peak heating among Single-pane, Double-pane and Low-e Glass (Window Library / Thermal Wall).



	WALL CONDUCTION	ROOF CONDUCTION	WINDOW GLASS+FRM	WINDOW GLASS SOLAR	DOOR CONDUCTION	INTERNAL SURFAC	UNDERGROUND SURF	OCCUPANTS TO SPACE	LIGHT TO SPACE	EQUIPMENT TO SPACE	INFILTRATION	TOTAL
SP and DP Diff (%)	1.2	1.2	-33.5	-17.7	1.2	0.0	1.4	0.8	0.0	1.5	0.0	-14.3
SP and Low-e Diff (%)	1.6	1.6	-46.3	-76.4	1.5	0.0	1.9	1.1	0.0	2.1	0.0	-16.3
DP and Low-e Diff (%)	0.4	0.4	-19.2	-71.3	0.3	0.0	0.5	0.3	0.0	0.6	0.0	-2.4

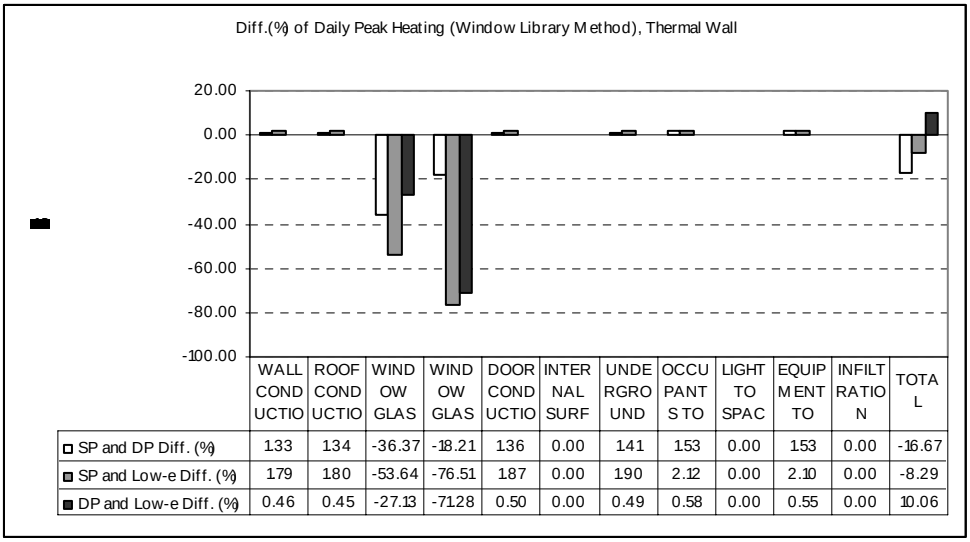
Figure 67. Difference (%) of peak heating (Window Library Method).

Daily Peak Heating (kBtu/day):



	WALL CONDUCTION	ROOF CONDUCTION	WINDOW GLASS+FRM	WINDOW GLASS SOLAR	DOOR CONDUCTION	INTERNAL SURFACE	UNDERGROUND SURF	OCCUPANTS TO SPACE	LIGHT TO SPACE	EQUIPMENT TO SPACE	INFILTRATION
Single Pane (-326.97)	-67.07	-69.43	-209.30	107.80	-5.87	0.00	-50.52	8.51	36.04	31.95	-109.08
Double Pane (-272.46)	-67.96	-70.36	-133.17	88.17	-5.95	0.00	-51.23	8.64	36.04	32.44	-109.08
Low-e (-299.86)	-68.27	-70.68	-97.04	25.32	-5.98	0.00	-51.48	8.69	36.04	32.62	-109.08

Figure 68. Comparison of daily peak heating among Single-pane, Double-pane and Low-e Glass (Window Library / Thermal Wall).



	WALL CONDUCTIO	ROOF CONDUCTIO	WINDOW GLAS	WINDOW GLAS	DOOR CONDUCTIO	INTERNAL SURF	UNDERGROUND	OCCUPANTS TO	LIGHT TO SPAC	EQUIPMENT TO	INFILTRATION	TOTAL
SP and DP Diff. (%)	1.33	1.34	-36.37	-18.21	1.36	0.00	1.41	1.53	0.00	1.53	0.00	-16.67
SP and Low-e Diff. (%)	1.79	1.80	-53.64	-76.51	1.87	0.00	1.90	2.12	0.00	2.10	0.00	-8.29
DP and Low-e Diff. (%)	0.46	0.45	-27.13	-71.28	0.50	0.00	0.49	0.58	0.00	0.55	0.00	10.06

Figure 69. Difference (%) of daily peak heating (Window Library Method).

Solar Gain of Thermal Wall

- QSOLG + QABSG: Transmitted plus reconducted solar heat gain through window (glass plus frame)
- QCON + QCONFR: Conduction heat gain through window (glass plus frame)

Single Pane / Thermal Wall:

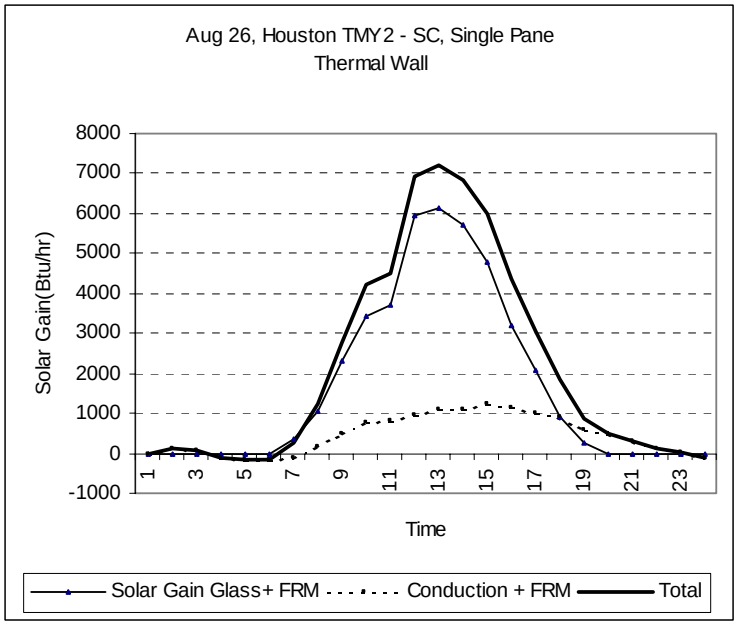


Figure 70. Solar gain of Single-pane / Shading Coefficient, Thermal Wall.

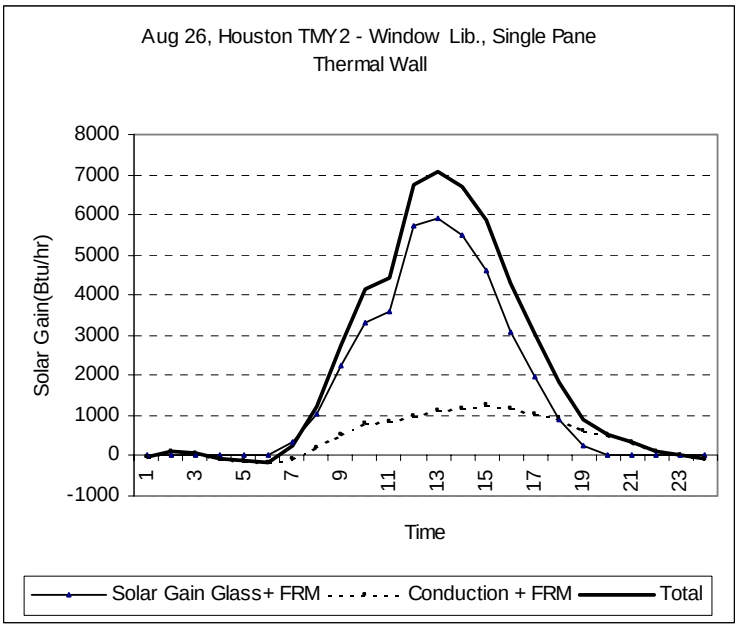


Figure 71. Solar gain of Single-pane / Window Library, Thermal Wall.

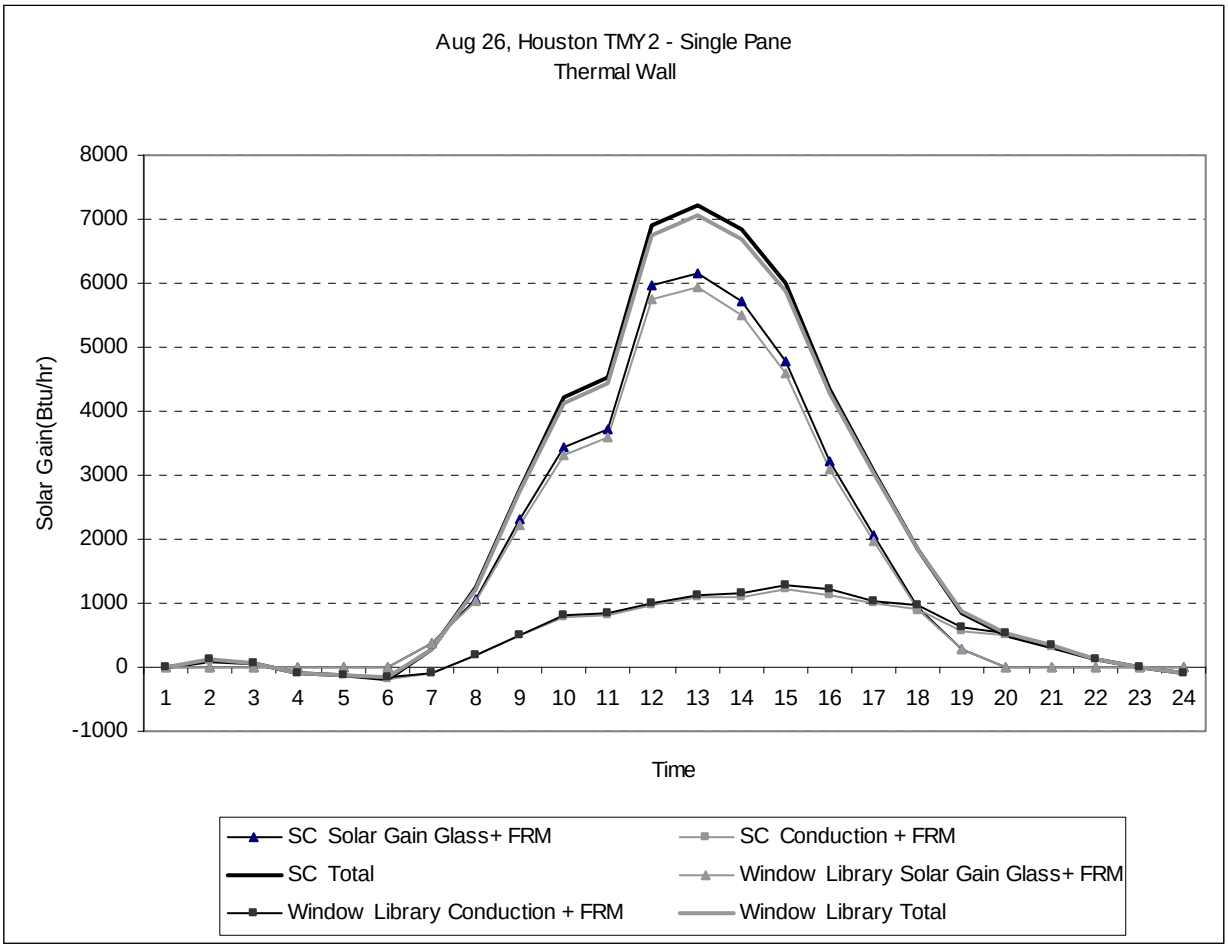


Figure 72. Solar gain of Single-pane / Shading Coefficient and Window Library, Thermal Wall.

Double Pane / Thermal Wall:

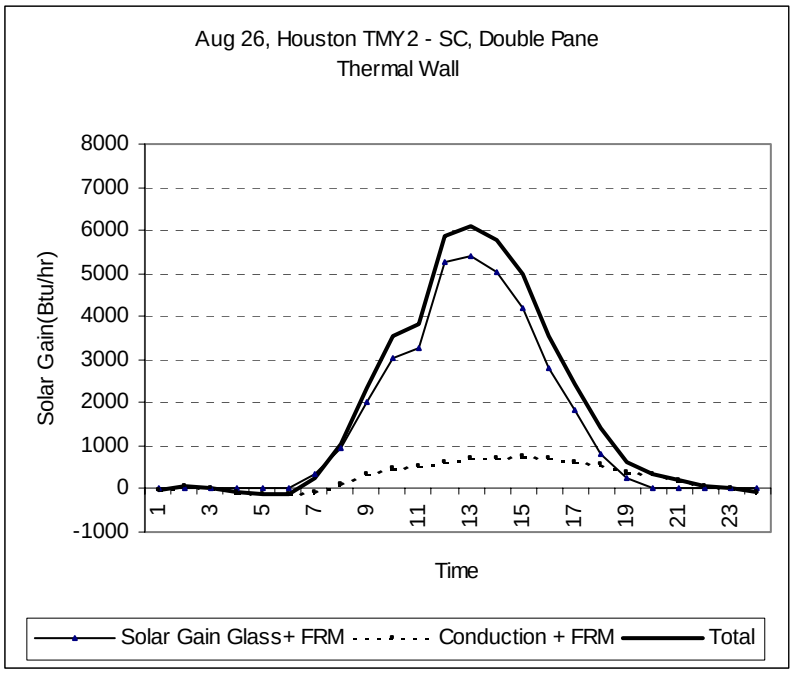


Figure 73. Solar gain of Double Pane / Shading Coefficient, Thermal Wall.

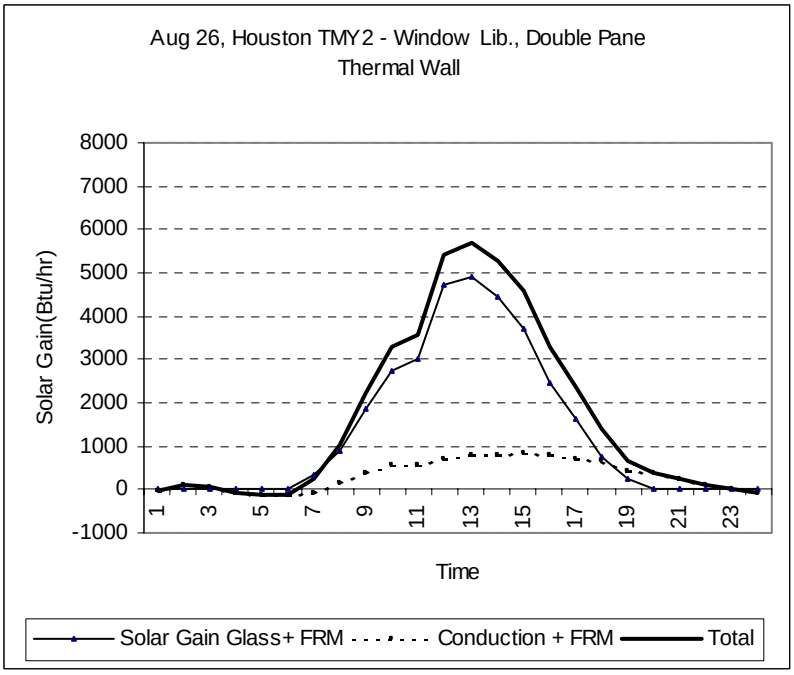


Figure 74. Solar gain of Double Pane / Window Library, Thermal Wall.

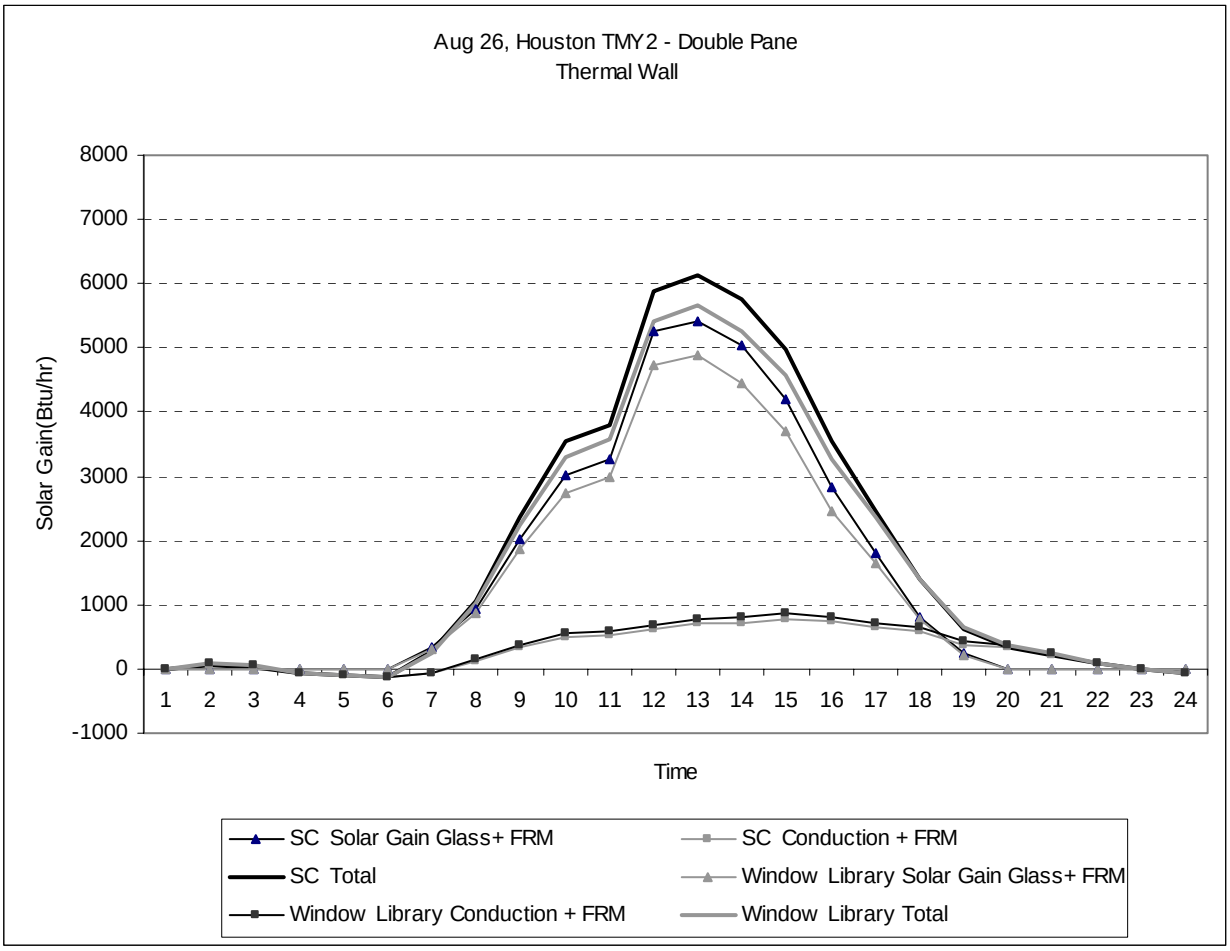


Figure 75. Solar gain of Double Pane / Shading Coefficient and Window Library, Thermal Wall.

Low-e / Thermal Wall:

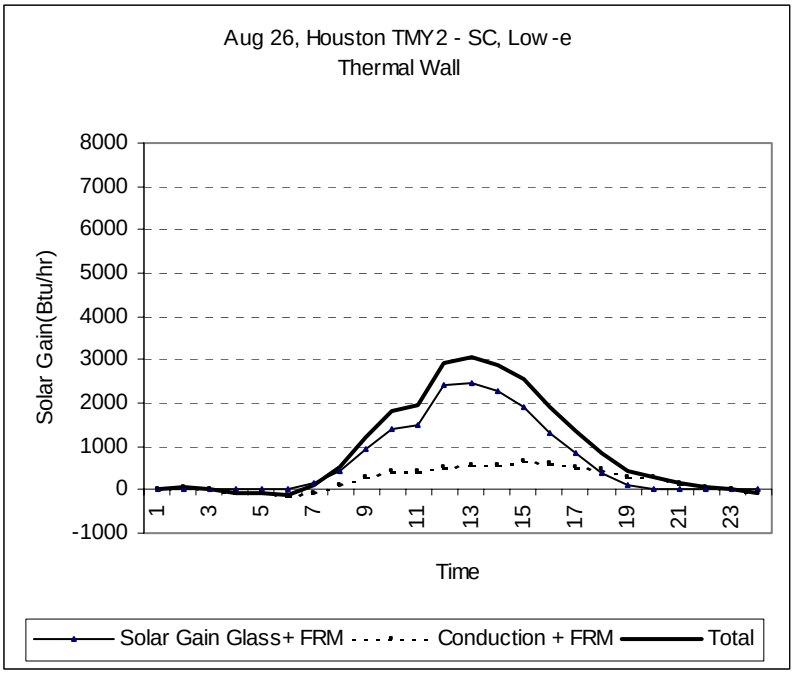


Figure 76. Solar gain of Low-e / Shading Coefficient, Thermal Wall.

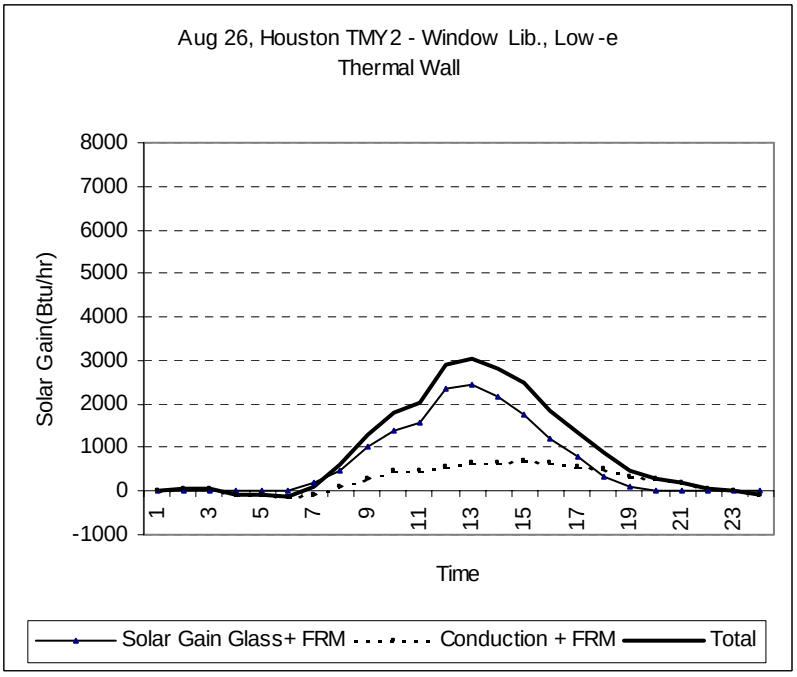


Figure 77. Solar gain of Low-e / Window Library, Thermal Wall.

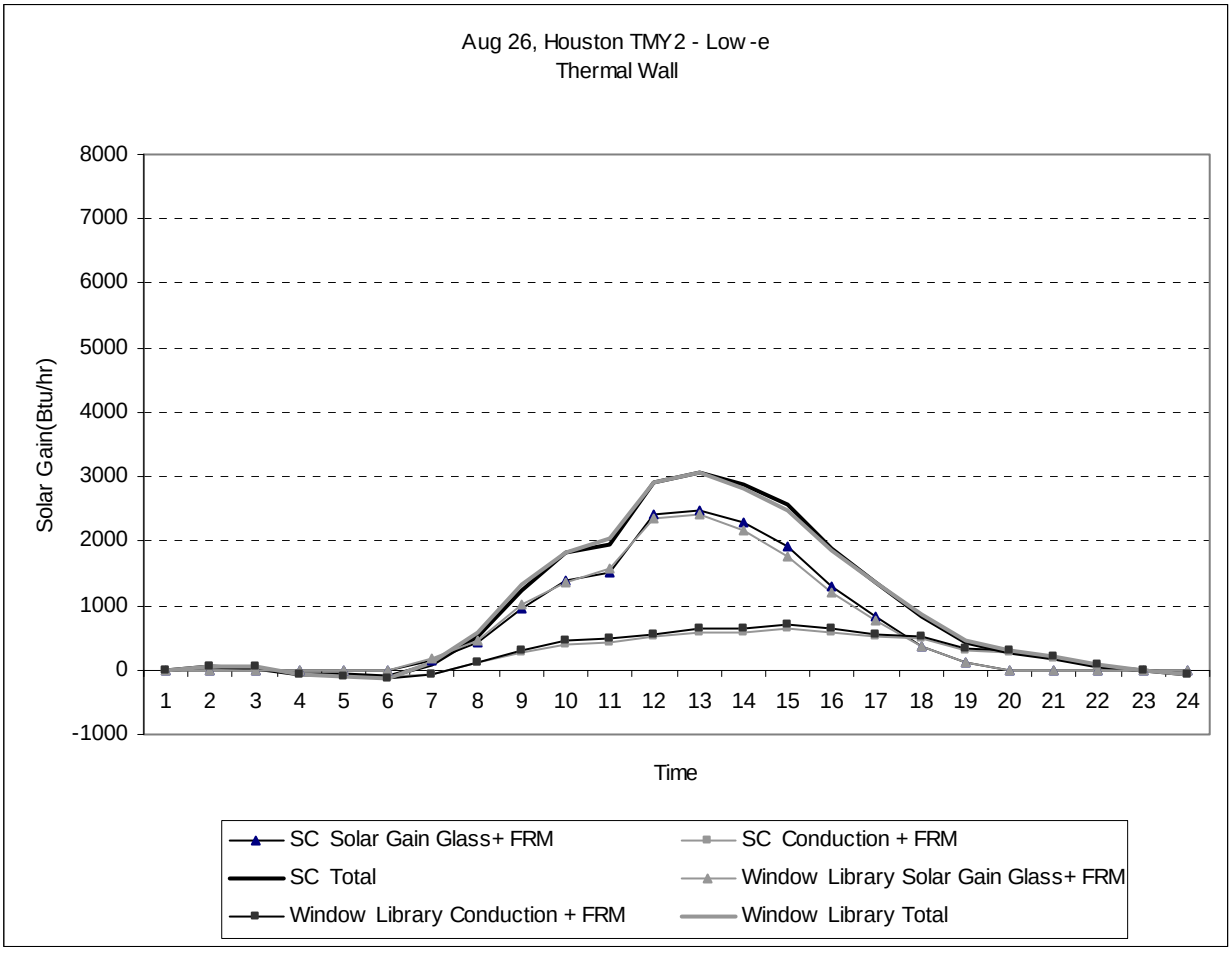


Figure 78. Solar gain of Low-e / Shading Coefficient and Window Library, Thermal Wall.

Total Solar Gain of Quick Wall:

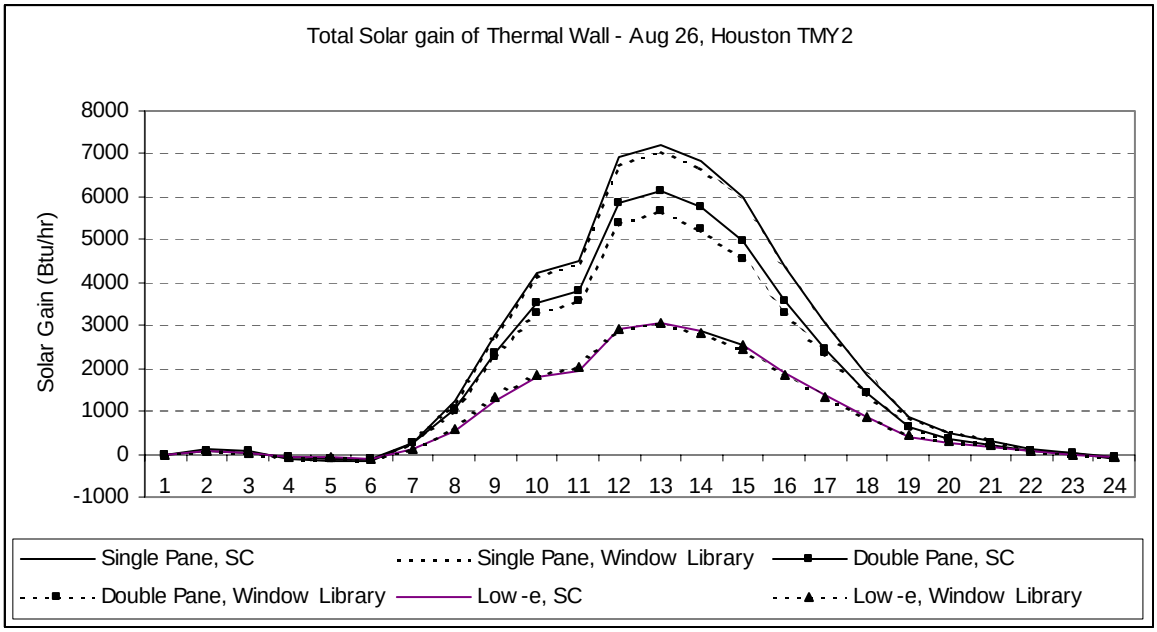
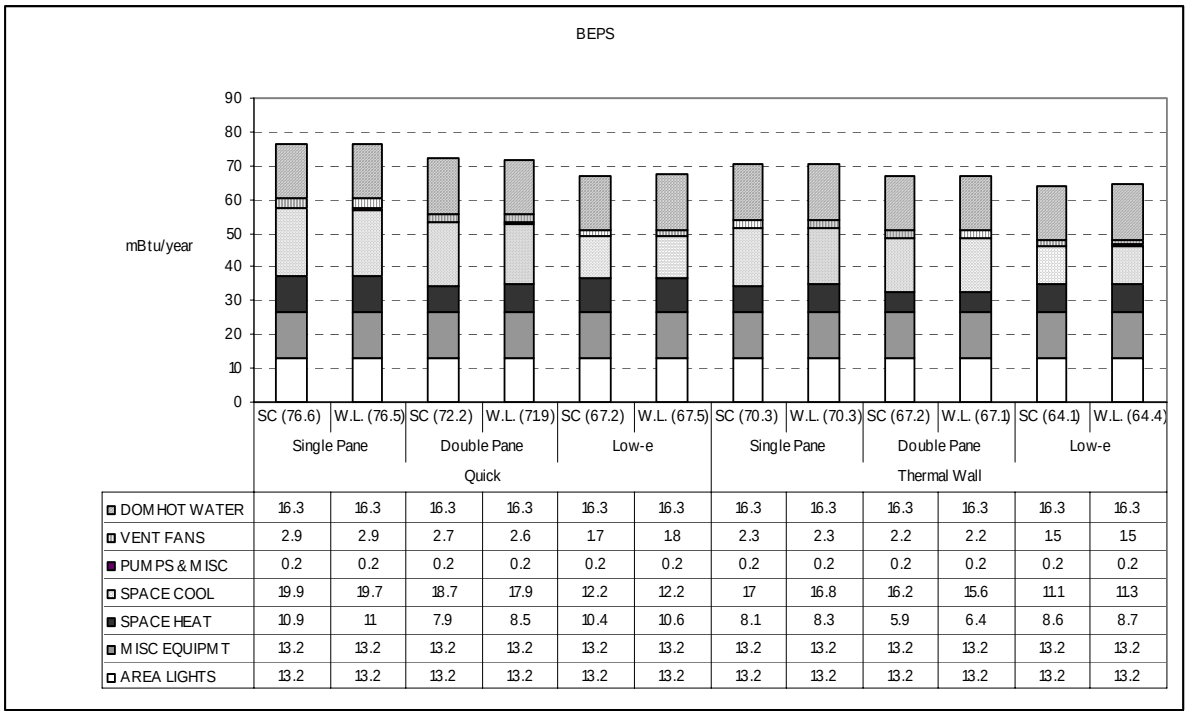


Figure 79. Solar gain of Low-e / Shading Coefficient and Window Library, Thermal Wall.

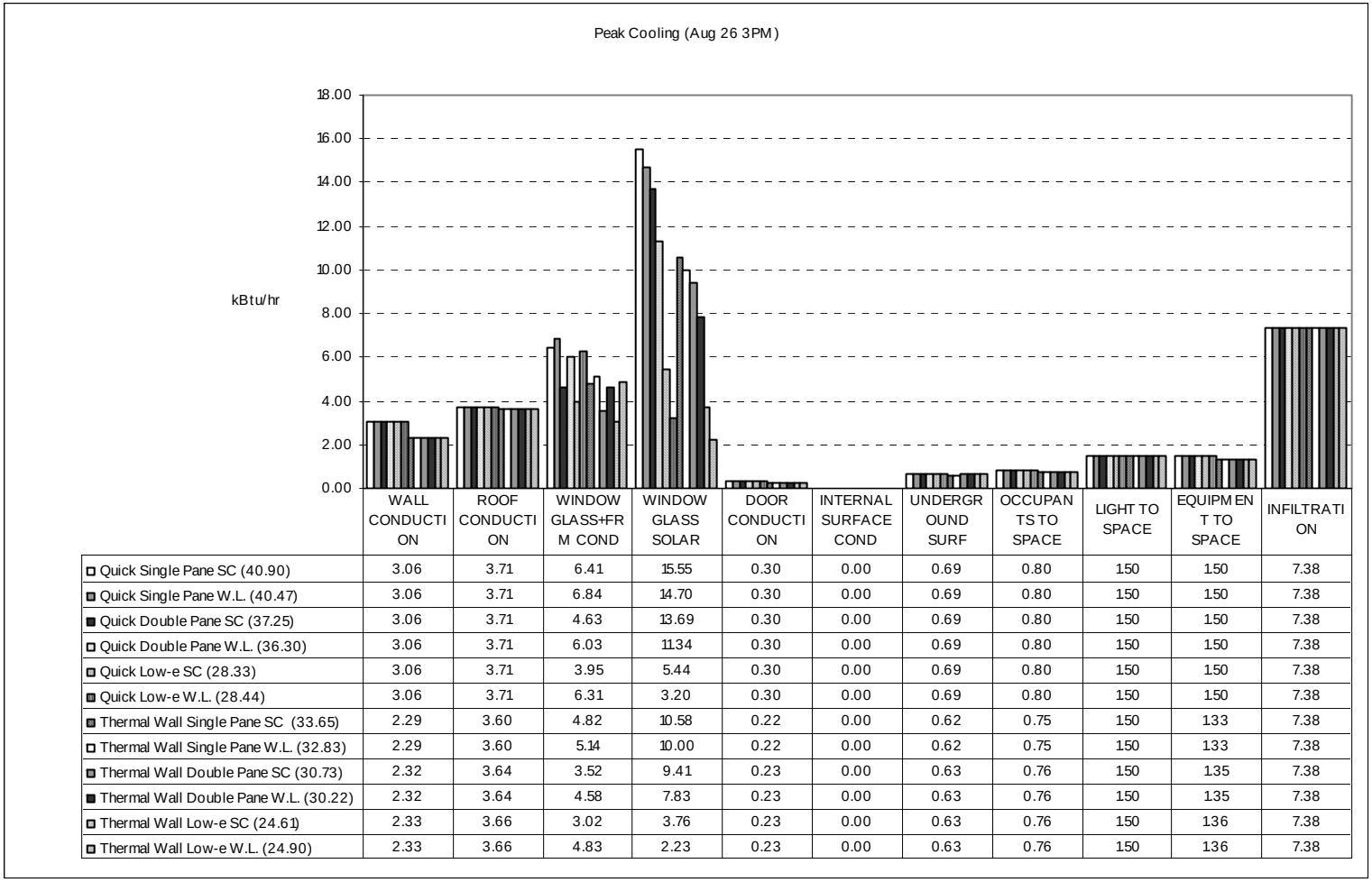
All Results:



DOM HOT WATER	16.3	16.3	16.3	16.3	16.3	16.3	16.3	16.3	16.3	16.3	16.3	16.3
VENT FANS	2.9	2.9	2.7	2.6	1.7	1.8	2.3	2.3	2.2	2.2	1.5	1.5
PUMPS & MISC	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
SPACE COOL	19.9	19.7	18.7	17.9	12.2	12.2	17	16.8	16.2	15.6	11.1	11.3
SPACE HEAT	10.9	11	7.9	8.5	10.4	10.6	8.1	8.3	5.9	6.4	8.6	8.7
MISC EQUIPMT	13.2	13.2	13.2	13.2	13.2	13.2	13.2	13.2	13.2	13.2	13.2	13.2
AREA LIGHTS	13.2	13.2	13.2	13.2	13.2	13.2	13.2	13.2	13.2	13.2	13.2	13.2

Figure 80. All annual BEPS results.

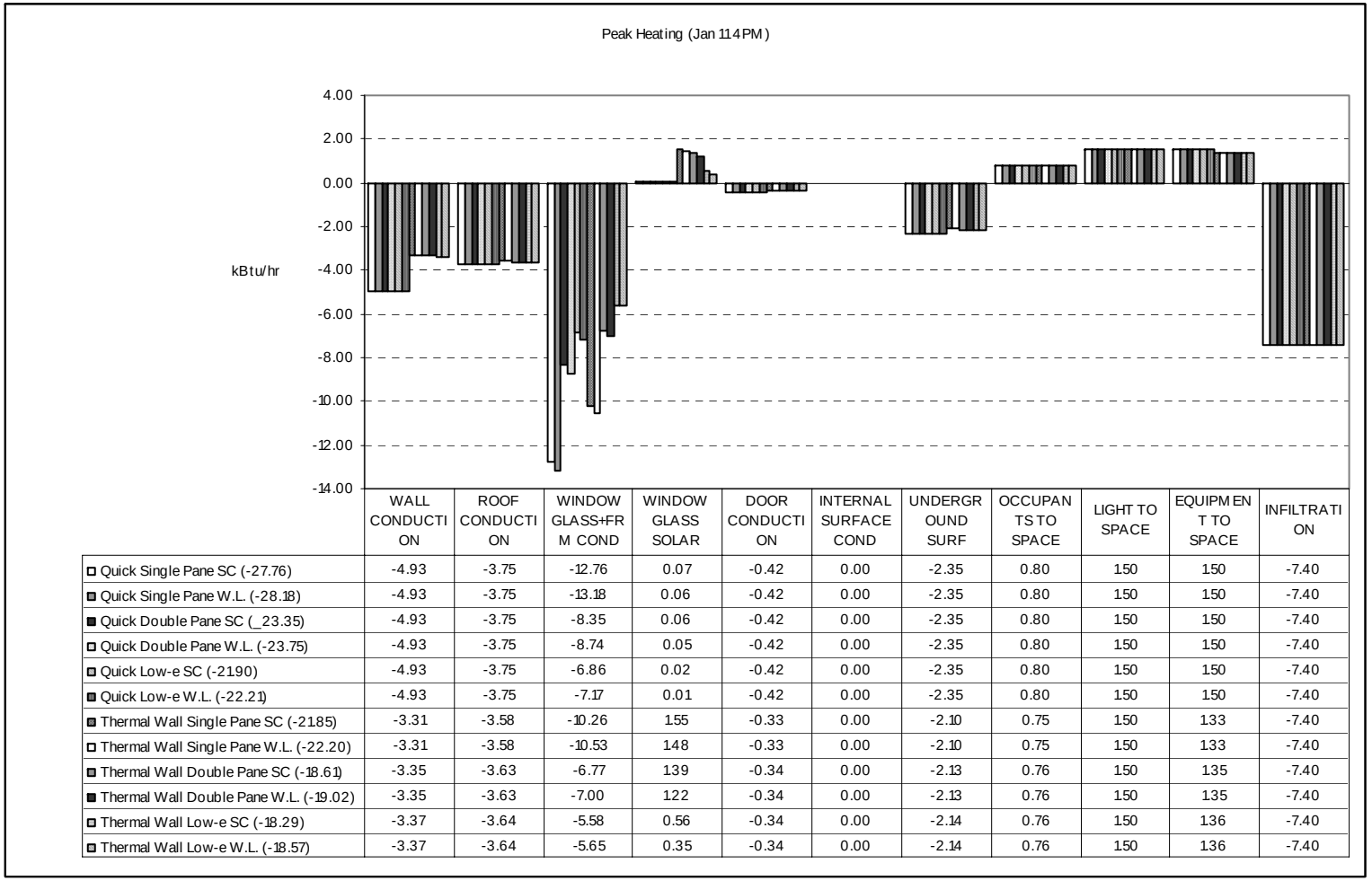
All Peak Cooling:



	WALL CONDUCTION	ROOF CONDUCTION	WINDOW GLASS+FRM COND	WINDOW GLASS SOLAR	DOOR CONDUCTION	INTERNAL SURFACE COND	UNDERGROUND SURF	OCCUPANTS TO SPACE	LIGHT TO SPACE	EQUIPMENT TO SPACE	INFILTRATION
Quick Single Pane SC (40.90)	3.06	3.71	6.41	15.55	0.30	0.00	0.69	0.80	1.50	1.50	7.38
Quick Single Pane W.L. (40.47)	3.06	3.71	6.84	14.70	0.30	0.00	0.69	0.80	1.50	1.50	7.38
Quick Double Pane SC (37.25)	3.06	3.71	4.63	13.69	0.30	0.00	0.69	0.80	1.50	1.50	7.38
Quick Double Pane W.L. (36.30)	3.06	3.71	6.03	11.34	0.30	0.00	0.69	0.80	1.50	1.50	7.38
Quick Low-e SC (28.33)	3.06	3.71	3.95	5.44	0.30	0.00	0.69	0.80	1.50	1.50	7.38
Quick Low-e W.L. (28.44)	3.06	3.71	6.31	3.20	0.30	0.00	0.69	0.80	1.50	1.50	7.38
Thermal Wall Single Pane SC (33.65)	2.29	3.60	4.82	10.58	0.22	0.00	0.62	0.75	1.50	1.33	7.38
Thermal Wall Single Pane W.L. (32.83)	2.29	3.60	5.14	10.00	0.22	0.00	0.62	0.75	1.50	1.33	7.38
Thermal Wall Double Pane SC (30.73)	2.32	3.64	3.52	9.41	0.23	0.00	0.63	0.76	1.50	1.35	7.38
Thermal Wall Double Pane W.L. (30.22)	2.32	3.64	4.58	7.83	0.23	0.00	0.63	0.76	1.50	1.35	7.38
Thermal Wall Low-e SC (24.61)	2.33	3.66	3.02	3.76	0.23	0.00	0.63	0.76	1.50	1.36	7.38
Thermal Wall Low-e W.L. (24.90)	2.33	3.66	4.83	2.23	0.23	0.00	0.63	0.76	1.50	1.36	7.38

Figure 81. All hourly peak cooling results.

All Peak Heating:



	WALL CONDUCTION	ROOF CONDUCTION	WINDOW GLASS+FRM COND	WINDOW GLASS SOLAR	DOOR CONDUCTION	INTERNAL SURFACE COND	UNDERGROUND SURF	OCCUPANTS TO SPACE	LIGHT TO SPACE	EQUIPMENT TO SPACE	INFILTRATION
Quick Single Pane SC (-27.76)	-4.93	-3.75	-12.76	0.07	-0.42	0.00	-2.35	0.80	1.50	1.50	-7.40
Quick Single Pane W.L. (-28.18)	-4.93	-3.75	-13.18	0.06	-0.42	0.00	-2.35	0.80	1.50	1.50	-7.40
Quick Double Pane SC (_23.35)	-4.93	-3.75	-8.35	0.06	-0.42	0.00	-2.35	0.80	1.50	1.50	-7.40
Quick Double Pane W.L. (-23.75)	-4.93	-3.75	-8.74	0.05	-0.42	0.00	-2.35	0.80	1.50	1.50	-7.40
Quick Low-e SC (-21.90)	-4.93	-3.75	-6.86	0.02	-0.42	0.00	-2.35	0.80	1.50	1.50	-7.40
Quick Low-e W.L. (-22.21)	-4.93	-3.75	-7.17	0.01	-0.42	0.00	-2.35	0.80	1.50	1.50	-7.40
Thermal Wall Single Pane SC (-21.85)	-3.31	-3.58	-10.26	1.55	-0.33	0.00	-2.10	0.75	1.50	1.33	-7.40
Thermal Wall Single Pane W.L. (-22.20)	-3.31	-3.58	-10.53	1.48	-0.33	0.00	-2.10	0.75	1.50	1.33	-7.40
Thermal Wall Double Pane SC (-18.61)	-3.35	-3.63	-6.77	1.39	-0.34	0.00	-2.13	0.76	1.50	1.35	-7.40
Thermal Wall Double Pane W.L. (-19.02)	-3.35	-3.63	-7.00	1.22	-0.34	0.00	-2.13	0.76	1.50	1.35	-7.40
Thermal Wall Low-e SC (-18.29)	-3.37	-3.64	-5.58	0.56	-0.34	0.00	-2.14	0.76	1.50	1.36	-7.40
Thermal Wall Low-e W.L. (-18.57)	-3.37	-3.64	-5.65	0.35	-0.34	0.00	-2.14	0.76	1.50	1.36	-7.40

Figure 82. All hourly peak heating results.