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October 2007

Program Description

A PC Program

COMFEN 1.0

for Calculating the Energy Demand and Comfort Impacts of Windows in Commercial Buildings

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COMFEN 1.0: Program Description

A PC Program for Calculating the Heating and Cooling Energy Use of Windows in Commercial Buildings

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1. INTRODUCTION

1.1. Overview

Today's energy-efficient windows can dramatically lower the heating and cooling costs associated with windows while increasing occupant comfort and minimizing window surface condensation problems. However, consumers are often confused about how to pick the most efficient window design for a commercial building. Product information typically offers window properties: U-factors or R-values, Solar Heat Gain Coefficients or Shading Coefficients, and air leakage rates. However, the relative importance of these properties depends on site- and building-specific conditions. Furthermore, these properties are based on static evaluation conditions that are very different from the real situation a window will be used in.

A computer tool such as COMFEN can help architects and builders pick the most energy-efficient and cost-effective window for a given application. It calculates heating and cooling energy use and associated costs as well as peak heating and cooling demand for specific window products. Users define a specific "scenario" by specifying the building type, geographic location, orientation, and window configuration. Users also specify size, shading, and thermal properties of the window they wish to investigate.

Update information, future releases, and program information about COMFEN and other software tools (such as WINDOW, THERM, and Optics) from the Windows and Daylighting Group at LBNL can be found on the World Wide Web at URL: http://windows.lbl.gov, in the Software section. To obtain COMFEN, WINDOW, or THERM, check the web site for the current downloadable version.

2. QUICK START

2.1. Getting started

- Install the COMFEN program (see Chapter 3, "Installation").
- When the program is installed, **double click** on the COMFEN icon.

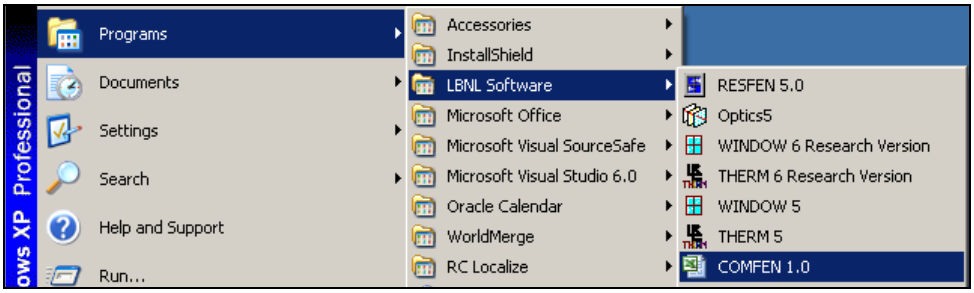


Figure 2-1. Click on the COMFEN icon in the Programs/LBNL Software list.

- This version of the program is based on a Microsoft Excel spreadsheet, so the program will open Excel to start. COMFEN is running macros in Excel, so it is necessary to allow them to run, by clicking "Enable Macros" when this dialog box appears

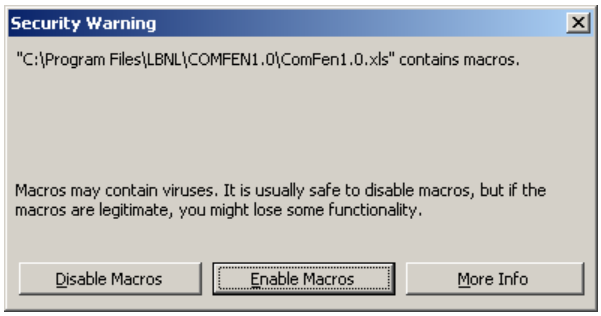


Figure 2-2. In order for COMFEN to operate properly, Excel Macros must be enabled.

It is recommended that you set the Macro Security level in Excel to Medium, which allows you to choose whether to run the macros or not, and results in the above Security Warning each time you try to run a spreadsheet with macros in it. You can set the Macro Security to Medium in the Tools/Macro/Security menu choice, and the following dialog box will appear

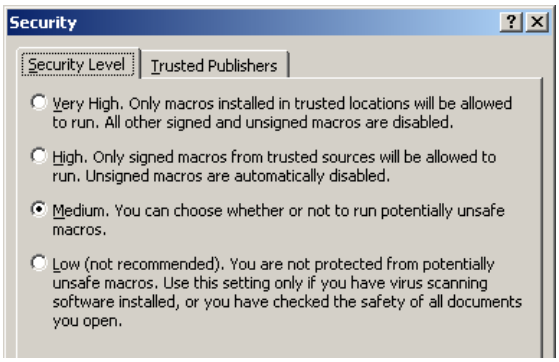


Figure 2-3.Setting Macro security (Tools/Macro/Security) to Medium allows you to choose whether to allow macros to be run.

- The program will open to the **Project** screen. Each **Project** is a comparison between up to four different facades. Location, façade orientation and daylighting controls are all factors that can be changed to see the effect on the energy consumption of a façade.

  There are a few sample projects in COMFEN, which can be viewed by selecting a project from the pulldown list next to Project Name. The Project shown below is a comparison of different shading and glazing systems on a west-facing façade

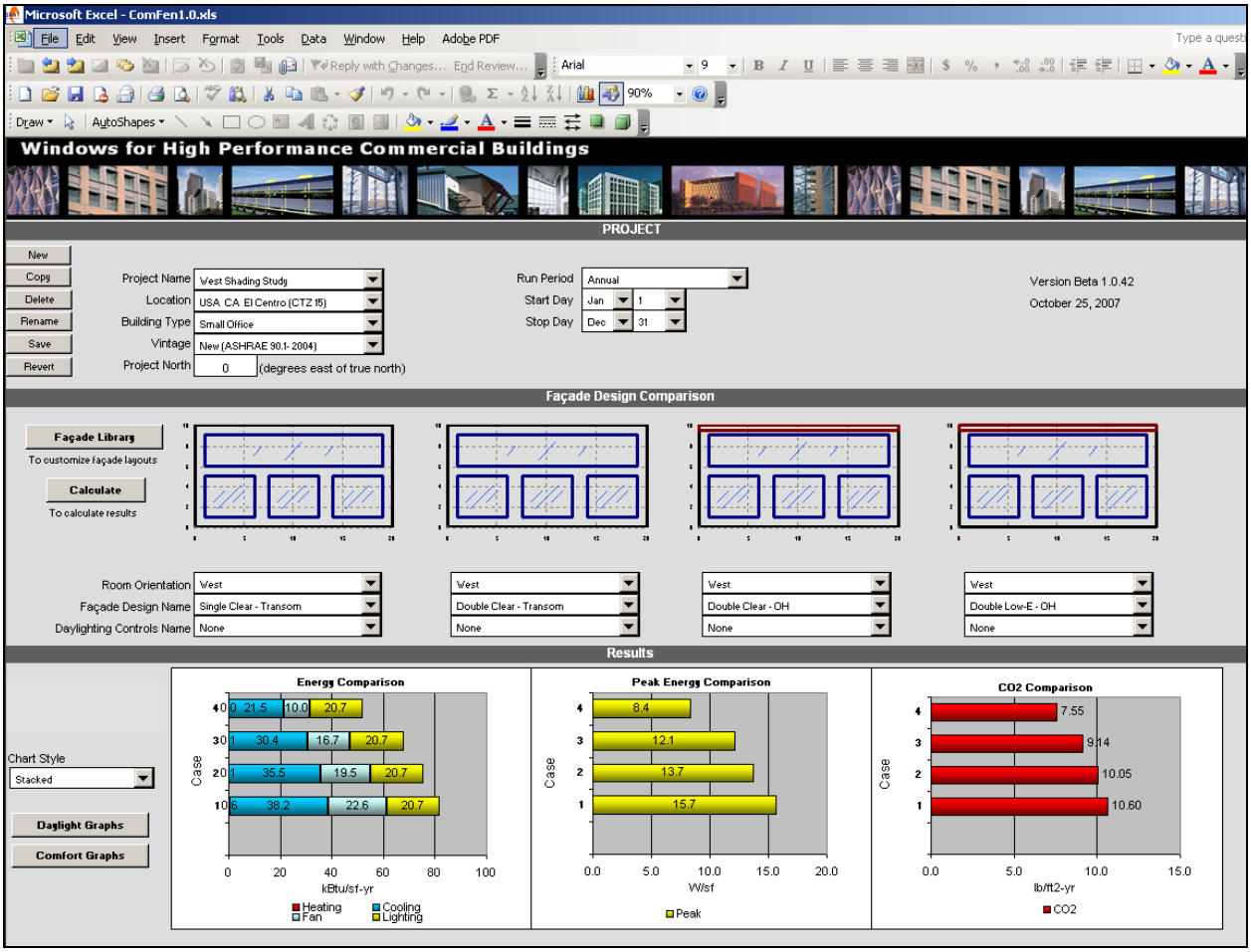


Figure 2-4. The main screen allows comparison of four different façade designs.

- To create a new façade to compare, click on the Façade Library button in the Façade Design Comparison section of the Project screen.

From the **Project** screen, click on the **Façade Library Button** to get to the **Facade Library** screen

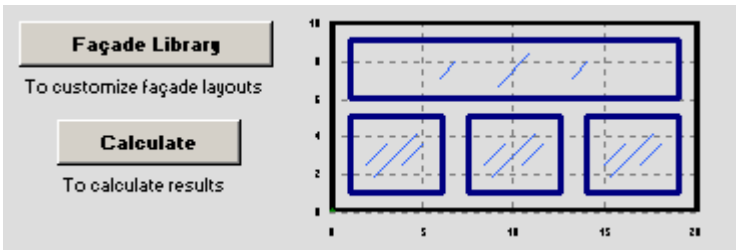


Figure 2-5. Click on the Façade Design button to define custom façade designs.

2.2. Defining Facades

The Façade Library screen is used to define the façade elements in a building, such as windows, overhangs and fins. Once a Façade is defined, it can be selected on the Project Screen.

There are several sample façade designs in the installation version of the program. They can be displayed by using the pulldownunder Façade Design Name.

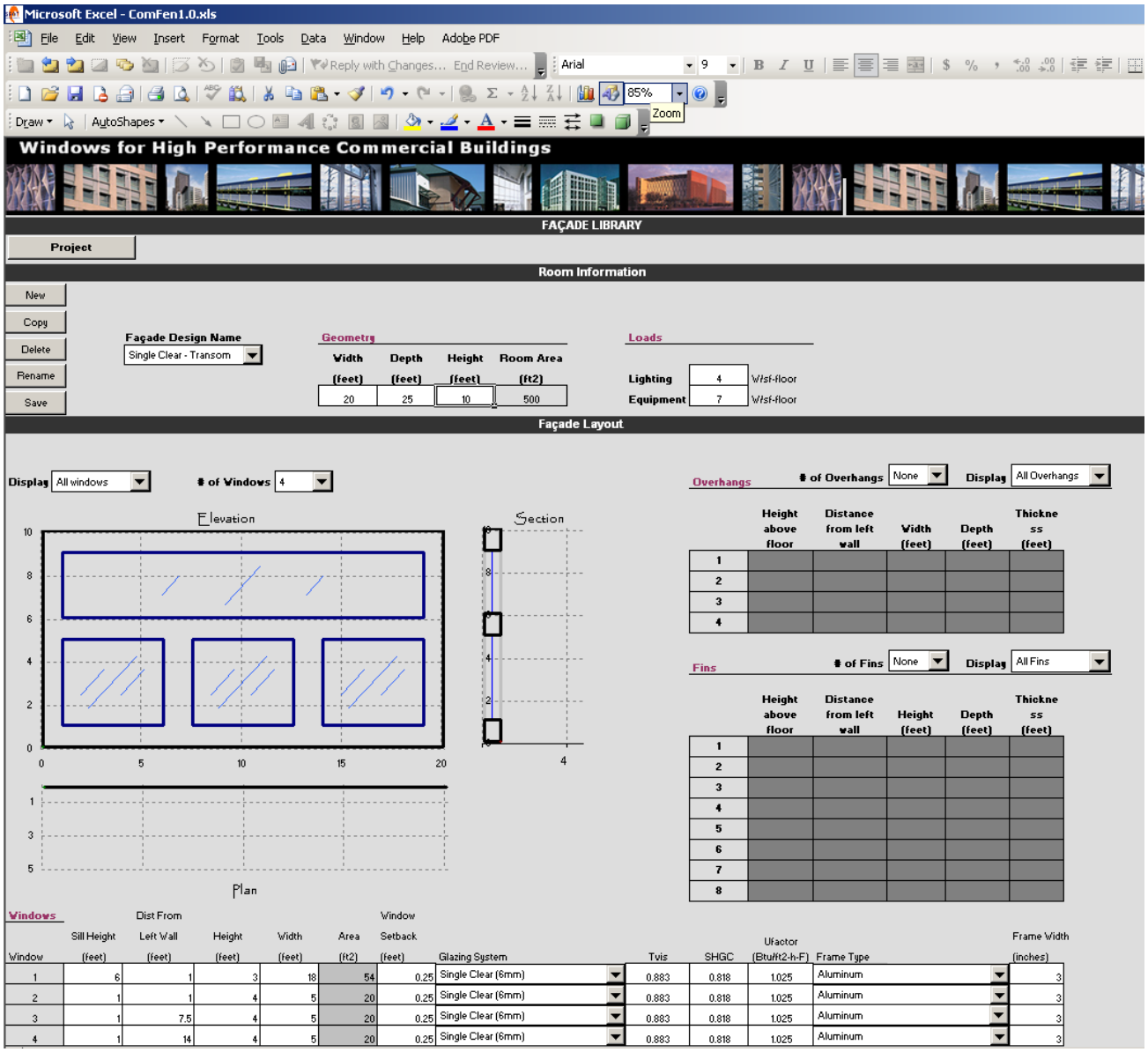


Figure 2-6. The Façade Design screen allows definition of custom façade designs.

2.2.1. View an Existing Façade

To view a façade that is already defined in the Façade Library, click on the pulldown list under Façade Design Name, and the existing facades will be displayed. Select a façade from the list, and the geometry and façade definitions will be displayed.

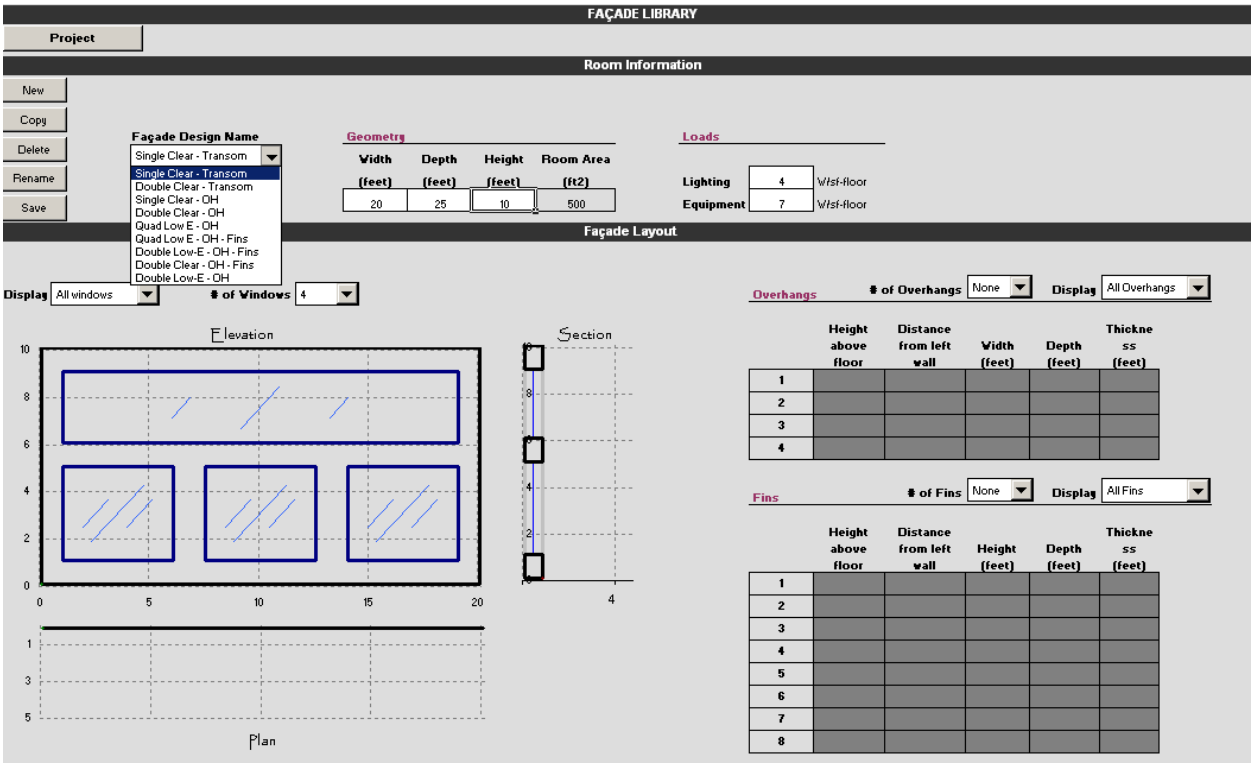


Figure 2-7. View a Façade that is already defined in the Façade Library.

2.2.2. Make a New Facade

To define a new façade, you can either make a new façade (**New** button) or copy an existing façade and modify if (**Copy** button). Here are the steps for making a new facade

Click on the **New** button at the top of the screen

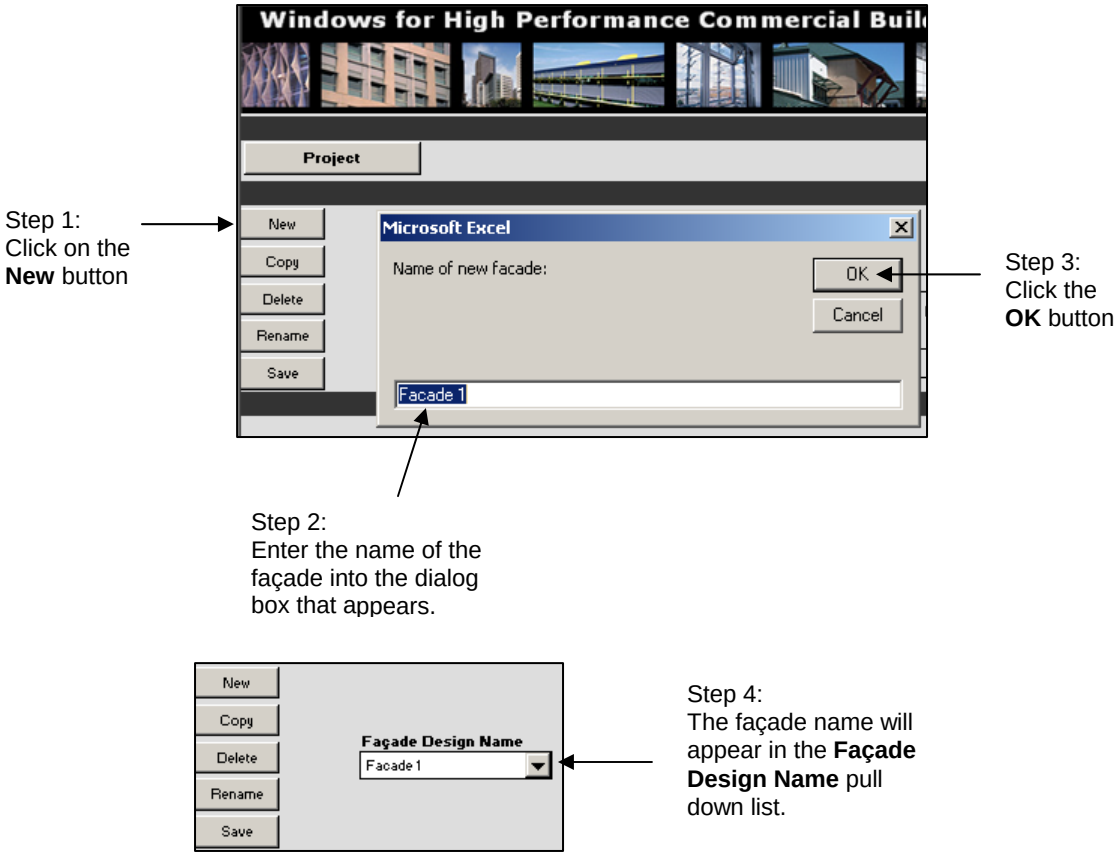


Figure 2-8. Define a New Facade.

2.2.3. Define the Room Geometry and Loads

Define the Room Geometry by entering values for the room **Width**, **Depth** and **Height**, as well as the **Lighting** and **Equipment** loads for the room. When you enter the room dimensions, the graphic below will be updated to reflect the new information.

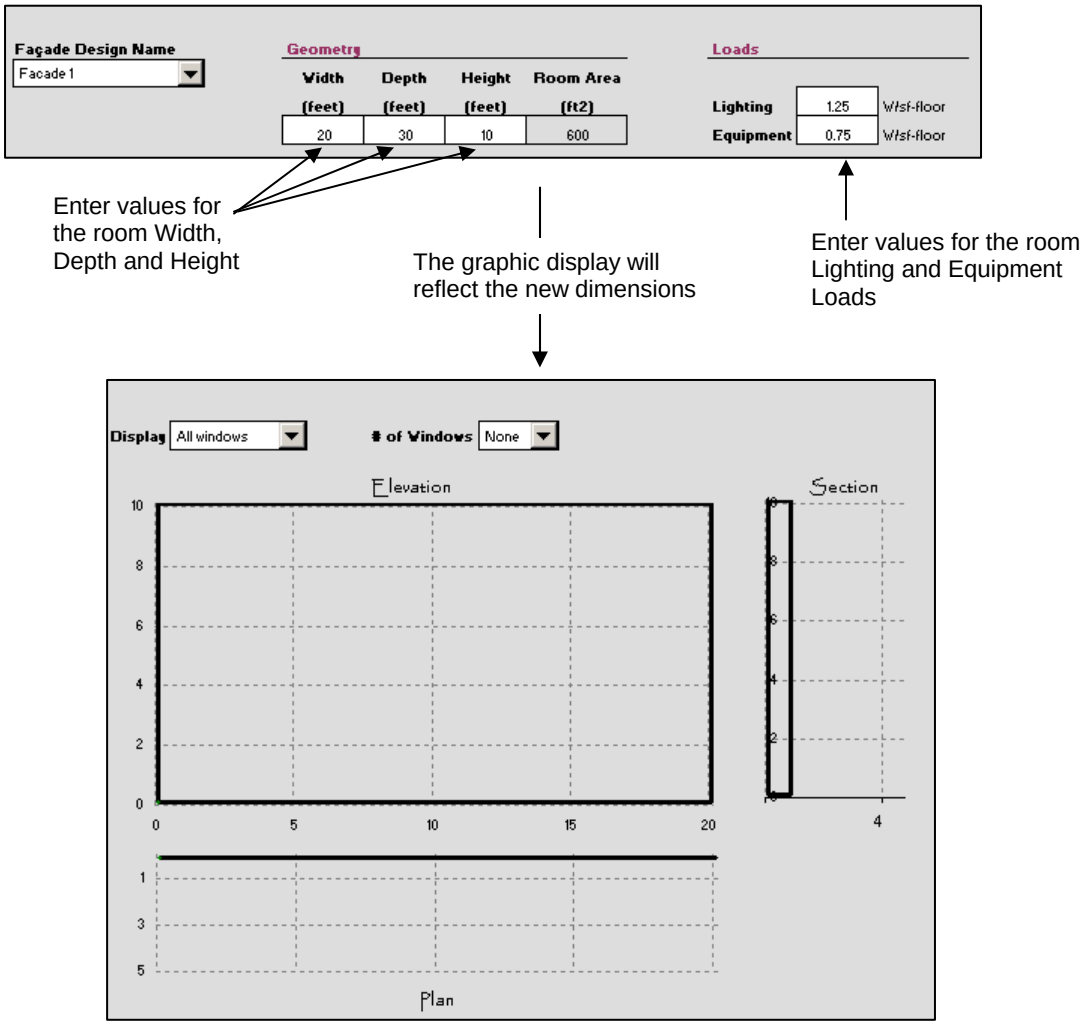
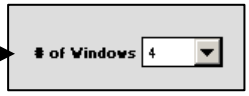


Figure 2-9. Define the room geometry and loads.

2.2.4. Define the Window Geometry

The façade window size and placement on the wall are defined by entering values into the table below the graphic display of the façade. As these values are entered into the table, the graphic display will be updated to show the new window placement and size. (See Chapter 4 for precise definitions of each value).

Step 1:
Set the number of windows in the façade



This will cause that number of lines to becomes active in the Windows section. Most of the values for the windows will be blank

Windows	Sill Height	Dist From Left Wall	Height	Width	Area	Window Setback						
Window	(feet)	(feet)	(feet)	(feet)	(ft2)	(feet)	Glazing System	Tvis	SHGC	Ufactor (Btu/ft2-h-F)	Frame Type	Frame Width (inches)
1					0		Single Clear (6mm)	0.883	0.818	1.025	Aluminum	
2					0		Single Clear (6mm)	0.883	0.818	1.025	Aluminum	
3					0		Single Clear (6mm)	0.883	0.818	1.025	Aluminum	
4					0		Single Clear (6mm)	0.883	0.818	1.025	Aluminum	

Enter dimensions for Sill Height, Distance from the Left wall, window Height and window Width for Window # 1

Windows	Sill Height	Dist From Left Wall	Height	Width	Area
Window	(feet)	(feet)	(feet)	(feet)	(ft2)
1	2	1	6	3.5	21
2					0
3					0
4					0

The graphic display of the façade will be updated with the new information.

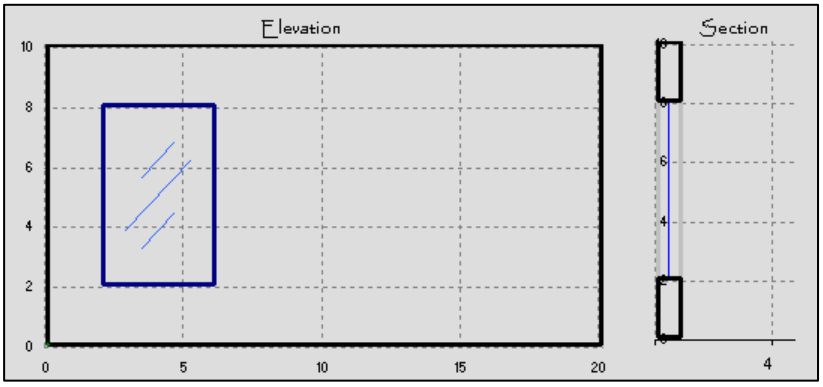
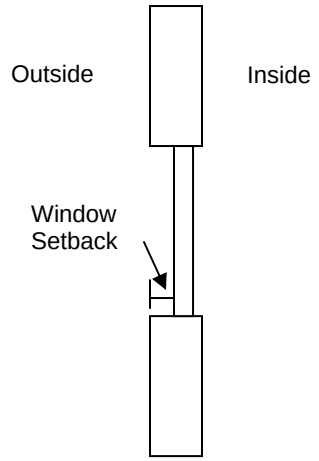


Figure 2-10. Define the windows for the facade.

Continue to define up to four windows for the façade.

Continue to define the window geometry for the facade

Windows Window	Sill Height (feet)	Dist From Left Wall (feet)	Height (feet)	Width (feet)	Area (ft2)	Window Setback (feet)
1	2	1	6	3.5	21	0.25
2	2	5.5	6	3.5	21	0.25
3	2	11	6	3.5	21	0.25
4	2	15.5	6	3.5	21	0.25



The graphic display of the façade will be updated as each window is defined.

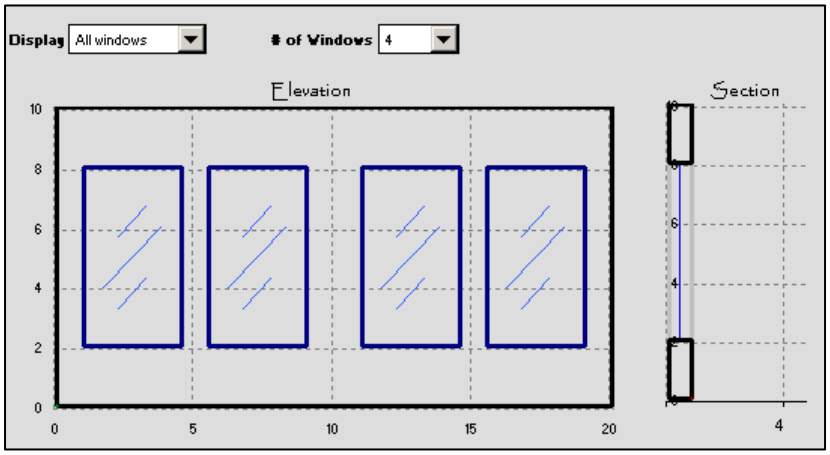


Figure 2-11. Define the rest of the windows for the facade.

Finish defining the windows by entering values for the Window Setback, Glazing System, Frame Type and Frame Width

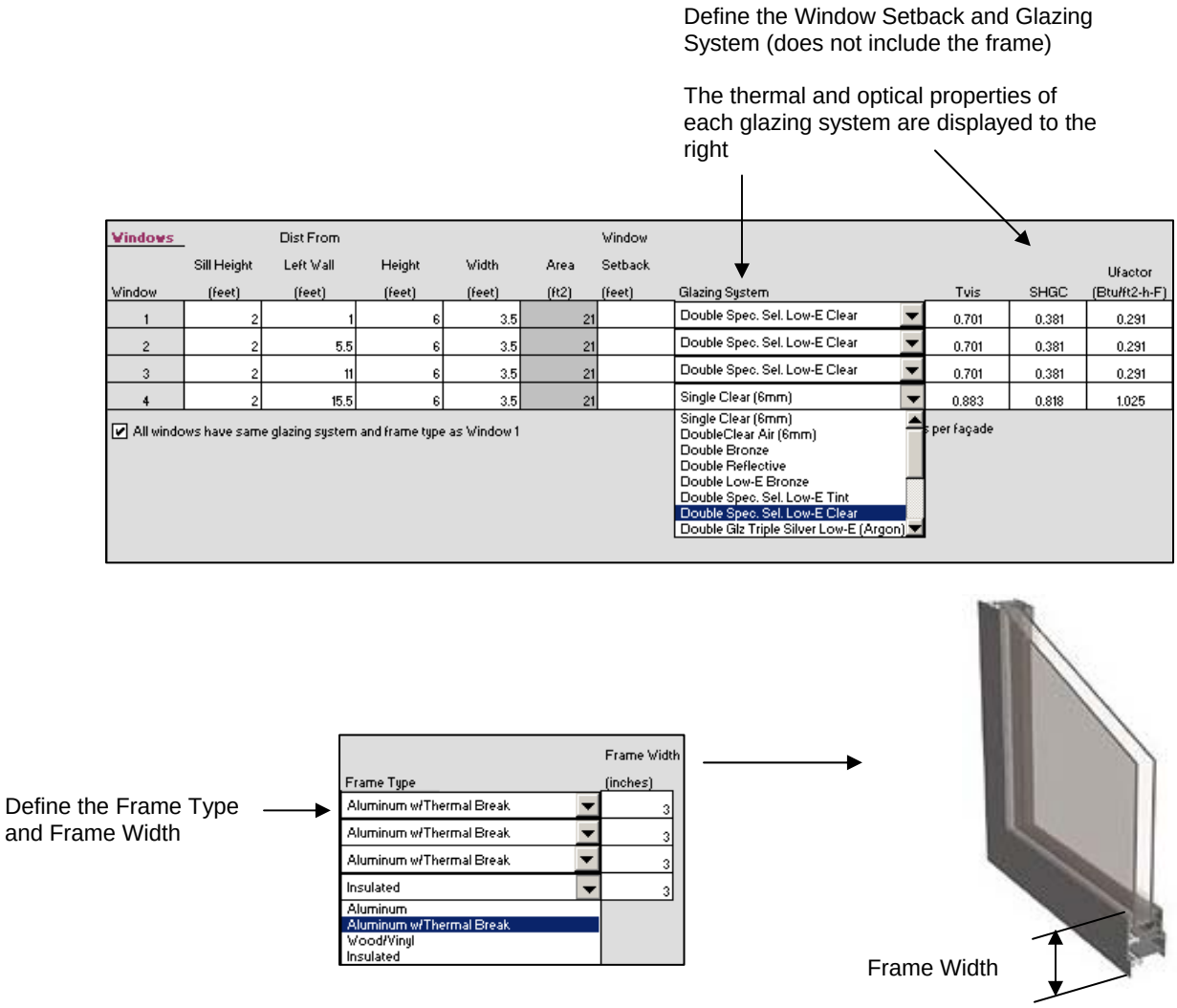


Figure 2-12. Define the glazing system and frame of the windows.

2.2.5. Controlling Window Display

It is possible to view one window at a time, using the pulldown labeled "Display" above the graphic of the window.

The default value for the Display pulldown list is "All Windows", which will display all the windows that are defined.

To see one window at a time, select the window number from the Display pulldown list.

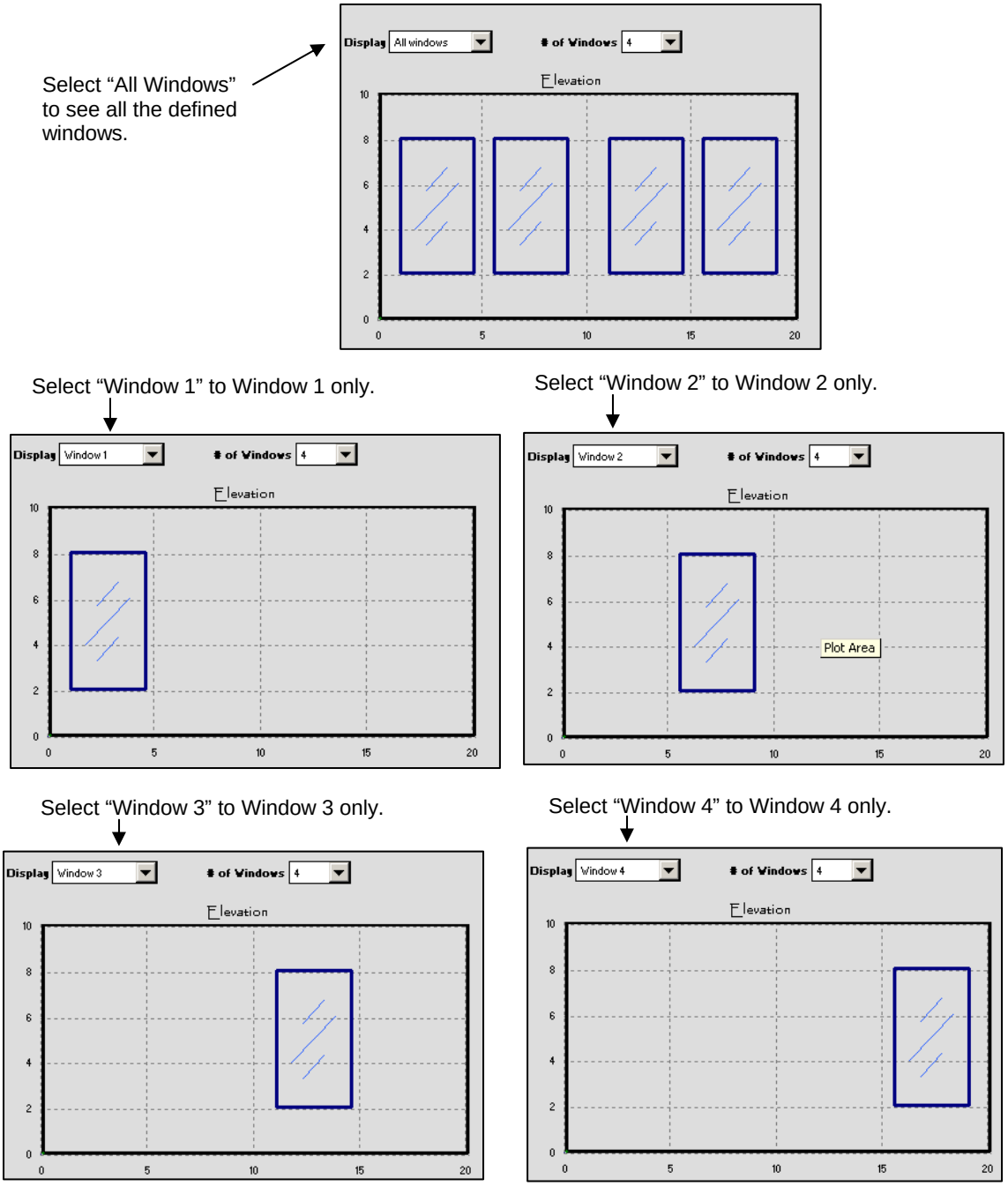


Figure 2-13. Viewing the windows one at a time.

2.2.6. . Define Overhangs

If there are overhangs associated with the windows, they can be defined as part of the façade.

Overhangs are defined by specifying their size and location on the façade, viewing the façade from the outside. Up to four overhangs can be defined per façade.

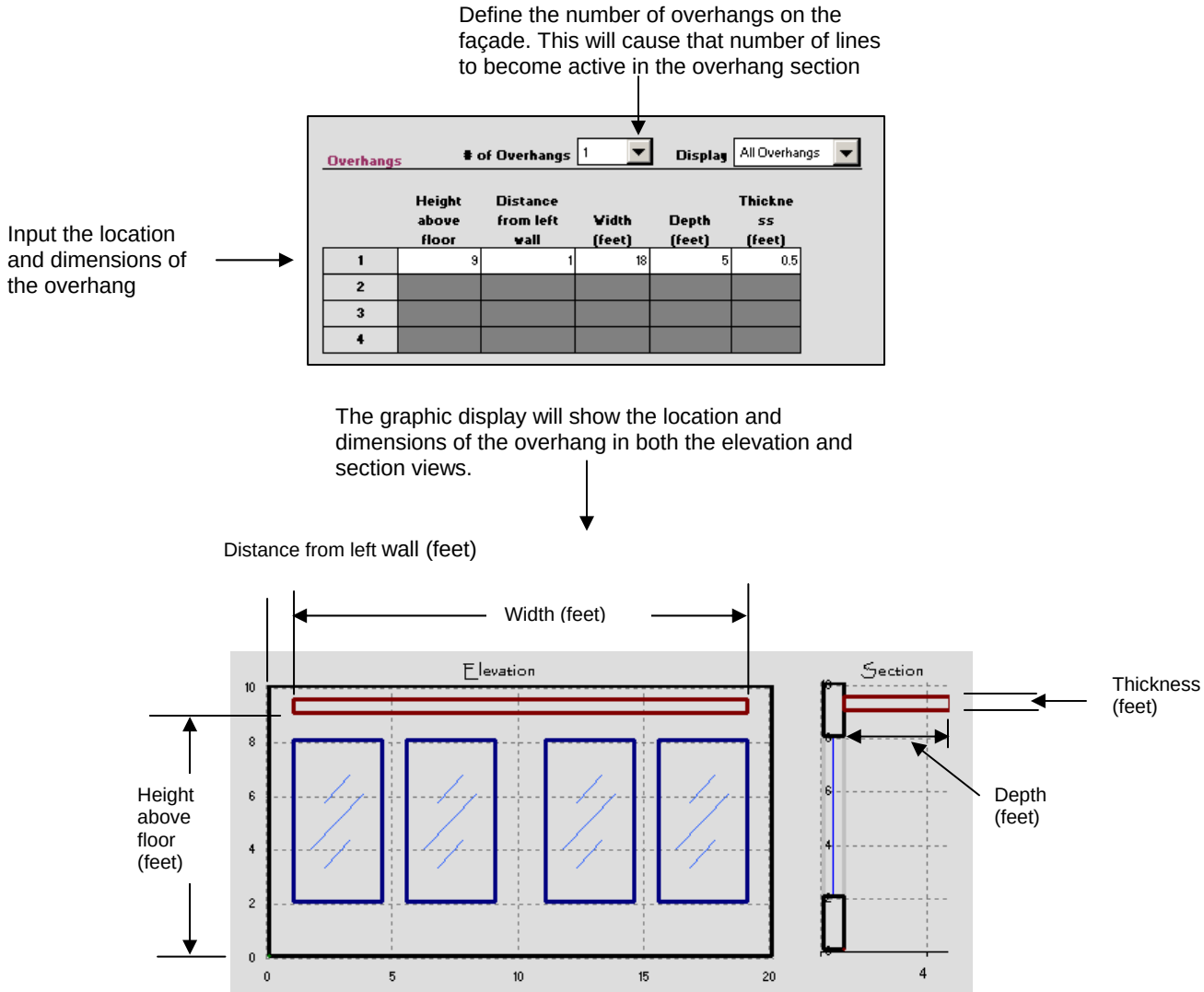


Figure 2-14. Define overhangs for the facade.

2.2.7. Define Fins

If there are fins associated with the windows, they can be defined as part of the façade. Fins are defined by specifying their size and location on the façade, viewing the façade from the outside. Up to eight fins can be defined per façade.

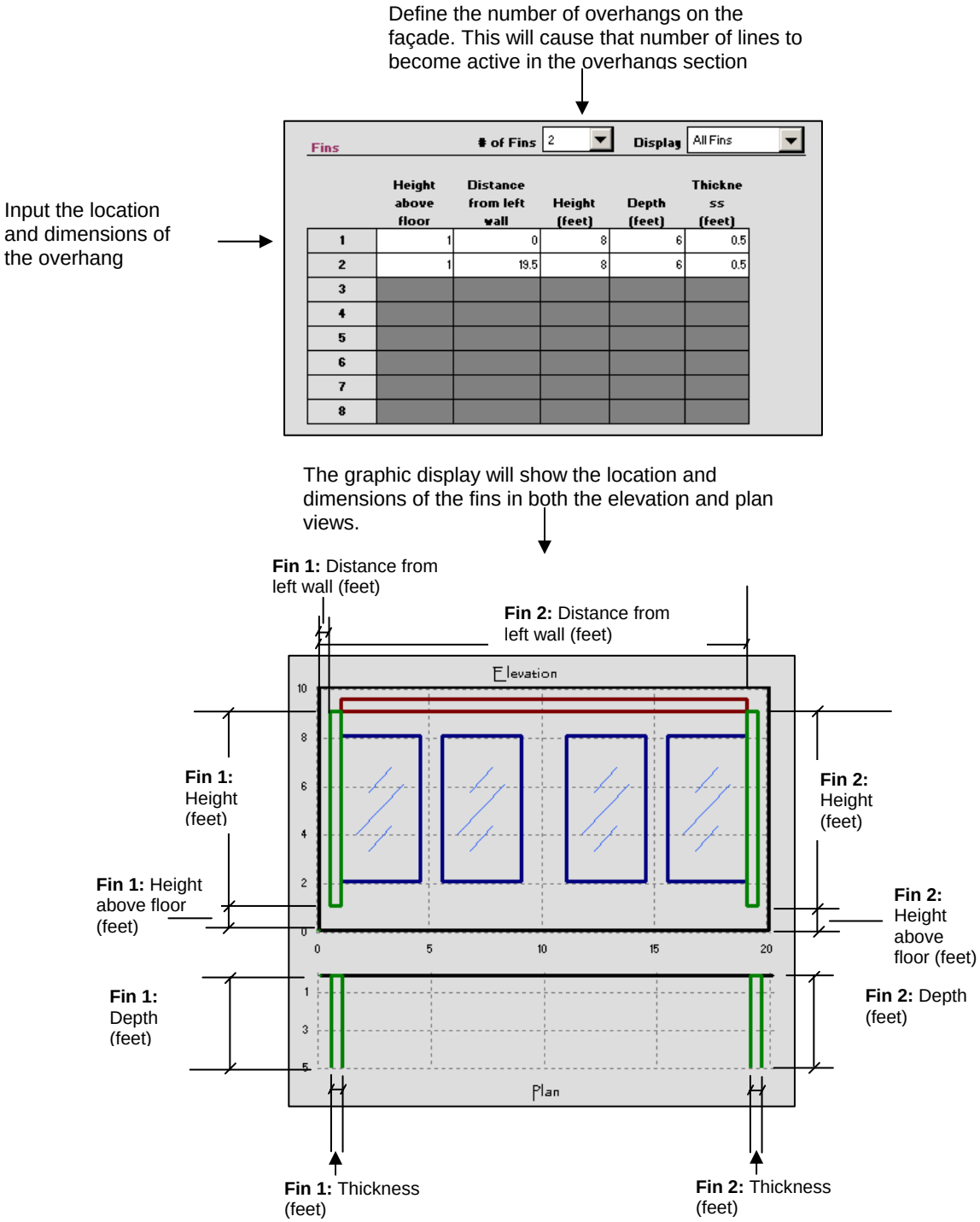


Figure 2-15. Define fins for the facade.

2.3. Comparing Facades

COMFEN allows comparison of up to four facades.

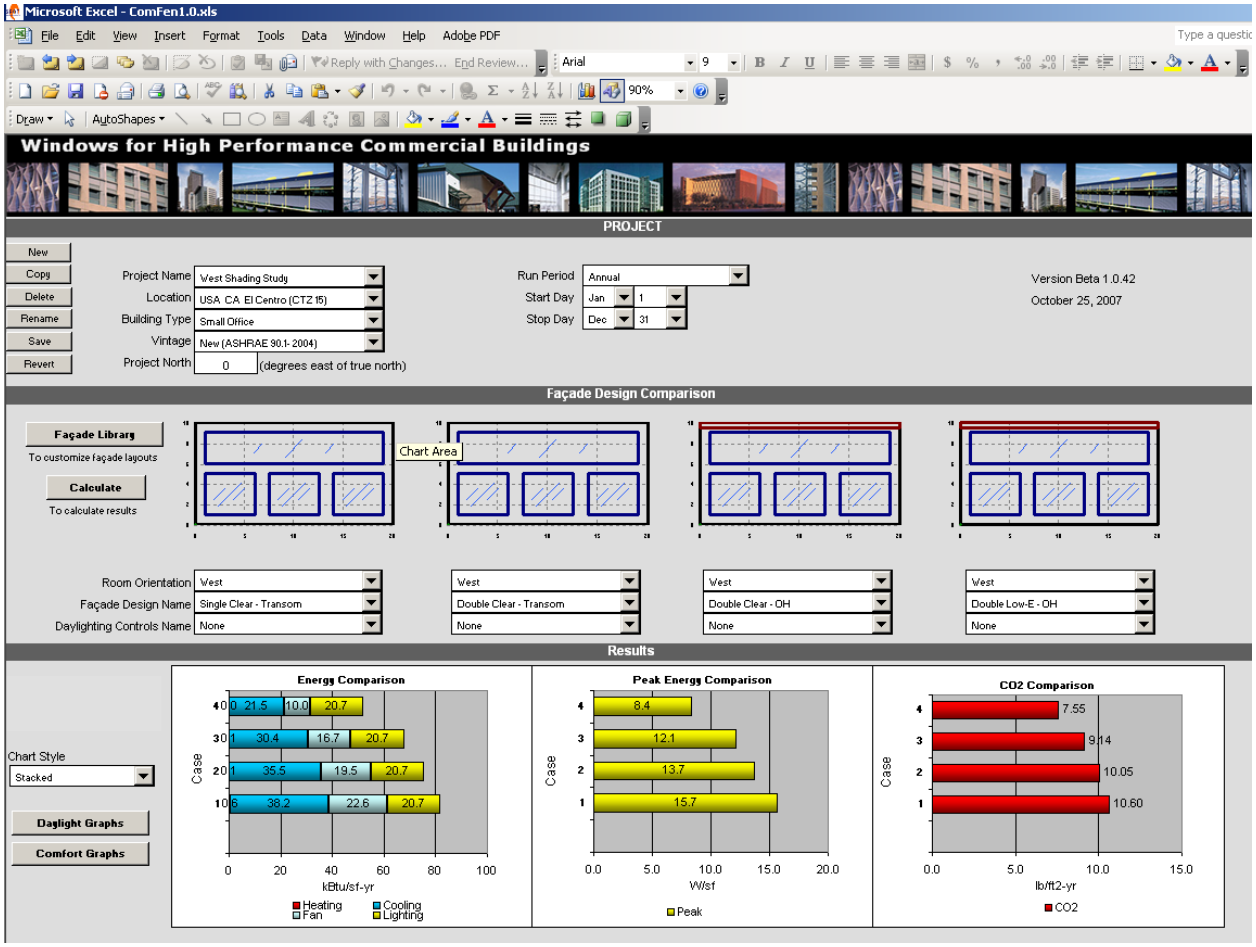


Figure 2-16. COMFEN allows comparison of up to four façade designs.

2.3.1. Define a New Project

To define a new project, you can either make a new project (using the New button) or copy an existing project (using the Copy button). Here are the steps for making a new project.

Click on the New button and enter the name of the project into the dialog box that appears.

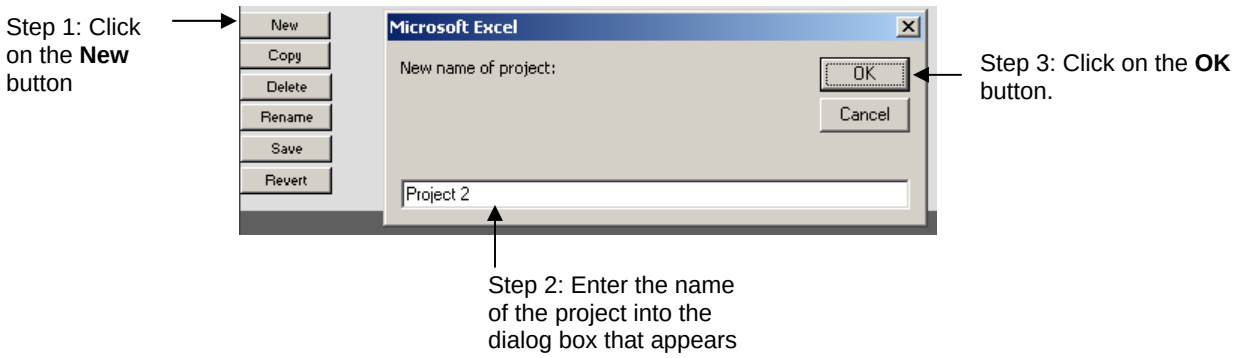


Figure 2-17. Make a new project.

A new project will be created with some default information, and one default façade. The other façade choices will be set to "None", and the results sections will be blank.

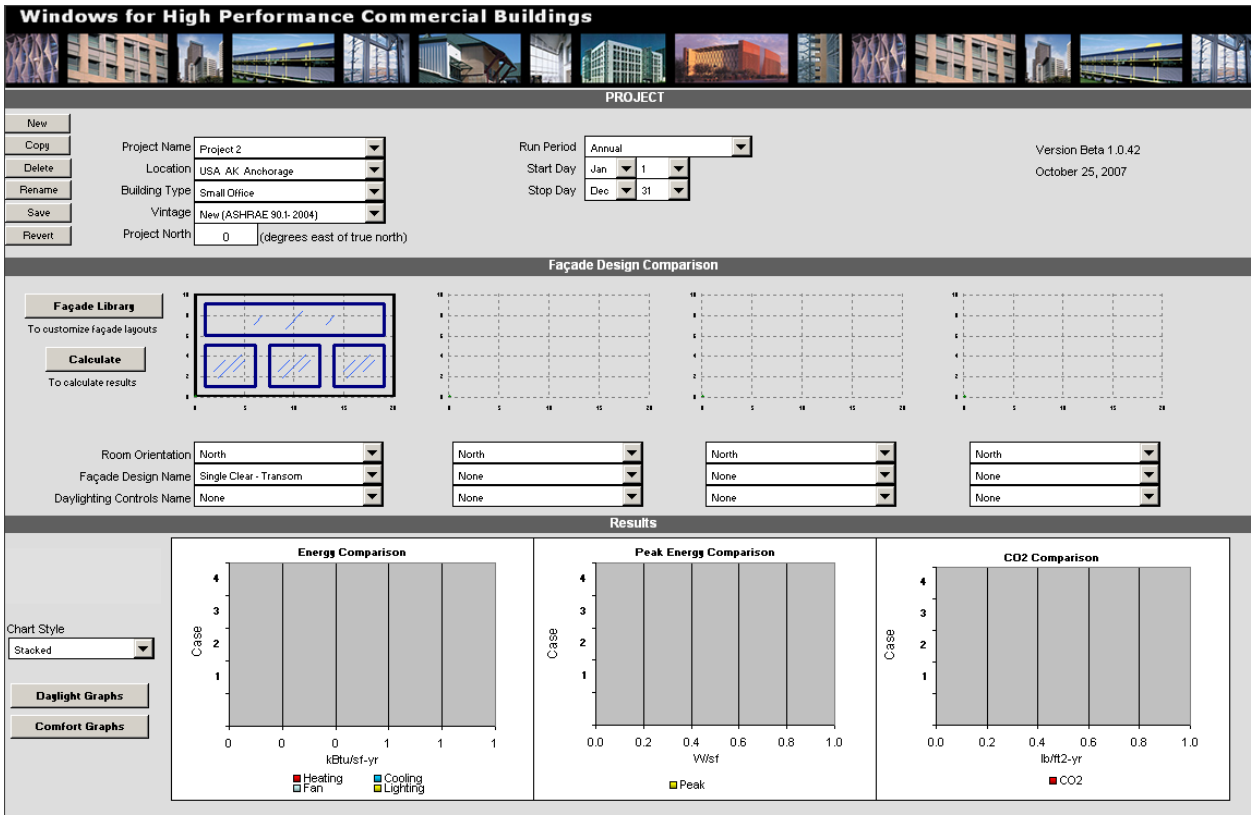


Figure 2-18. The new project will have some default settings and one default facade.

Define the Project level information as needed:

- **Project Name:** Defined at the time of creating the project. This pulldown list will contain all projects that have been defined.
- **Location:** select the appropriate location for the project.
- **Building Type:** Currently the only choice is small office
- **Vintage:** Currently the only choice is new construction, based on ASHRAE 90.1-2004
- **Project North:** Define the degrees east of north of the project, if it is not oriented in the cardinal orientations.
- **Run Period:** This determines the days for running the energy calculation. The options are:
  - **Annual:** This choice runs the energy calculation for the entire year, January 1 through December 31.
  - **One Day:** This choice runs the energy calculation for one day, and the Start and Stop day must be specified
  - **Custom:** This choice runs the energy calculation for the days specified under Start and Stop Day.

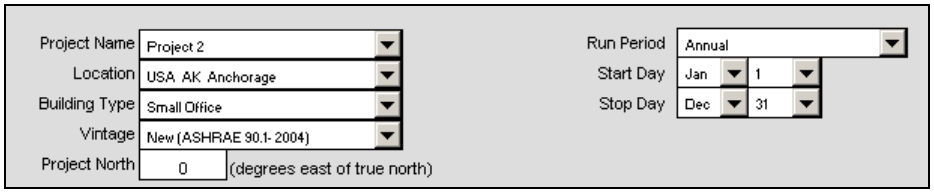


Figure 2-19. Define the project level information.

2.3.2. Choose Facades to Compare

For each case, click on the pulldown list for Façade Design Name and select the façade. This list will contain all the facades that have been defined. A minimum of one case and a maximum of four cases can be defined.

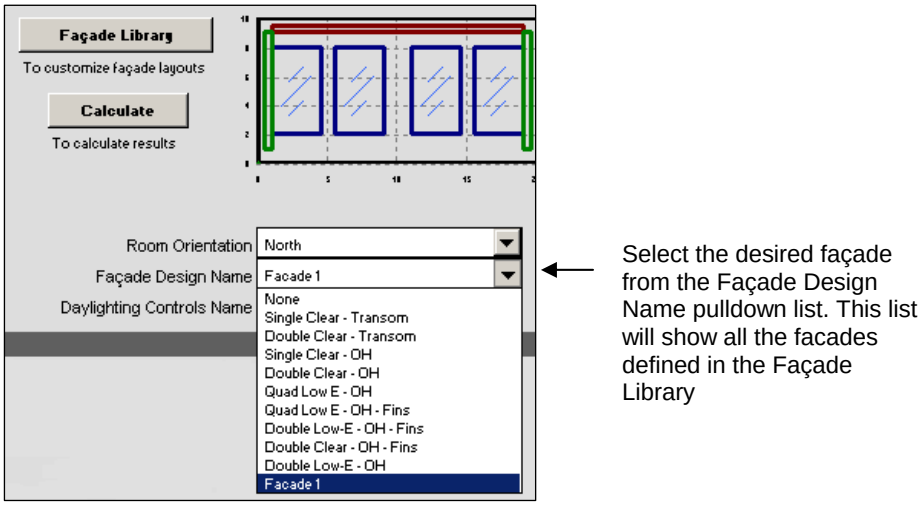


Figure 2-20. Select a façade for each case from the Façade Design Name pulldown list which will contain all the facades that have been defined.

Select a room orientation (the direction the exterior façade will face).

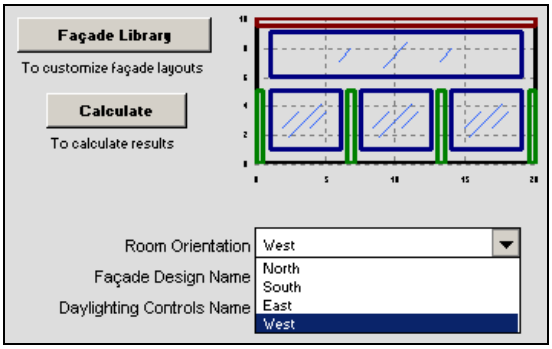


*Figure 2-21. Define the façade orientation from the **Room Orientation** pulldown list.*

Select a Daylighting Control method if desired.

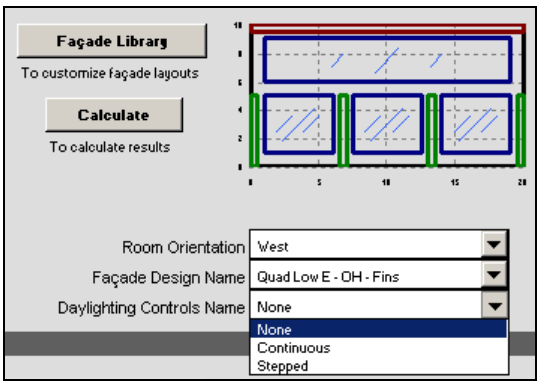


*Figure 2-22. Define the Daylighting Controls from the **Daylighting Controls Name** pulldown list.*

2.3.3. Calculate the Results

When the desired façade designs have been defined, calculate the results by clicking on the Calculate button .

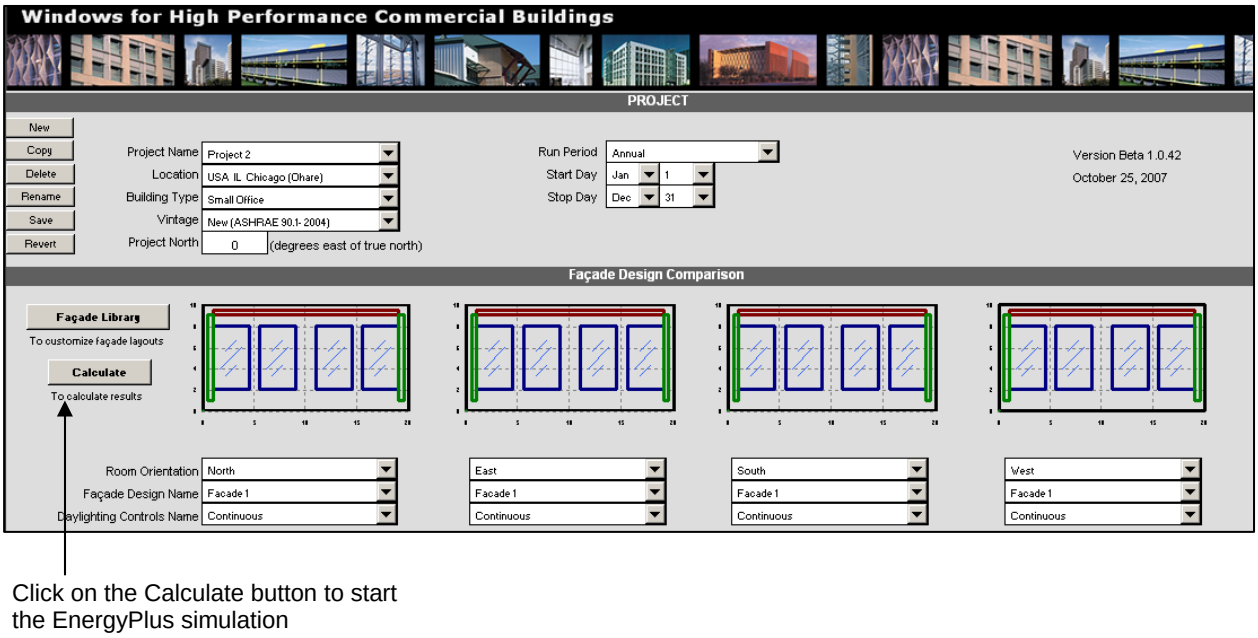


Figure 2-23. Click the Calculate button to start the EnergyPlus simulaiton.

A DOS window will open, displaying the status of the EnergyPlus simulation as it proceeds. When the simulation has completed, the DOS window will close.

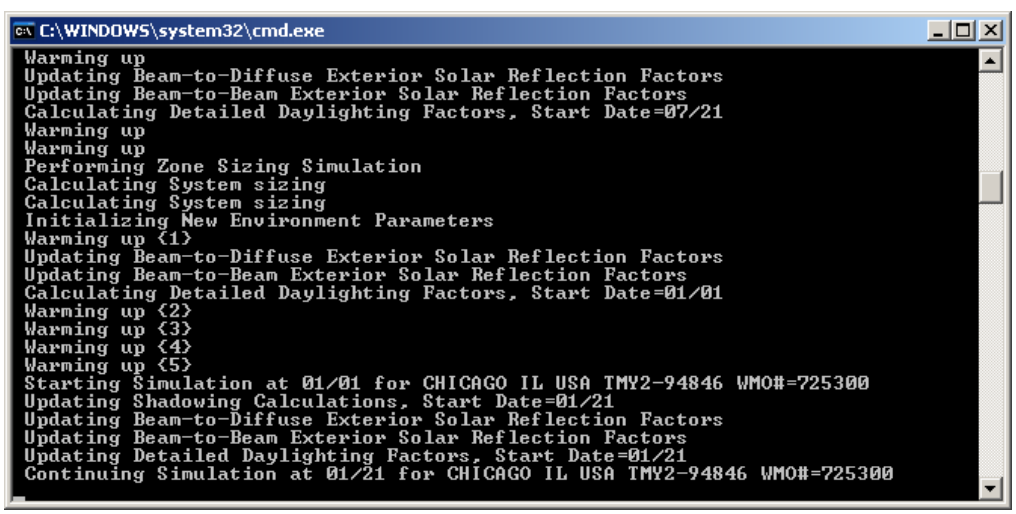
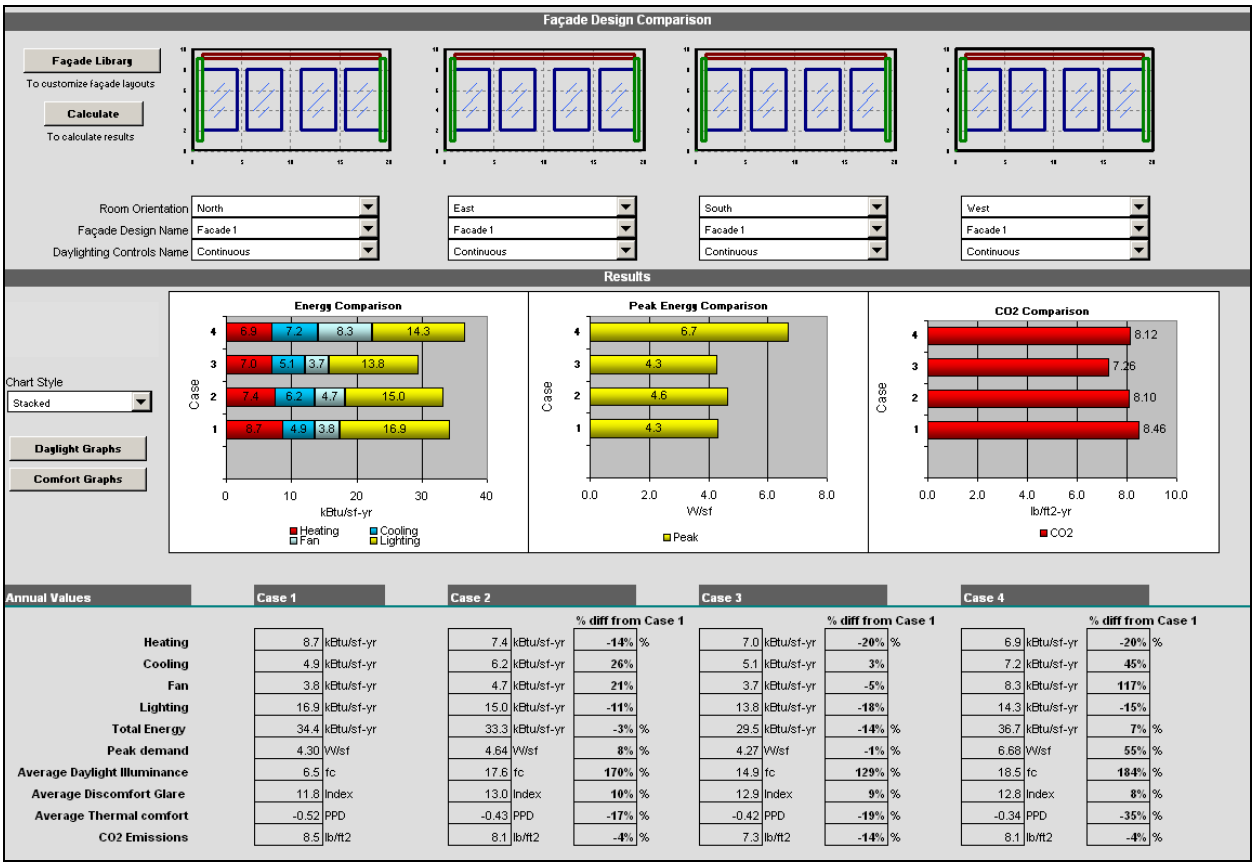


Figure 2-24. A DOS window shows the progress of the EnergyPlus simulation.

When the DOS window has closed, the simulation is finished, and the results can be updated. Click the Update Results button in the Results section of the screen, and the results tables should reflect the new simulation results.



Annual Values	Case 1		Case 2		% diff from Case 1		Case 3		% diff from Case 1		Case 4		% diff from Case 1	
Heating	8.7	kBtu/sf-yr	7.4	kBtu/sf-yr	-14%	%	7.0	kBtu/sf-yr	-20%	%	6.9	kBtu/sf-yr	-20%	%
Cooling	4.9	kBtu/sf-yr	6.2	kBtu/sf-yr	26%		5.1	kBtu/sf-yr	3%		7.2	kBtu/sf-yr	45%	
Fan	3.8	kBtu/sf-yr	4.7	kBtu/sf-yr	21%		3.7	kBtu/sf-yr	-5%		8.3	kBtu/sf-yr	117%	
Lighting	16.9	kBtu/sf-yr	15.0	kBtu/sf-yr	-11%		13.8	kBtu/sf-yr	-18%		14.3	kBtu/sf-yr	-15%	
Total Energy	34.4	kBtu/sf-yr	33.3	kBtu/sf-yr	-3%	%	29.5	kBtu/sf-yr	-14%	%	36.7	kBtu/sf-yr	7%	%
Peak demand	4.30	W/sf	4.64	W/sf	8%	%	4.27	W/sf	-1%	%	6.68	W/sf	55%	%
Average Daylight Illuminance	6.5	fc	17.6	fc	170%	%	14.9	fc	129%	%	18.5	fc	184%	%
Average Discomfort Glare	11.8	Index	13.0	Index	10%	%	12.9	Index	9%	%	12.8	Index	8%	%
Average Thermal comfort	-0.52	PPD	-0.43	PPD	-17%	%	-0.42	PPD	-19%	%	-0.34	PPD	-35%	%
CO2 Emissions	8.5	lb/ft2	8.1	lb/ft2	-4%	%	7.3	lb/ft2	-14%	%	8.1	lb/ft2	-4%	%

Figure 2-25. When the simulation is completed, the results are displayed graphically and numerically.

3. INSTALLATION

3.1. Hardware Requirements

First, make sure your computer system meets these specifications:

- At least 16 MB of random access memory (RAM), configured as extended memory. 32 MB of RAM is preferred for optimum operation.
- Microsoft Windows 2000™ or Windows XP™.
- Hard disk drive with at least 100 megabytes of available disk space.
- Monitor and mouse.

3.2. Setup

The installation program can be downloaded from the LBNL website at http://windows.lbl.gov/software/comfen/1/.

Follow these steps to install the program:

2. Click the **Start** toolbar button and select **Run**:

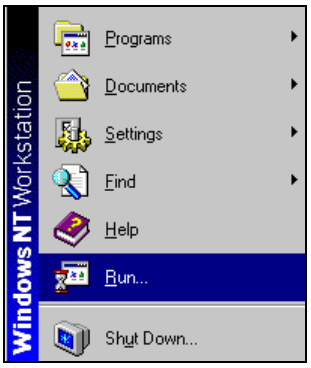


*Figure 3-1. Pick **Run** from the Start toolbar.*

In the **Run** window, type

< drive>:<path>COMFEN1_0Setup.exe

where <drive>:<path> is the drive letter and directory path for the location of the installation file on your computer

Press the **OK** button in the **Run** dialog box.

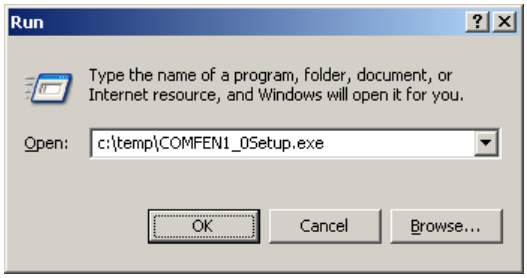


*Figure 3-2. Type <drive letter>: COMFEN5Setup.exe and press **OK**.*

2. A Welcome window will display. Click the **Next** button to proceed with the installation, or **Cancel** to stop.

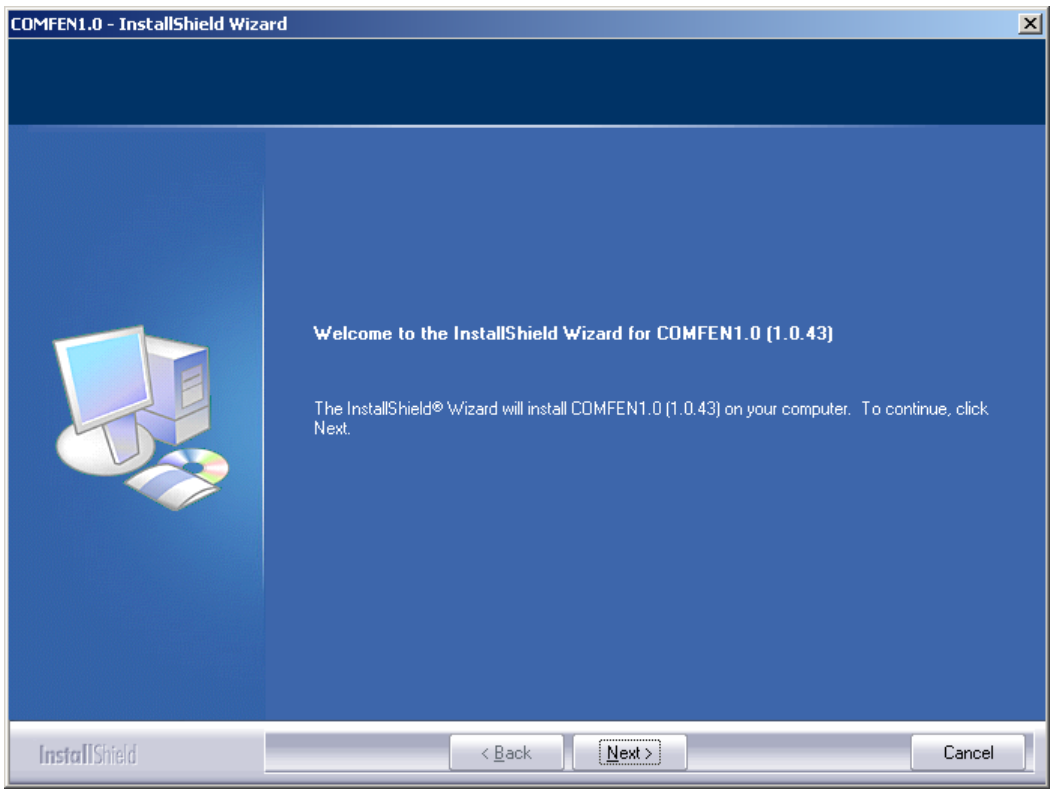


Figure 3-3. The initial COMFEN Welcom window.

3. The **Software License Agreement** window will display next. Read through the license and make sure you agree to all the terms before proceeding. To proceed with the installation, click on the **Yes** button, or click on **No** to stop.

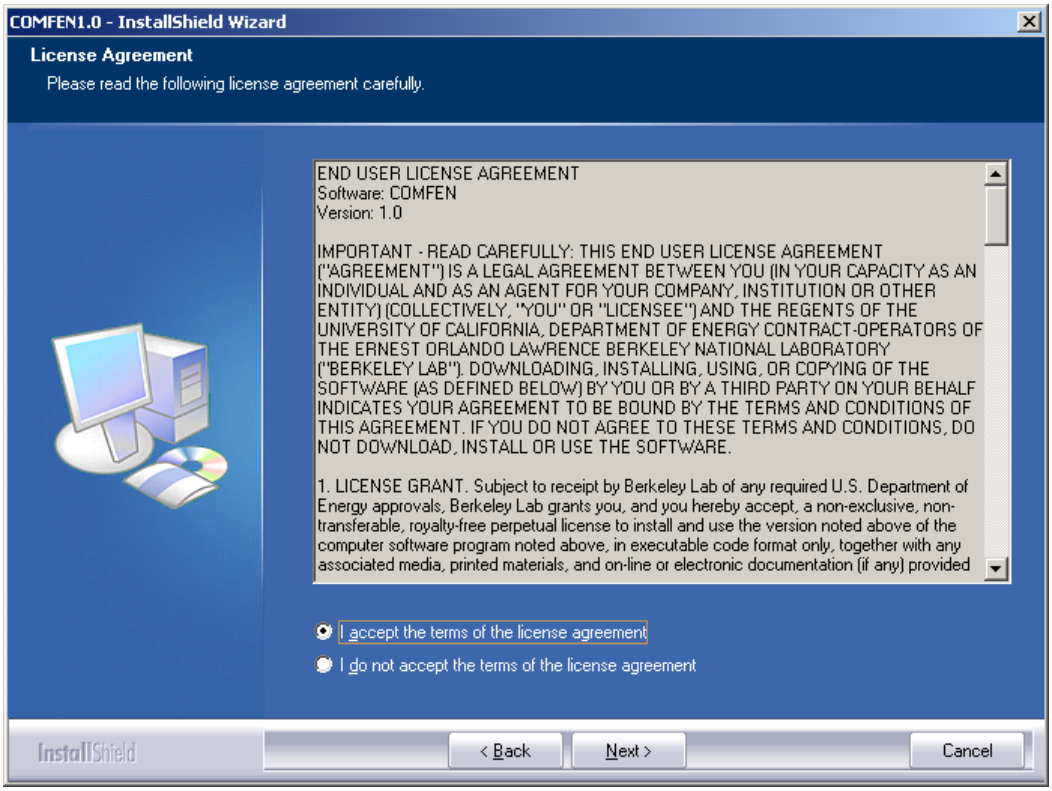


Figure 3-4. The COMFEN License Agreement window.

4. The **Setup Type** window will display next.

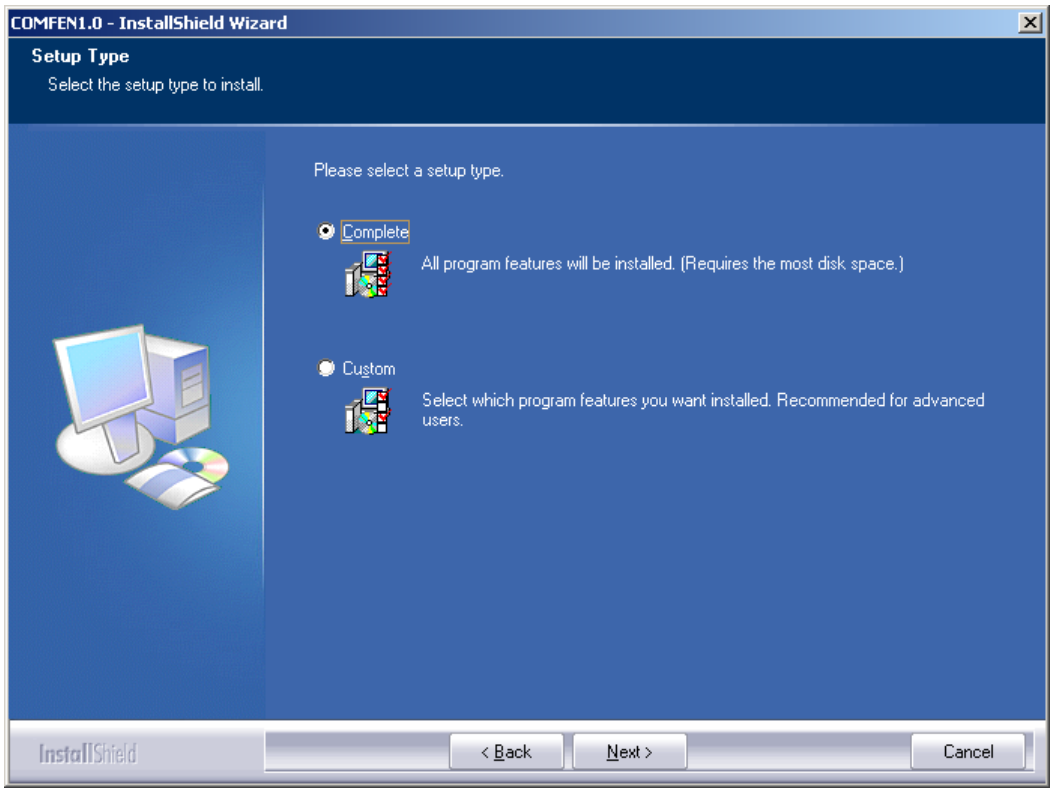


Figure 3-5. The Setup Type window.

The choices are:

Complete: This will install the complete program in the default directory of c:\Program Files\LBNL

Custom: This choice will cause another screen to display with choices of where to install the program.

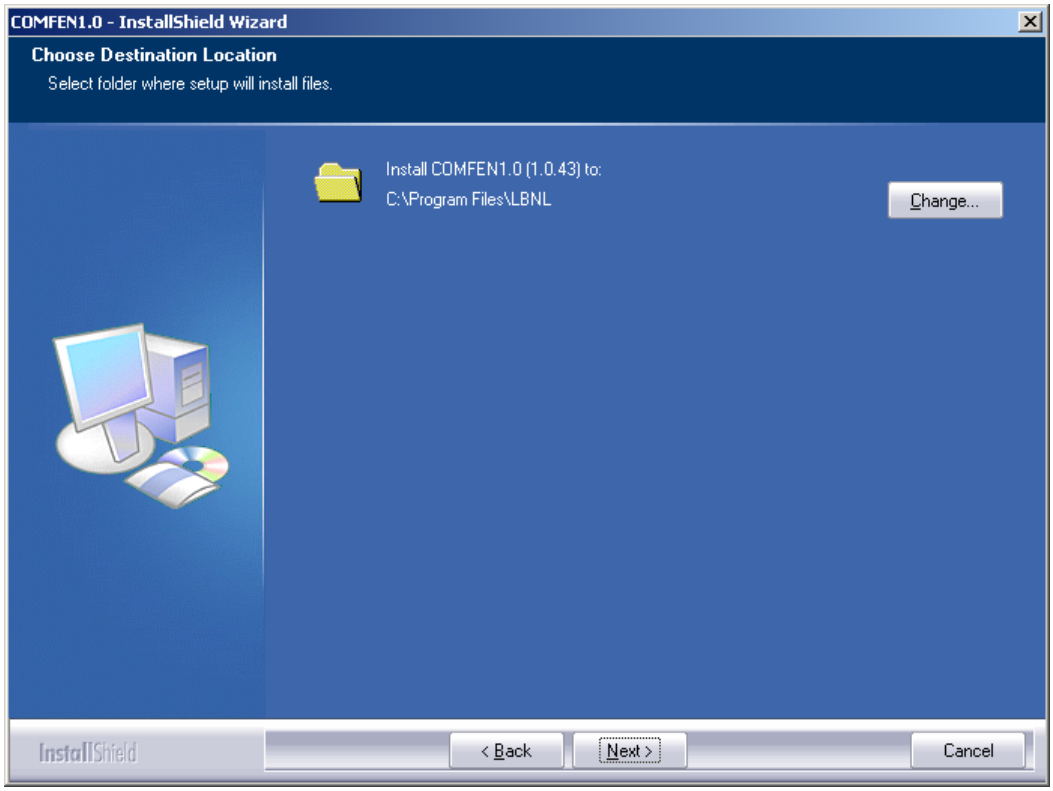


Figure 3-6. The Setup Type window for the Custom Setup choice, which allows a different directory to be specified for the installation.

5. The **Ready to Install the Program** window will display next. Press the **Install** button to begin the installation.

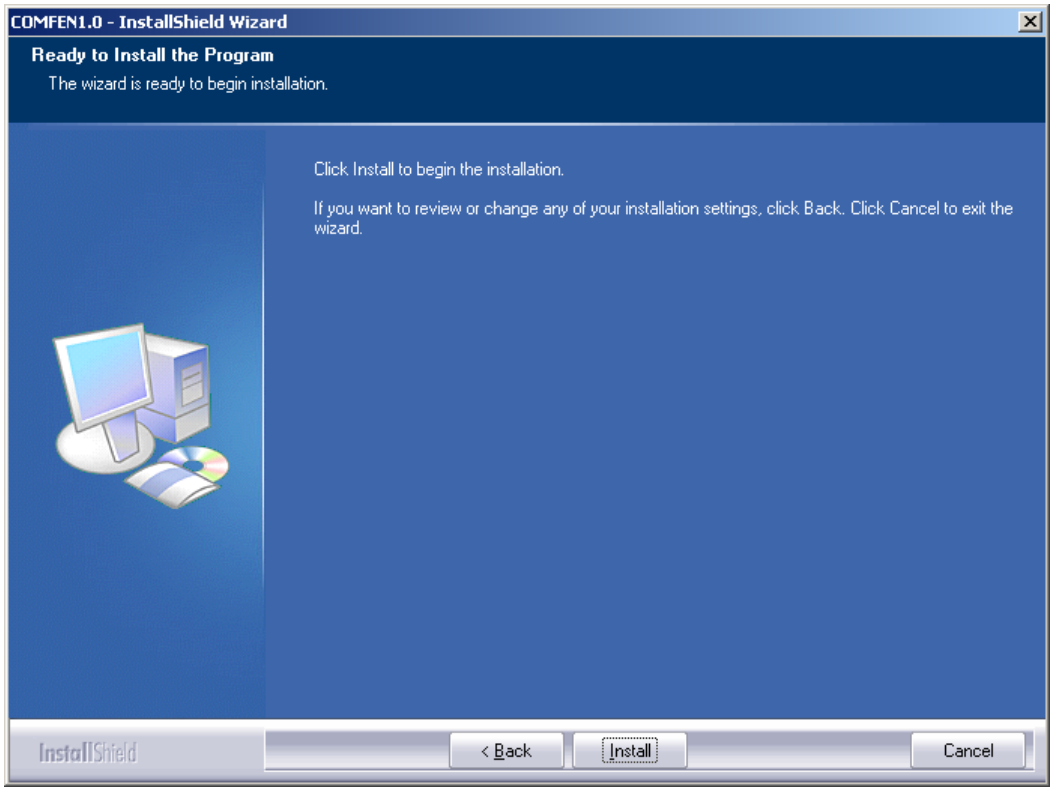


Figure 3-7. ***Ready to Install the Program*** *screen.*

6. The next screen to display is the **Setup Status** screen, which shows the files being installes.

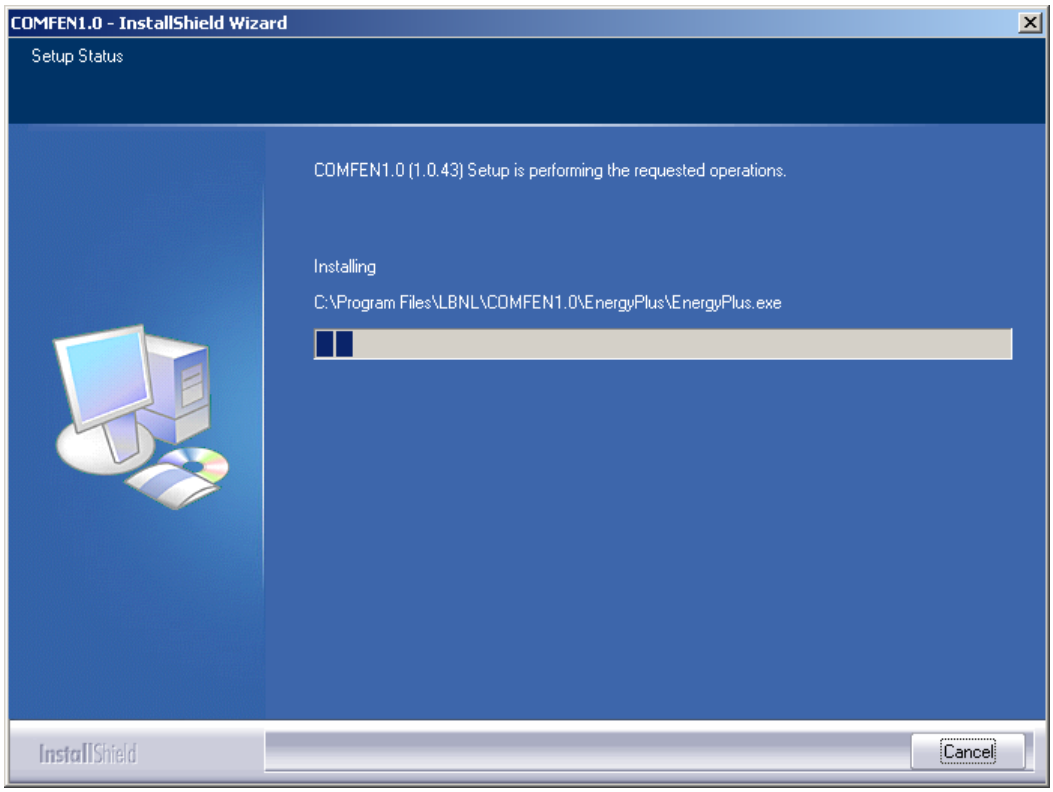


*Figure 3-8. The **Setup Status** screen shows the files being installed.*

7. When the installation is complete, the **InstallShield Wizard Complete** screen will be displayed. Press **Finish** to finalize the installation. Sometimes this screen will appear, but you can't click the **Finish** button. In this case, click on another area of the screen, then click back to this screen and you should be able to click on the **Finish** button.

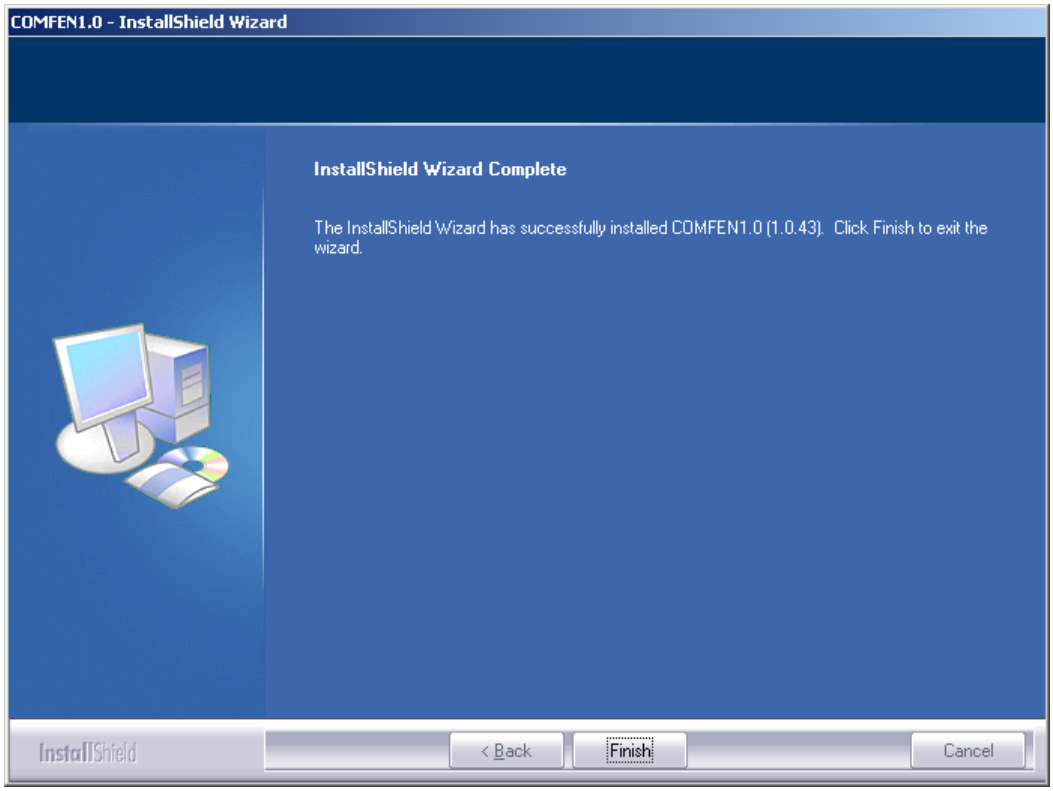


*Figure 3-9. The **InstallShield Wizard Complete** screen will display when the installation is finished. Press the **Finish** button to finalize the installation.*

8. Setup will automatically put a COMFEN Icon in the **Programs** menu under the **LBNL Software** group, accessed from the **Start** button.

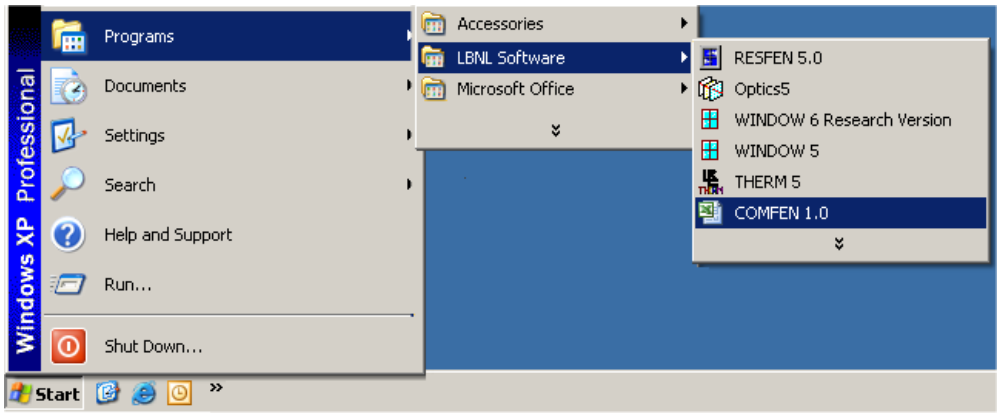


Figure 3-10. Program icon to run COMFEN.

3.3. Running COMFEN

To run COMFEN, click on the Windows95™, Windows98™ or WindowsNT™ **Start** button, go to the **Programs** menu, single click on the **LBNL Software** group, and single click on the **COMFEN** icon:

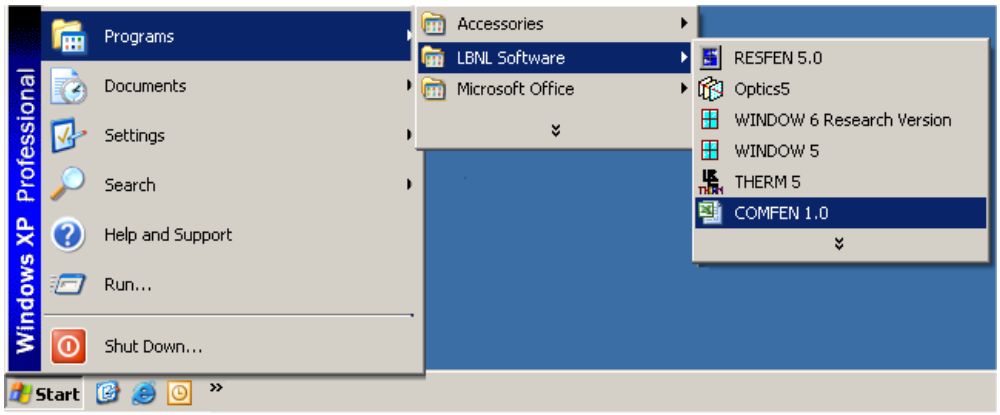


Figure 3-11. Click on Start / Programs / LBNL Software / COMFEN 1.0

The Project screen will open.

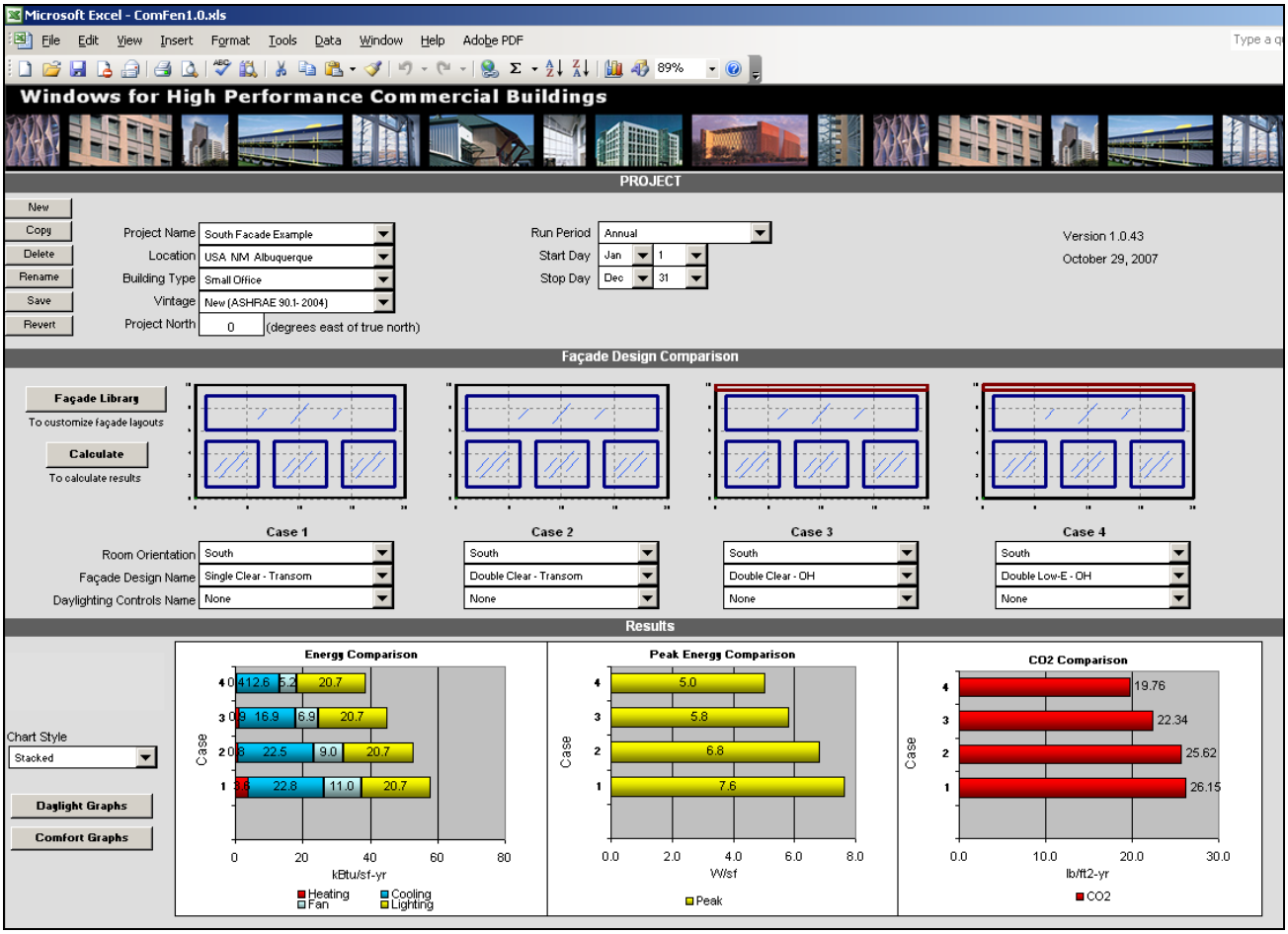


Figure 3-12. Main COMFEN screen.

3.4. Uninstalling COMFEN

If you need to uninstall COMFEN, follow the steps below.

1. Go to the Control Panel (via Start/ Settings/Control Panel) and go to the Add/Remove Programs choice

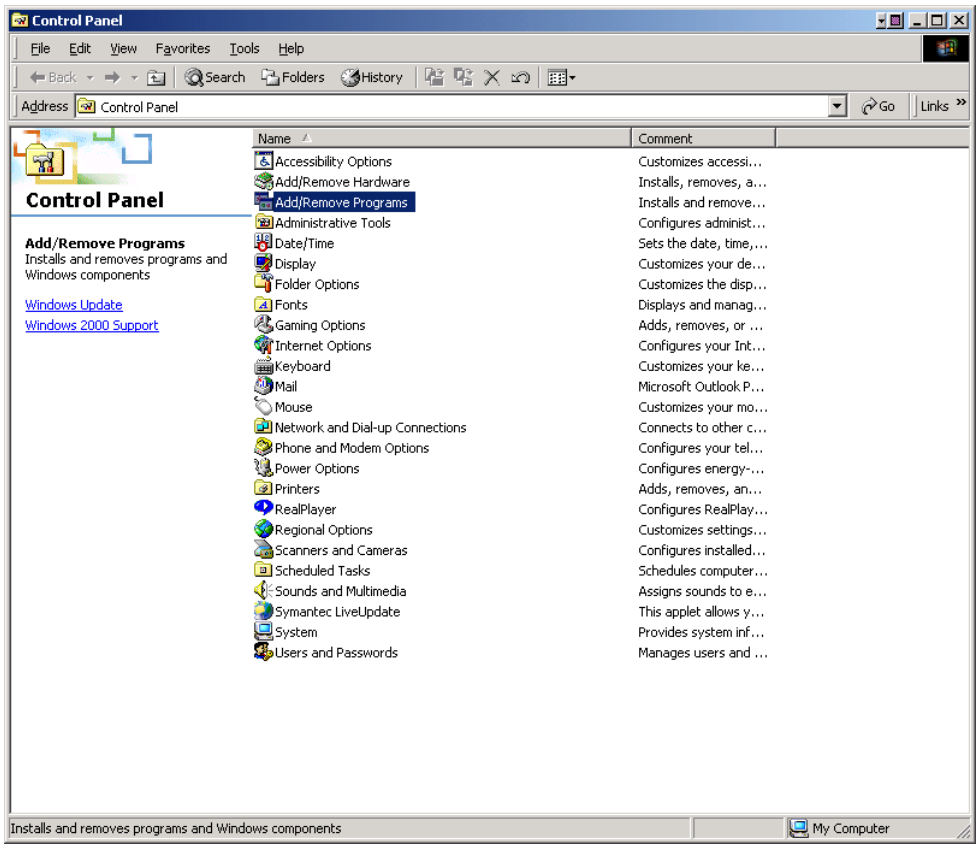


Figure 3-13. Go to the Control Panel (Start/Settings/Control Panel) and click on Add/Remove Programs.

2. Select COMFEN from the list of currently installed programs and click on the Change/Remove button.

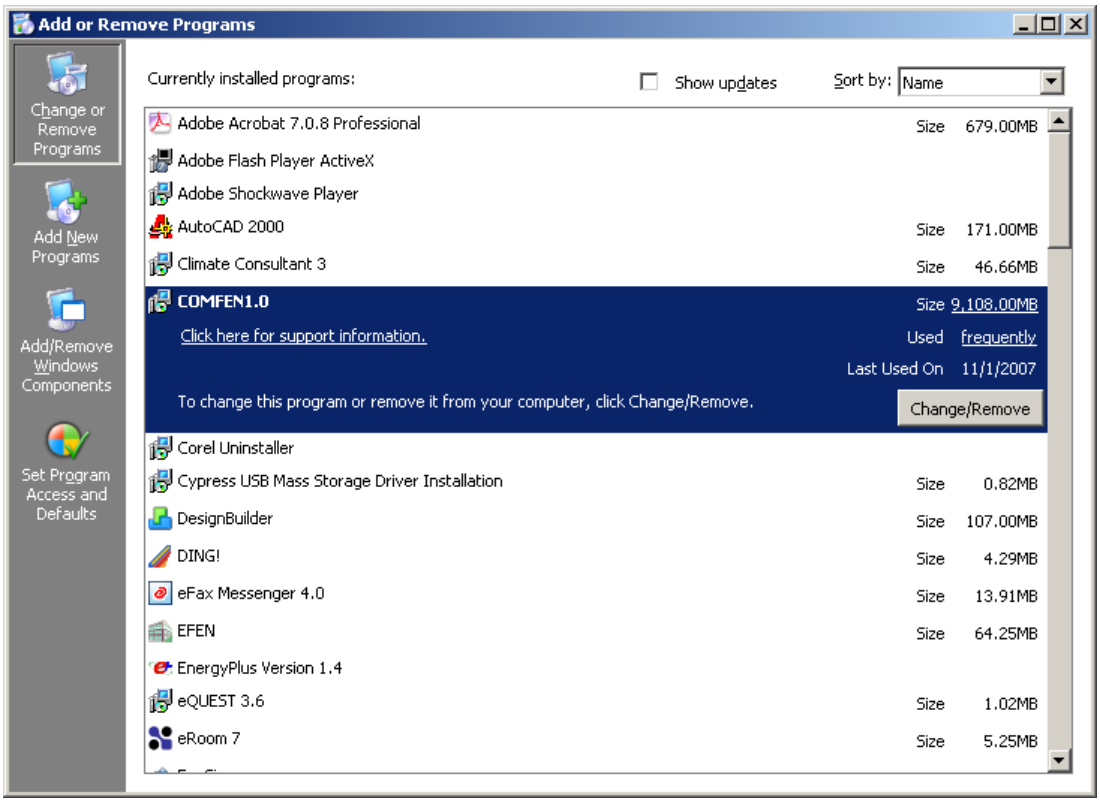


Figure 3-14. Select COMFEN from the list of currently installed programs.

3. The InstallShield Wizard Welcome Screen appears with three choices. Click on the **Remove** radio button and then click on the **Next** button.

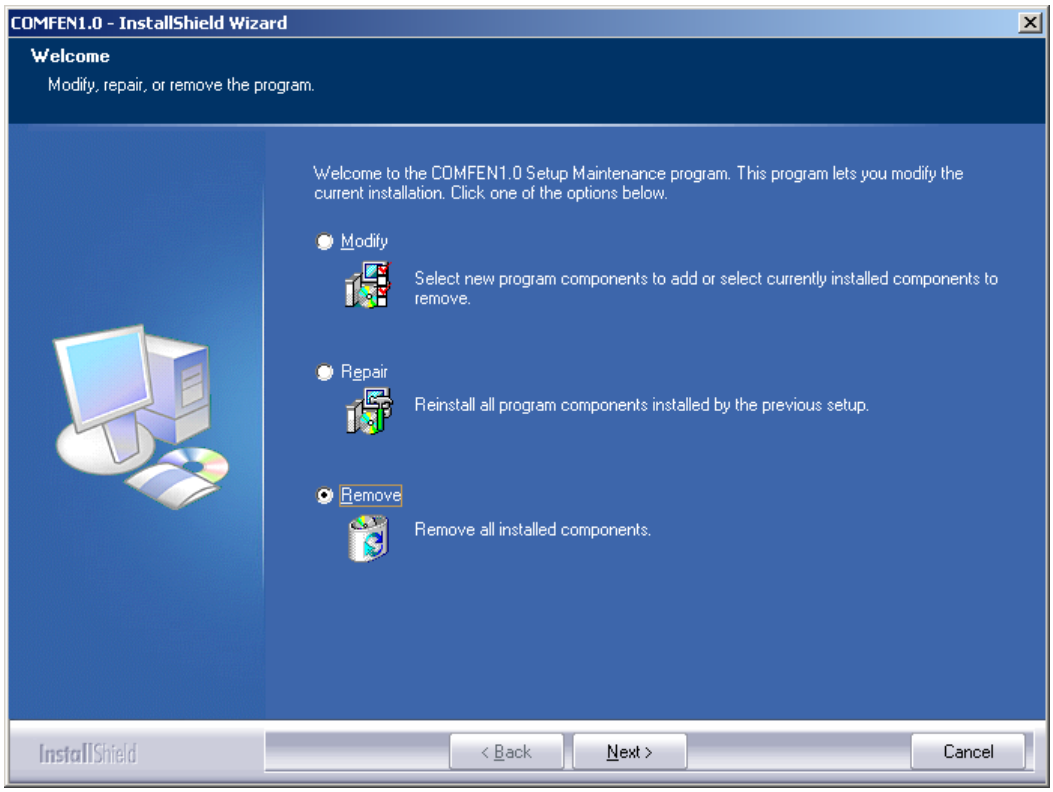


Figure 3-15. The InstallShield Wizard appears.

4. The program will ask if you want to completely remove the application. Click **OK** to uninstall the program, or **Cancel** to cancel the uninstall process.

Figure 3-16. Click OK to continue with the uninstall process.

5. When the uninstall process is complete, the **Maintenance Complete** screen appears. Click **Finish** to complete the uninstall.

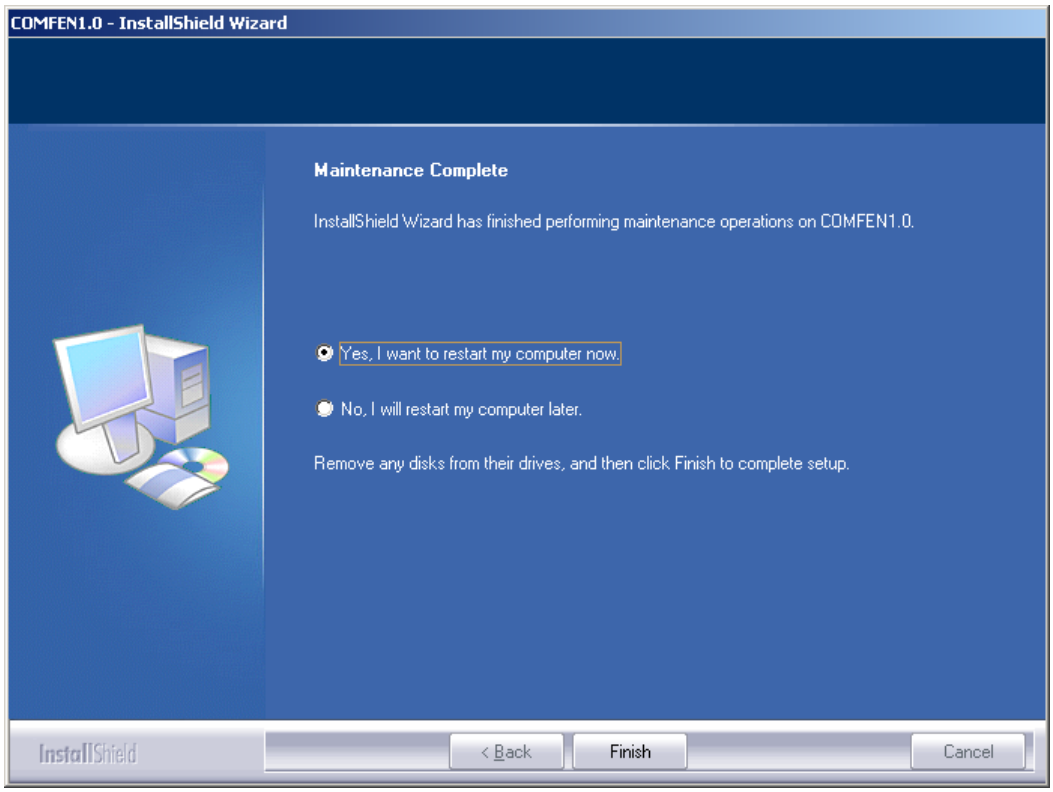


*Figure 3-17. Click **Finish** to complete the uninstall process.*

3.5. Troubleshooting

When you first run the program after installing it, the results may show as zeros after the first calculation. If you have this problem, close the program, run it again, and the problem should go away.

Please send E-mail to COMFENhelp@lbl.gov if you have any trouble running the program.

4. PROGRAM DESCRIPTION

4.1. Overview

COMFEN is a program with a simple user interface, shown in Figure 4-1, tied to a powerful analytical tool, EnergyPlus. When COMFEN starts, the program opens the Project screen.

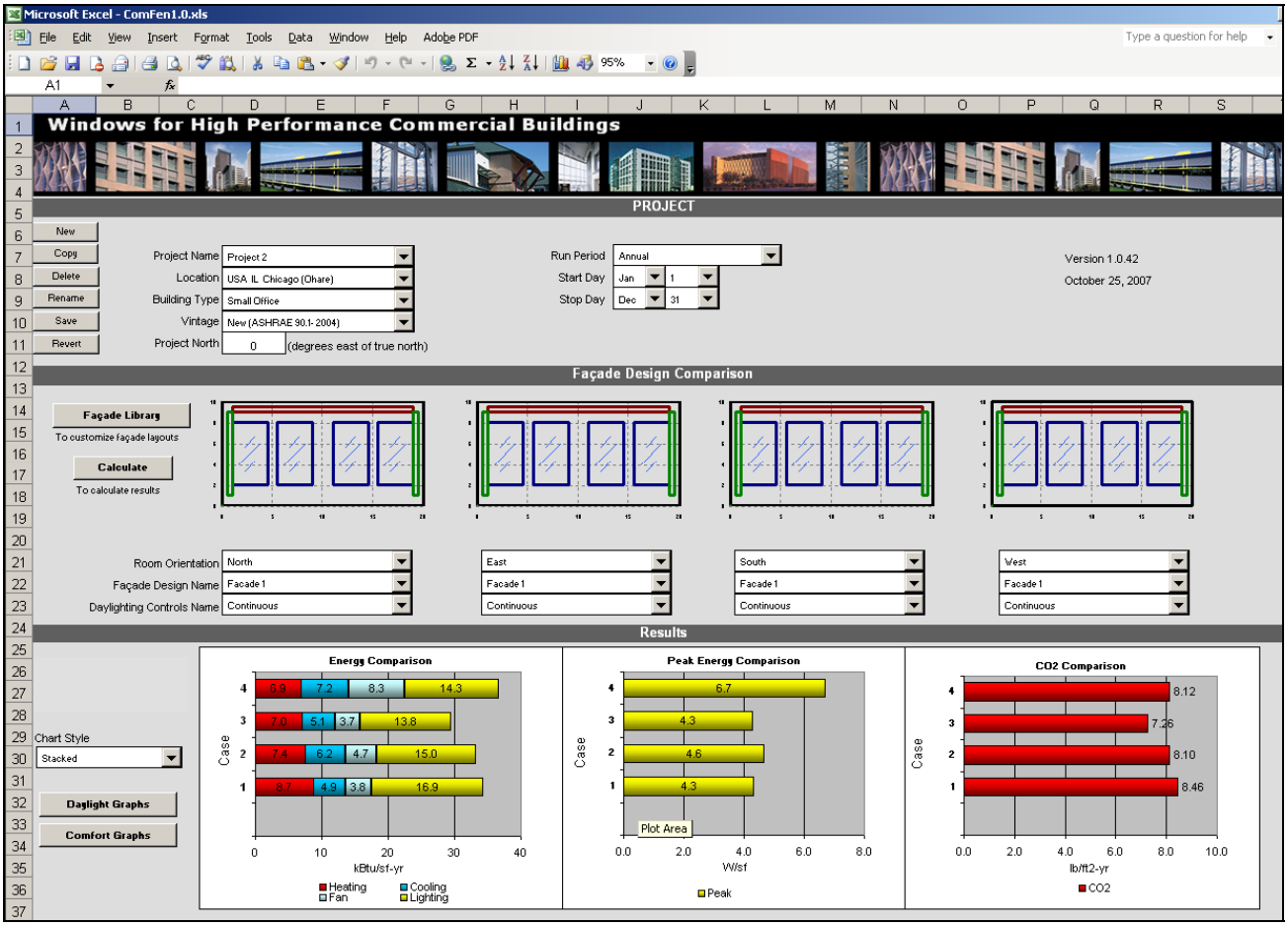


Figure 4-1. The COMFEN Project Screen

4.2. Steps to complete a COMFEN run

The primary steps to complete a COMFEN calculation are:

- In the Façade Library screen, define the façade to be studied in the Façade Library screen
- In the Project screen, select a façade from the Façade Library, the façade orientation, and daylighting controls. You can compare up to four façade design/daylighting/orientation combinations
- Click on the Calculate button and the program will calculate the heating, cooling, lighting, and fan energy for each façade, as well as peak energy consumption and a simple CO_2 comparison.
- View the answers in the **Results** section when the simulation has finished.

The following sections of this chapter describe the program in detail.

4.3. Project Screen

The Project screen allows comparison of up to four building facades for the same location.

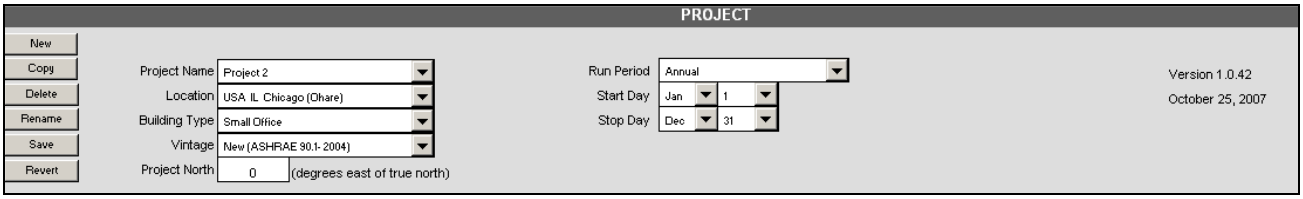


Figure 4-2. Upper section of the project screen.

4.3.1. Upper Section

The upper section of the Project screen is used to define the main project parameters, such as location, building type, and project orientation.

Buttons

There are several buttons on the upper left of the Project screen:

Figure 4-3. Buttons on the Project screen.

New	The **New** button is used to make a new Project. The program will ask for a project name, and then the facades will all be deleted except for the first, which will default to the first façade in the Façade Library.
Copy	The **Copy** button is used to copy the currently selected Project. The facades will be copied but the results will be deleted.
Delete	The **Delete** button is used to delete the currently selected Project.
Rename	The **Rename** button is used to rename the currently selected Project.
Save	The **Save** button is used to save the currently selected Project. The program will also ask if you would like to save the current Project when you select another Project from the pulldown list, or move to the Façade Library.
Revert	The **Revert** button is used this reverts to the last saved version of the Project (deleting all the changes made since the last Save).

Project Information

This section has the following input values:

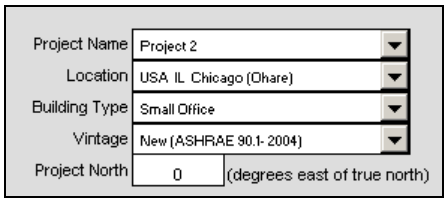


Figure 4-4. Project information.

Project Name — Name of the project. This pulldown list contains all the defined projects. These names are user defined, entered when using the **New**, **Copy**, or **Rename** buttons.

Location — Location for the analysis. The location choice will control the weather data used for the simulation. Table 4-1 lists the location names and associated EnergyPlus weather files. The naming convention of the location is <country> <state> <city>; for some international cities, the state is not included.

There are some California cities which have multiple entries, each with a reference to a different weather file. The "CZ<nn>RV2" weather files are a special set which represent the weather data for an entire California Climate Zone (the <nn> number is the climate zone number), rather than just one city in the climate zone.

Table 4-1. Location Names and Weather Files

Location Name	EnergyPlus Weather Files
USA AK Anchorage	USA_AK_Anchorage_TMY2.epw
USA AK Fairbanks	USA_AK_Fairbanks_TMY2.epw
USA AL Birmingham	USA_AL_Birmingham_TMY2.epw
USA AR Little.Rock	USA_AR_Little.Rock_TMY2.epw
USA AZ Phoenix	USA_AZ_Phoenix_TMY2.epw
USA CA Arcata	USA_CA_Arcata_TMY2.epw
USA CA Arcata (CTZ 01)	CZ01RV2.epw
USA CA Bakersfield	USA_CA_Bakersfield_TMY2.epw
USA CA Barstow-Daggett	USA_CA_Barstow-Daggett_TMY2.epw
USA CA China Lake (CTZ 14)	CZ14RV2.epw
USA CA El Centro (CTZ 15)	CZ15RV2.epw
USA CA El Toro (CTZ 08)	CZ08RV2.epw
USA CA Fresno	USA_CA_Fresno_TMY2.epw
USA CA Long Beach	USA_CA_Long.Beach_TMY2.epw
USA CA Long Beach (CTZ 06)	CZ06RV2.epw
USA CA Los Angeles	USA_CA_Los.Angeles_TMY2.epw
USA CA Mount Shasta	USA_CA_Mount.Shasta_TMY.epw
USA CA Oakland (CTZ 03)	CZ03RV2.epw
USA CA Pasadena (CTZ 09)	CZ09RV2.epw
USA CA Red Bluff (CTZ 11)	CZ11RV2.epw
USA CA Riverside (Ctz 10)	CZ10RV2.epw
USA CA Sacramento	USA_CA_Sacramento_TMY2.epw
USA CA Sacramento (CTZ 12)	CZ12RV2.epw
USA CA San Diego	USA_CA_San.Diego_TMY2.epw
USA CA San Diego (CTZ 07)	CZ07RV2.epw
USA CA San Francisco	USA_CA_San.Francisco_TMY2.epw

Location Name	EnergyPlus Weather Files
USA CO Boulder	USA_CO_Boulder_TMY2.epw
USA CO Denver (Stapleton)	USA_CO_Denver-Stapleton_TMY.epw
USA DC Washington (Dulles)	USA_VA_Sterling-Washington.Dulles_TMY2.epw
USA DE Wilmington	USA_DE_Wilmington_TMY2.epw
USA FL Miami	USA_FL_Miami_TMY2.epw
USA FL Orlando	USA_FL_Orlando_TMY.epw
USA FL Tampa	USA_FL_Tampa_TMY2.epw
USA GA Atlanta	USA_GA_Atlanta_TMY2.epw
USA HI Honolulu	USA_HI_Honolulu_TMY2.epw
USA IA Des.Moines	USA_IA_Des.Moines_TMY2.epw
USA ID Boise	USA_ID_Boise_TMY2.epw
USA IL Chicago (Ohare)	USA_IL_Chicago-OHare_TMY2.epw
USA IN Fort.Wayne	USA_IN_Fort.Wayne_TMY2.epw
USA KS Wichita	USA_KS_Wichita_TMY2.epw
USA KY Lexington	USA_KY_Lexington_TMY2.epw
USA KY Louisville	USA_KY_Louisville_TMY2.epw
USA LA New.Orleans	USA_LA_New.Orleans_TMY2.epw
USA MA Boston	USA_MA_Boston-City.WSO_TMY.epw
USA MD Baltimore	USA_MD_Baltimore_TMY2.epw
USA MI Detroit	USA_MI_Detroit-Metro.AP_TMY2.epw
USA MN Duluth	USA_MN_Duluth_TMY2.epw
USA MN Minneapolis-St.Paul	USA_MN_Minneapolis-St.Paul_TMY2.epw
USA MO Kansas.City	USA_MO_Kansas.City_TMY2.epw
USA MO Springfield	USA_MO_Springfield_TMY2.epw
USA MO St.Louis	USA_MO_St.Louis_TMY2.epw
USA MS Jackson	USA_MS_Jackson_TMY2.epw
USA MT Billings	USA_MT_Billings_TMY2.epw
USA MT Helena	USA_MT_Helena_TMY2.epw
USA NC Charlotte	USA_NC_Charlotte_TMY2.epw
USA NC Wilmington	USA_NC_Wilmington_TMY2.epw
USA ND Fargo	USA_ND_Fargo_TMY2.epw
USA NE Omaha	USA_NE_Omaha_TMY2.epw
USA NJ Newark	USA_NJ_Newark_TMY2.epw
USA NM Albuquerque	USA_NM_Albuquerque_TMY2.epw
USA NV Las.Vegas	USA_NV_Las.Vegas_TMY2.epw
USA NV Reno	USA_NV_Reno_TMY2.epw
USA NY New York City (La.Guardia)	USA_NY_New.York.City-La.Guardia_TMY.epw
USA OH Columbus	USA_OH_Columbus_TMY2.epw
USA OK Tulsa	USA_OK_Tulsa_TMY2.epw
USA OR Portland	USA_OR_Portland_TMY2.epw
USA RI Providence	USA_RI_Providence_TMY2.epw
USA TN Memphis	USA_TN_Memphis_TMY2.epw
USA TX Austin	USA_TX_Austin_TMY2.epw
USA TX Houston	USA_TX_Houston-Intercontinental_TMY2.epw
USA UT Salt.Lake.City	USA_UT_Salt.Lake.City_TMY2.epw
USA VA Norfolk	USA_VA_Norfolk_TMY2.epw
USA VT Burlington	USA_VT_Burlington_TMY2.epw
USA WA Seattle (Tacoma)	USA_WA_Seattle-Tacoma_TMY2.epw

Location Name	EnergyPlus Weather Files
USA WI Madison	USA_WI_Madison_TMY2.epw
USA WV Charleston	USA_WV_Charleston_TMY2.epw
USA WY Casper	USA_WY_Casper_TMY2.epw
AUS ACT Canberra	AUS_ACT.Canberra_IWEC.epw
AUS NSW Sydney	AUS_NSW.Sydney_IWEC.epw
AUS NT Darwin	AUS_NT.Darwin_IWEC.epw
AUS QLD Brisbane	AUS_QLD.Brisbane_IWEC.epw
AUS SA Adelaide	AUS_SA.Adelaide_IWEC.epw
AUS VIC Melbourne	AUS_VIC.Melbourne_IWEC.epw
AUS WA Learmonth	AUS_WA.Learmonth_IWEC.epw
AUS WA Perth	AUS_WA.Perth_IWEC.epw
AUS WA Port Hedland	AUS_WA.Port.Hedland_IWEC.epw
IND Ahmadabad	IND_Ahmadabad_IWEC.epw
IND Bombay	IND_Bombay_IWEC.epw
IND Calcutta	IND_Calcutta_IWEC.epw
IND Goa Panaji	IND_Goa.Panaji_IWEC.epw
IND Madras	IND_Madras_IWEC.epw
IND Nagpur	IND_Nagpur_IWEC.epw
IND New Delhi	IND_New.Delhi_IWEC.epw
IND Trivandrum	IND_Trivandrum_IWEC.epw
ISR Jerusalem	ISR_Jerusalem_IWEC.epw
RUS Arkhangelsk	RUS_Arkhangelsk_IWEC.epw
RUS Moscow	RUS_Moscow_IWEC.epw
RUS Saint-Petersburg	RUS_Saint-Petersburg_IWEC.epw

Building Type

The Building Type controls the basic geometry of the building, as well as other modeling assumptions. Currently the list of building types includes:

- **Small Office**

Vintage

The Vintage controls the exterior surface R-values, such as the walls. Currently the list of vingtages includes:

- **New (ASHRAE 90.1-2004):** this defines the R-values of the wall insulation based on the ASHRAE 90.1-2004 standard for new construction, which specifies the R-values by climate zone. The Location choice will determine the ASHRAE 90.1 climate zone and thus the R-value for the building.

Project North

Project North defines the overall project orientation, assuming that 0 faces due north. Values: Degrees east of north. So a Project North value of 10 would mean that the project would face 10 degrees east of north, and that value would be added automatically to the orientation definitions for North, South, East and West for this project. **Default:** 0 (Project faces true north). **Legal values:** 0-359. **Units:** degrees.

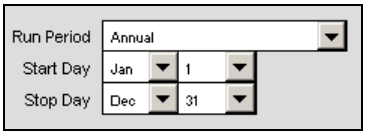


Figure 4-5. Simulation information.

Run Period This determines the days for running the EnergyPlus simulation. These controls allow simulation of certain portions of the year that of interest. The options are:

- **Annual:** This choice runs the simulation for the entire year, January 1 through December 31.
- **One Day:** This choice runs the simulation for one day, and the Start and Stop day must be specified
- **Custom:** This choice runs the simulation for the days specified under Start and Stop Day.

Start Day The month and day on which the simulation will start (at midnight of that day)

Stop Day The month and day on which the simulation will stop (at midnight of that day)

4.3.2. Façade Design Comparison Section

The Façade Design Comparison section of the Project screen is used to compare up to four different facades including the façade orientation and daylighting controls.

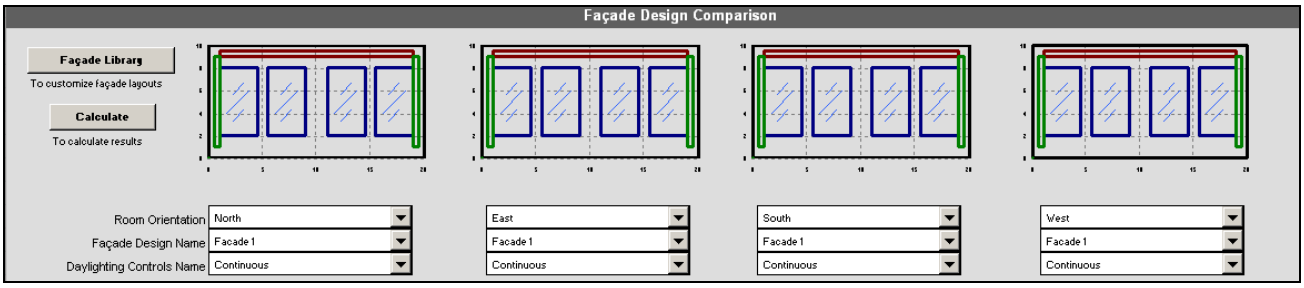


Figure 4-6. Simulation information.

Buttons

There are two buttons on the left side of the section:

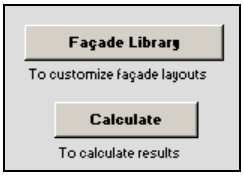


Figure 4-7. Façade Design Comparison buttons.

Façade Library — The Façade Library button is used to go to the Façade Library screen, where new facades can be defined, or existing facades can be modified.

Calculate — The Calculate button is used to start an EnergyPlus simulation, and calculate resutlts. The calculation can take a few minutes, depending on the computer system. When the Calculate button is clicked, a DOS screen will appear, indicating the progress of the simulation.

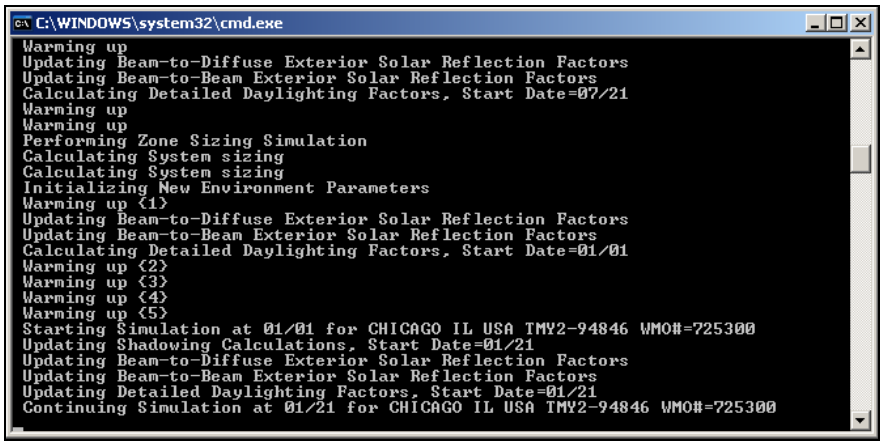


Figure 4-8. When the Calculate button is clicked, a DOS window appears showing the progress of the EnergyPlus simulation.

Façade Comparison Information

This section allows selection of facades from the Façade Library, and allows specification of façade orientation and daylighting controls. A minimum of one façade, up to a maximum of four facades, can be compared. The same façade can be compared with and without daylighting controls, or on different orientations. Or different façade designs can be compared on the same orientation.

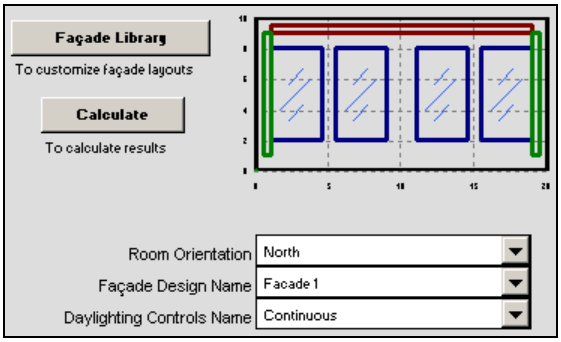


Figure 4-9. Selecting the facades to compare.

Room Orientation

The orientation of the façade. The orientation choices are the four cardinal directions:

- North
- South
- East
- West

If the façade is not facing these cardinal orientations, this can be accounted for by entering a value in the Project North box in the Project Information.

Façade Design Name

The Façade Design Name pulldown list will contain the name of all the facades in the Façade Library. When a façade is selected, the graphic above will change to display the geometry of the façade.

Daylighting Controls Name

The Daylighting Controls Name pulldown list contains the choices for lighting and daylighting controls:

- **None:** No lighting controls based on daylight levels.
- **Continuous:** Continuous lighting controls based on daylight levels. Min Power Fraction = 0.1, Min Light Fraction = 0.05

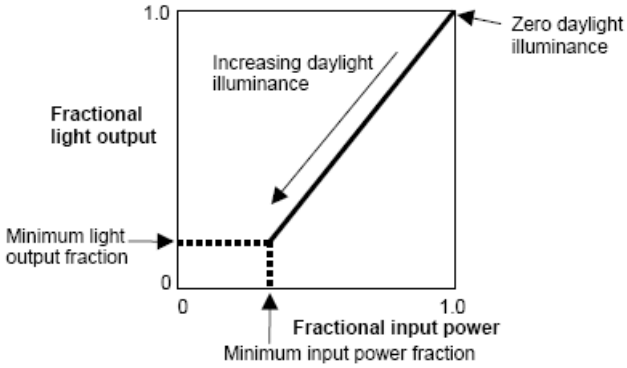


Figure 4-10. Continuous light dimming based on daylight levels. (from the EnergyPlus Input/Output documentation)

- **Stepped:** Stepped lighting controls based on daylight levels. Min Power Fraction = 0, Min Light Fraction = 0, Number of Steps = 3, Probability of Reset = 1.0 (perfect occupants)

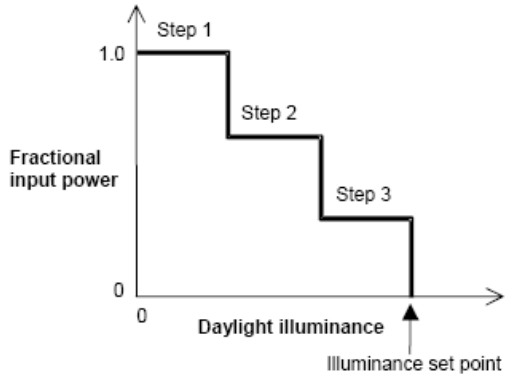


Figure 4-11. Stepped lighting controls based on daylight levels. (from the EnergyPlus Input/Output documentation)

The daylighting control logic is embedded in the program, and is as follows:

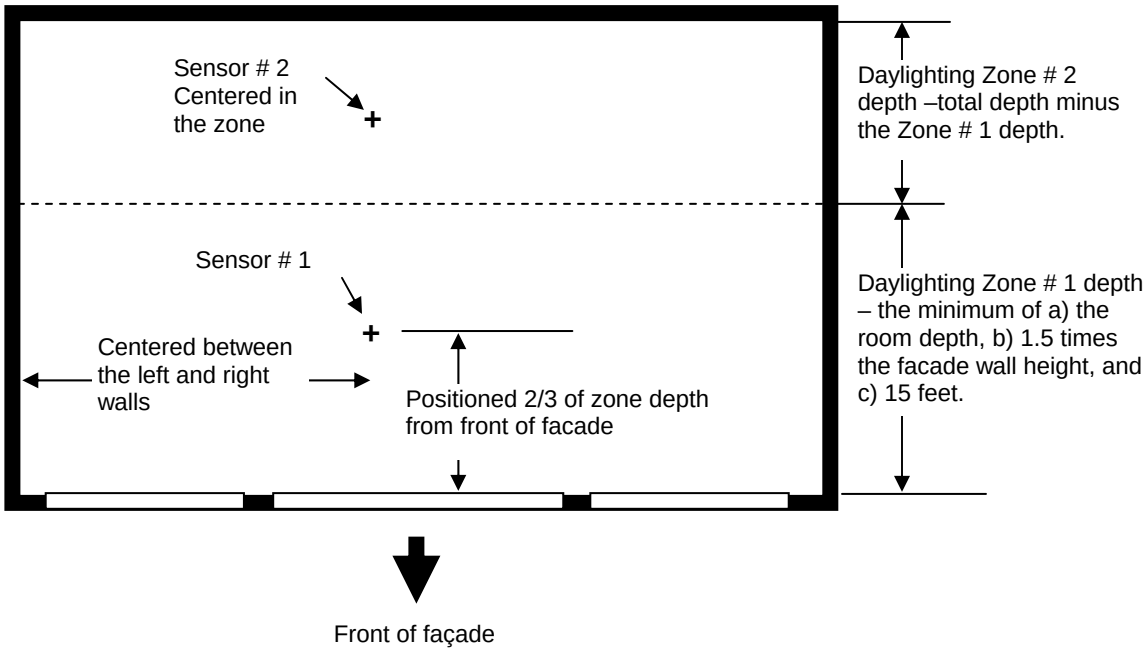


Figure 4-12. Plan view of daylighting control sensors.

Daylight Illuminance	The daylight illuminance set point is currently set at 50 footcandles
Zone Depth	A primary daylight zone depth is calculated as the minimum of a) the room depth, b) 1.5 times the facade wall height, and c) 15 feet.
Sensor height	The daylight sensors are located 2.5 feet above the floor of each daylight zone.
Sensor # 1	Daylight sensor #1 is positioned 2/3 of the primary daylight zone depth from facade wall, centered in the width of the facade zone. Sensor #1 controls a fraction of the facade zone lights equal to the primary daylight zone depth divided by the facade zone depth.

Sensor # 2 — Any remaining depth in the facade zone is considered a secondary daylight zone. Reference Point #2 is positioned halfway between the primary daylight zone depth and the "back wall".

Sensor #2, if used, controls the remaining fraction of lights.

Glare — The glare azimuth is set to face the facade wall.

Maximum Glare Index — The Maximum Glare Index is set to 22. However, since there are not currently any dynamically controlled shading devices, no aspect of the facade changes above this glare index value.

4.3.3. Results

The Results section has several sections – annual results in graphic and tabular form, as well as monthly results and detailed results for comfort and daylighting. The following section describes the results.

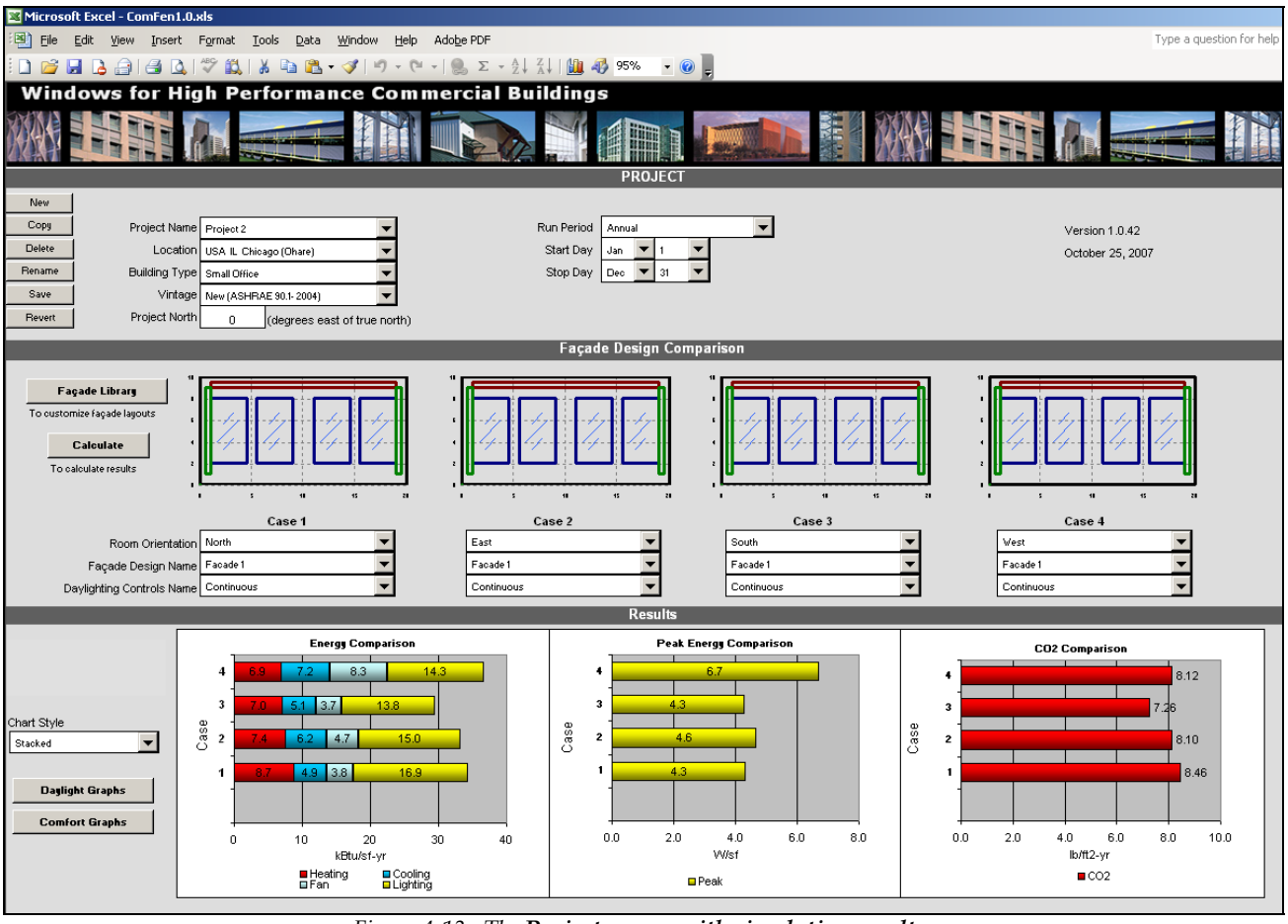


*Figure 4-13. The **Project screen with simulation results.***

The first section of Results shows annual results in graphic form for Energy Consumption, Peak Energy, and CO2.

Energy Consumption — The Energy Consumption graph shows the total annual consumption for each façade for heating, cooling, fan and lighting energy. **Units:** kBtu/sf-yr.

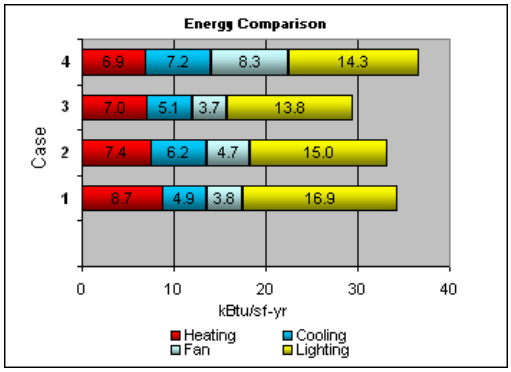


Figure 4-14. Energy Comparison ***results.***

Peak Energy Comparison

The Peak Energy Comparison graph shows the peak energy for each façade. The peak energy consumption includes lighting, electrical equipment, fan and cooling energy.

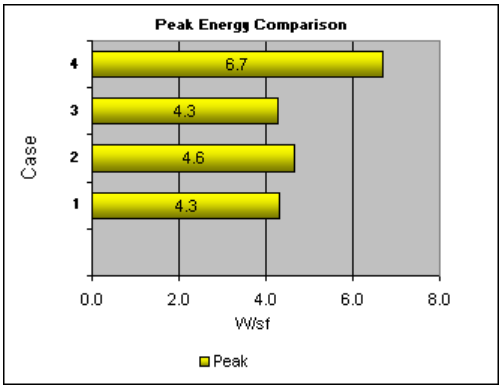


Figure 4-15. Peak Energy Comparison ***results.***

CO2 Comparison

The CO_2 Comparison graph gives a simple comparison of CO_2 emissions, based on energy consumption. The following table shows the factors used to calculate these emissions for cities in the United States. Factors have not yet been determined for the international locations.

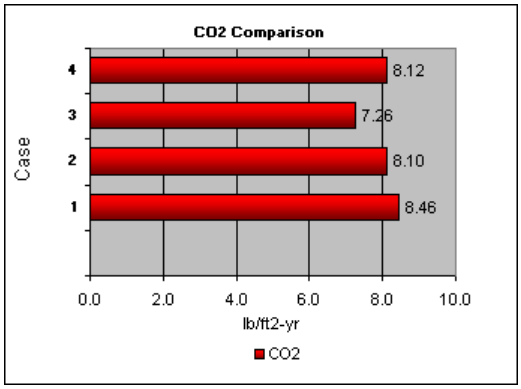


Figure 4-16. CO_2 Comparison ***results.***

The source for the CO_2 Electricity Factors is from the EIA Document"Updated State-level Greenhouse Gas Emission Coefficients for Electricity Generation, 1998 – 2000", which can be found on the following website:

http://tonto.eia.doe.gov/FTPROOT/environment/e-supdoc-u.pdf

Table 4-2. Location Names and Weather Files

Location (City Name)	CO_2 Electricity Factor	CO_2 Natural Gas Factor
USA AK Anchorage	1.38	0.12
USA AK Fairbanks	1.38	0.12
USA AL Birmingham	1.31	0.12
USA AR Little.Rock	1.29	0.12
USA AZ Phoenix	1.05	0.12
USA CA Arcata	0.61	0.12
USA CA Arcata (CTZ 01)	0.61	0.12
USA CA Bakersfield	0.61	0.12
USA CA Barstow-Daggett	0.61	0.12
USA CA China Lake (CTZ 14)	0.61	0.12
USA CA El Centro (CTZ 15)	0.61	0.12
USA CA El Toro (CTZ 08)	0.61	0.12
USA CA Fresno	0.61	0.12
USA CA Long Beach	0.61	0.12
USA CA Long Beach (CTZ 06)	0.61	0.12
USA CA Los Angeles	0.61	0.12
USA CA Mount Shasta	0.61	0.12
USA CA Oakland (CTZ 03)	0.61	0.12
USA CA Pasadena (CTZ 09)	0.61	0.12
USA CA Red Bluff (CTZ 11)	0.61	0.12
USA CA Riverside (Ctz 10)	0.61	0.12
USA CA Sacramento	0.61	0.12
USA CA Sacramento (CTZ 12)	0.61	0.12
USA CA San Diego	0.61	0.12
USA CA San Diego (CTZ 07)	0.61	0.12
USA CA San Francisco	0.61	0.12
USA CO Boulder	1.93	0.12
USA CO Denver (Stapleton)	1.93	0.12
USA DC Washington (Dulles)	1.16	0.12
USA DE Wilmington	1.83	0.12
USA FL Miami	1.39	0.12
USA FL Orlando	1.39	0.12
USA FL Tampa	1.39	0.12
USA GA Atlanta	1.37	0.12
USA HI Honolulu	1.66	0.12
USA IA Des.Moines	1.88	0.12
USA ID Boise	0.03	0.12
USA IL Chicago (Ohare)	1.16	0.12
USA IN Fort.Wayne	2.08	0.12
USA KS Wichita	1.68	0.12
USA KY Lexington	2.01	0.12
USA KY Louisville	2.01	0.12
USA LA New.Orleans	1.18	0.12
USA MA Boston	1.28	0.12
USA MD Baltimore	1.37	0.12
USA MI Detroit	1.58	0.12
USA MN Duluth	1.52	0.12

Location (City Name)	CO_2 Electricity Factor	CO_2 Natural Gas Factor
USA MN Minneapolis-St.Paul	1.52	0.12
USA MO Kansas.City	1.84	0.12
USA MO Springfield	1.84	0.12
USA MO St.Louis	1.84	0.12
USA MS Jackson	1.29	0.12
USA MT Billings	1.43	0.12
USA MT Helena	1.43	0.12
USA NC Charlotte	1.24	0.12
USA NC Wilmington	1.24	0.12
USA ND Fargo	2.24	0.12
USA NE Omaha	1.4	0.12
USA NJ Newark	0.71	0.12
USA NM Albuquerque	2.02	0.12
USA NV Las.Vegas	1.52	0.12
USA NV Reno	1.52	0.12
USA NY New York City (La.Guardia)	0.86	0.12
USA OH Columbus	1.8	0.12
USA OK Tulsa	1.72	0.12
USA OR Portland	0.28	0.12
USA RI Providence	1.05	0.12
USA TN Memphis	1.3	0.12
USA TX Austin	1.46	0.12
USA TX Houston	1.46	0.12
USA UT Salt.Lake.City	1.93	0.12
USA VA Norfolk	1.16	0.12
USA VT Burlington	0.03	0.12
USA WA Seattle (Tacoma)	0.25	0.12
USA WI Madison	1.64	0.12
USA WV Charleston	1.98	0.12
USA WY Casper	2.15	0.12

To the left of the graphs are more options:

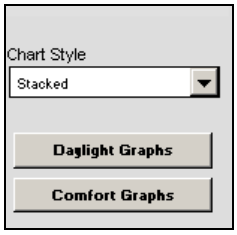


Figure 4-17. Options for graphic results

Chart Style The charts can be either "Stacked" or "Clustered". These options only apply to the Energy Comparison graph

- **Stacked:** By default the graphs are "stacked".

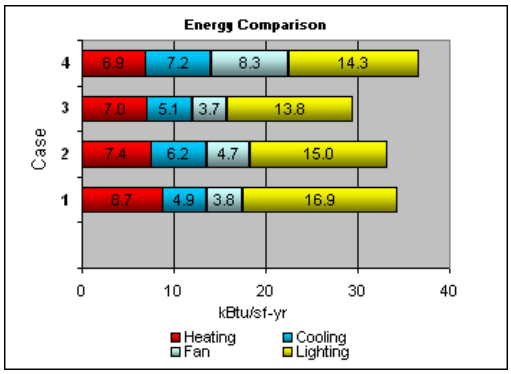


Figure 4-18. Stacked graphic results

- **Clustered:** The other option is "clustered". This style is useful for comparing the individual components of the graphs, such as looking at how the lighting energy compares for each case.

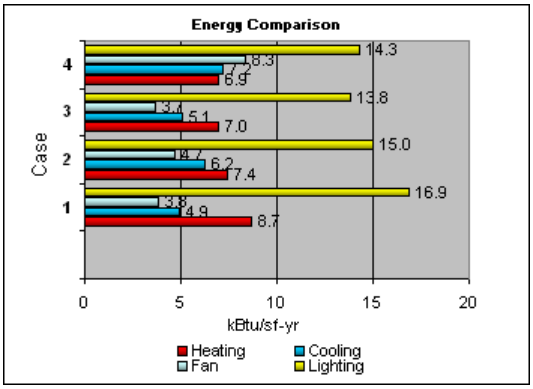


Figure 4-19. Clustered graphic results

Daylight Graphs

Clicking the Dayight Graphs button opens a new screen of results, which show daylighting results for every hour on the selected date, for all the cases together or each case individually.

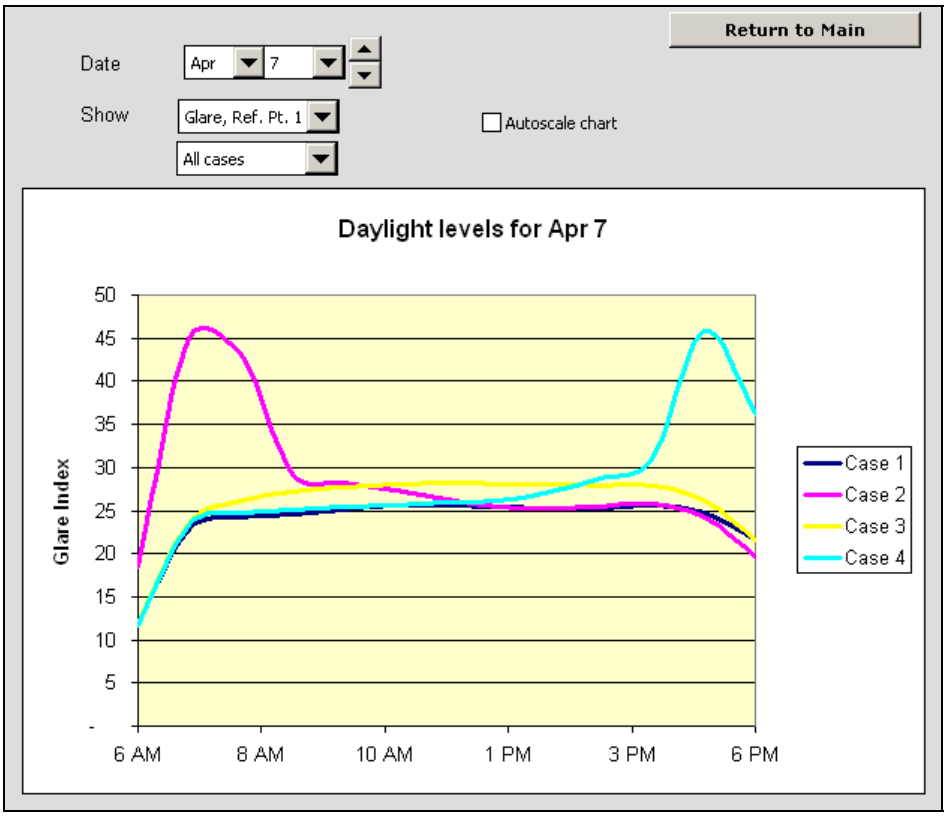
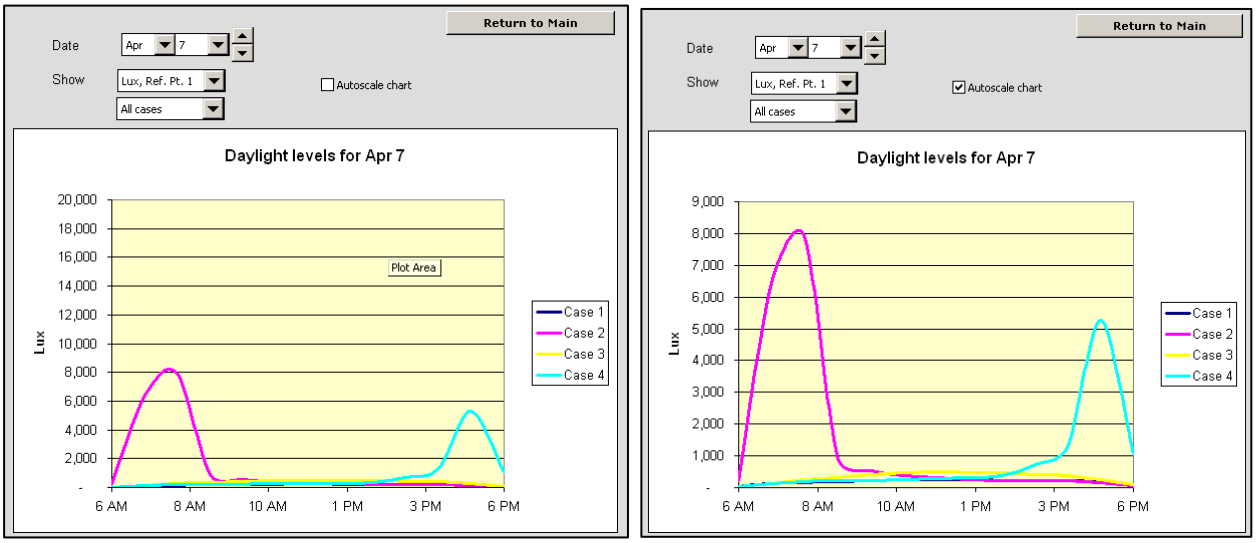


Figure 4-20. Daylight Graph

Date:	Set the month and day that you want results displayed for
Show	This pulldown list has four choices: ▪ Lux, Ref. Pt. 1: The lux calculated at daylight sensor #1. ▪ Lux, Ref. Pt. 2: The lux calculated at daylight sensor #2. ▪ Glare, Ref. Pt. 1: The glare index calculated at daylight sensor #1 ▪ Glare, Ref. Pt. 2: The glare index calculated at daylight sensor #2.
Case pulldown	This pulldown list allows you to see the results for each case individually, or all cases together.

Autoscale Chart Checking this checkbox sets the scale to the largest datapoint, rather than keeping the scale the same for each reference point choice.



Autoscale Off Autoscale On

Figure 4-21. Daylight Graphs with Autoscale off and on

Comfort Graphs

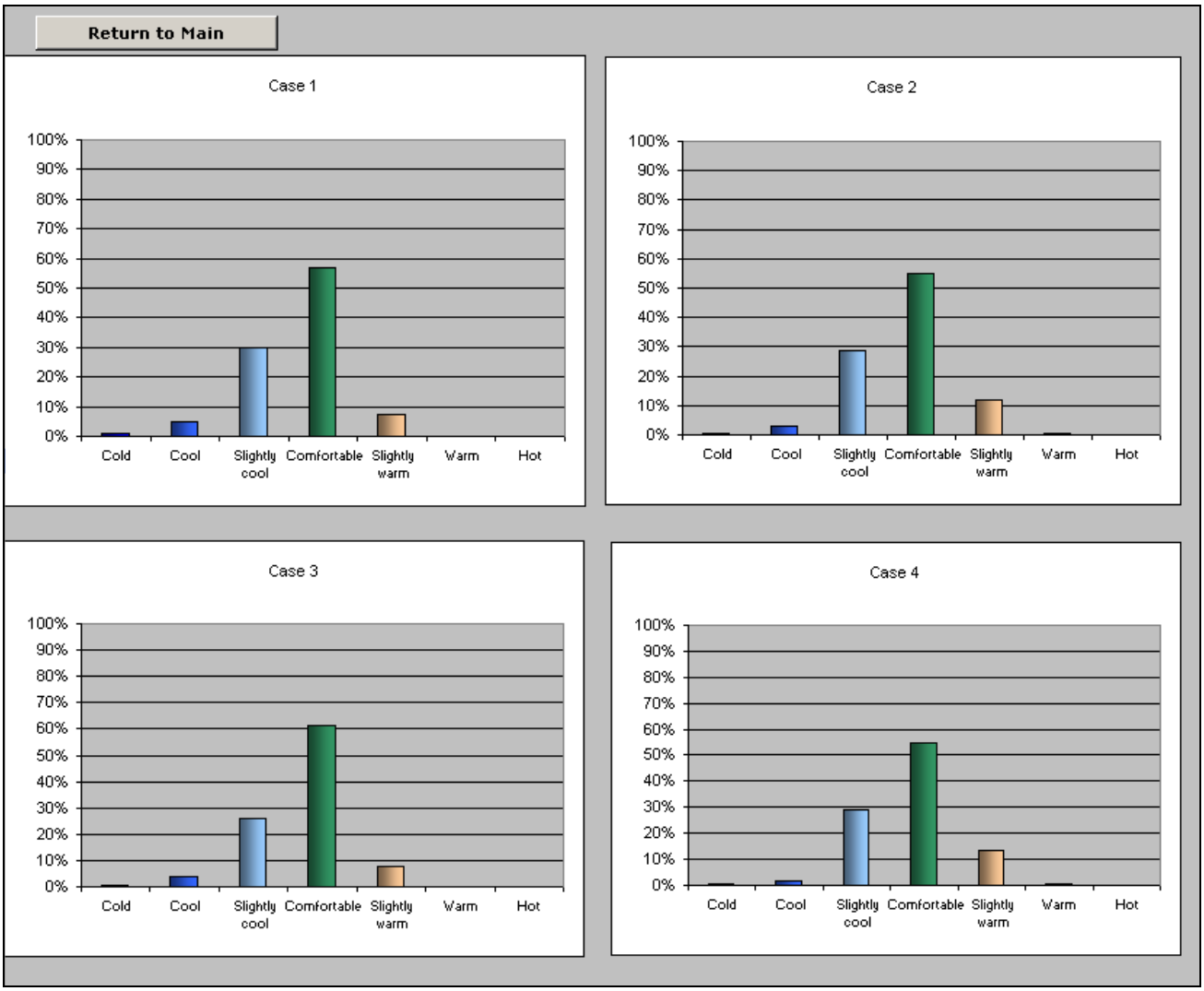


Figure 4-22. Comfort Graphs

Annual Tabular Results

Results are also presented in tabular form for each case, including the % difference from Case 1 of all the other cases.

Annual Values	Case 1		Case 2				Case 3				Case 4			
					% diff from Case 1				% diff from Case 1				% diff from Case 1	
Heating	8.7	kBtu/sf-yr	7.4	kBtu/sf-yr	-14%	%	7.0	kBtu/sf-yr	-20%	%	6.9	kBtu/sf-yr	-20%	%
Cooling	4.9	kBtu/sf-yr	6.2	kBtu/sf-yr	26%		5.1	kBtu/sf-yr	3%		7.2	kBtu/sf-yr	45%	
Fan	3.8	kBtu/sf-yr	4.7	kBtu/sf-yr	21%		3.7	kBtu/sf-yr	-5%		8.3	kBtu/sf-yr	117%	
Lighting	16.9	kBtu/sf-yr	15.0	kBtu/sf-yr	-11%		13.8	kBtu/sf-yr	-18%		14.3	kBtu/sf-yr	-15%	
Total Energy	34.4	kBtu/sf-yr	33.3	kBtu/sf-yr	-3%	%	29.5	kBtu/sf-yr	-14%	%	36.7	kBtu/sf-yr	7%	%
Peak demand	4.30	W/sf	4.64	W/sf	8%	%	4.27	W/sf	-1%	%	6.68	W/sf	55%	%
Average Daylight Illuminance	6.5	fc	17.6	fc	170%	%	14.9	fc	129%	%	18.5	fc	184%	%
Average Discomfort Glare	11.8	Index	13.0	Index	10%	%	12.9	Index	9%	%	12.8	Index	8%	%
Average Thermal comfort	-0.52	PPD	-0.43	PPD	-17%	%	-0.42	PPD	-19%	%	-0.34	PPD	-35%	%
CO2 Emissions	8.5	lb/ft2	8.1	lb/ft2	-4%	%	7.3	lb/ft2	-14%	%	8.1	lb/ft2	-4%	%

Figure 4-23. Comfort Graphs

Monthly Graphic Results

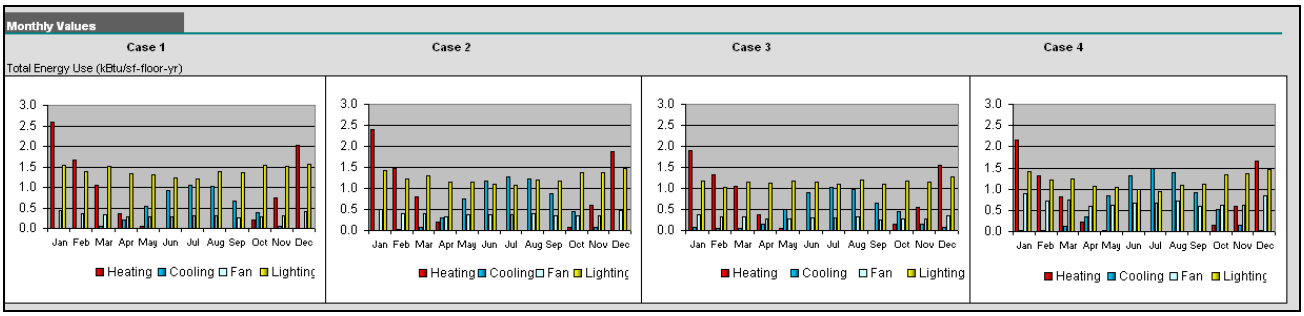


Figure 4-24. Monthly Total Energy Use Graphs

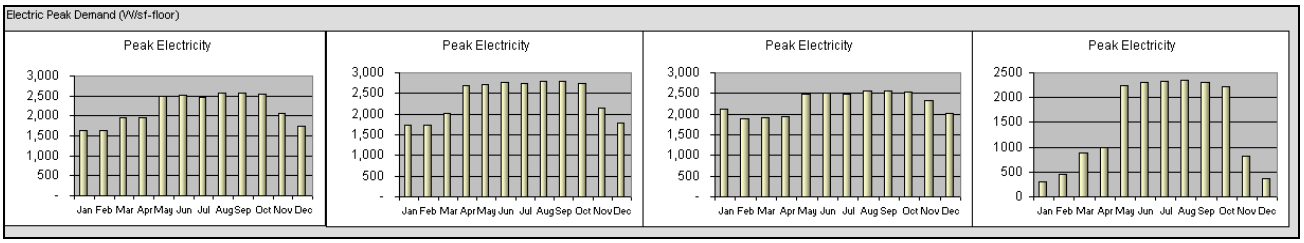


Figure 4-25. Monthly Electric Peak Demand Graphs

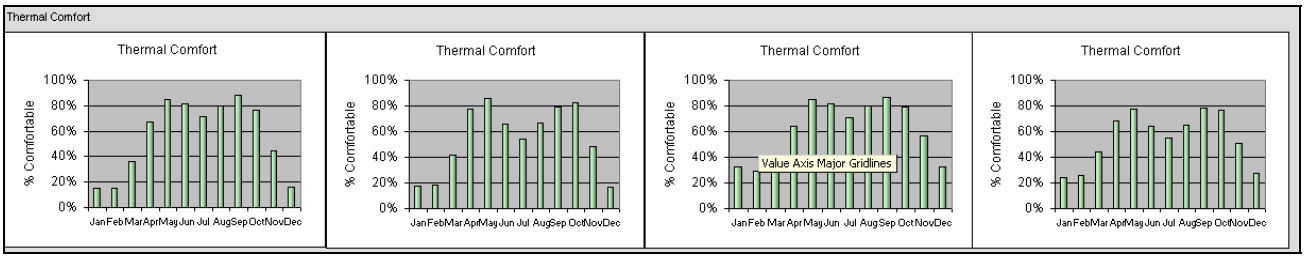


Figure 4-26. Monthly Thermal Comfort Graphs

4.4. Façade Library Screen

The **Façade Library** is used to define individual façade configurations. This is where window and exterior shading geometry are defined, as well as the glazing and frame systems for each window. Up to 4 windows can be defined for one facade.

Project Button The Project button at the top of the Façade Library screen takes you back to the Project screen.

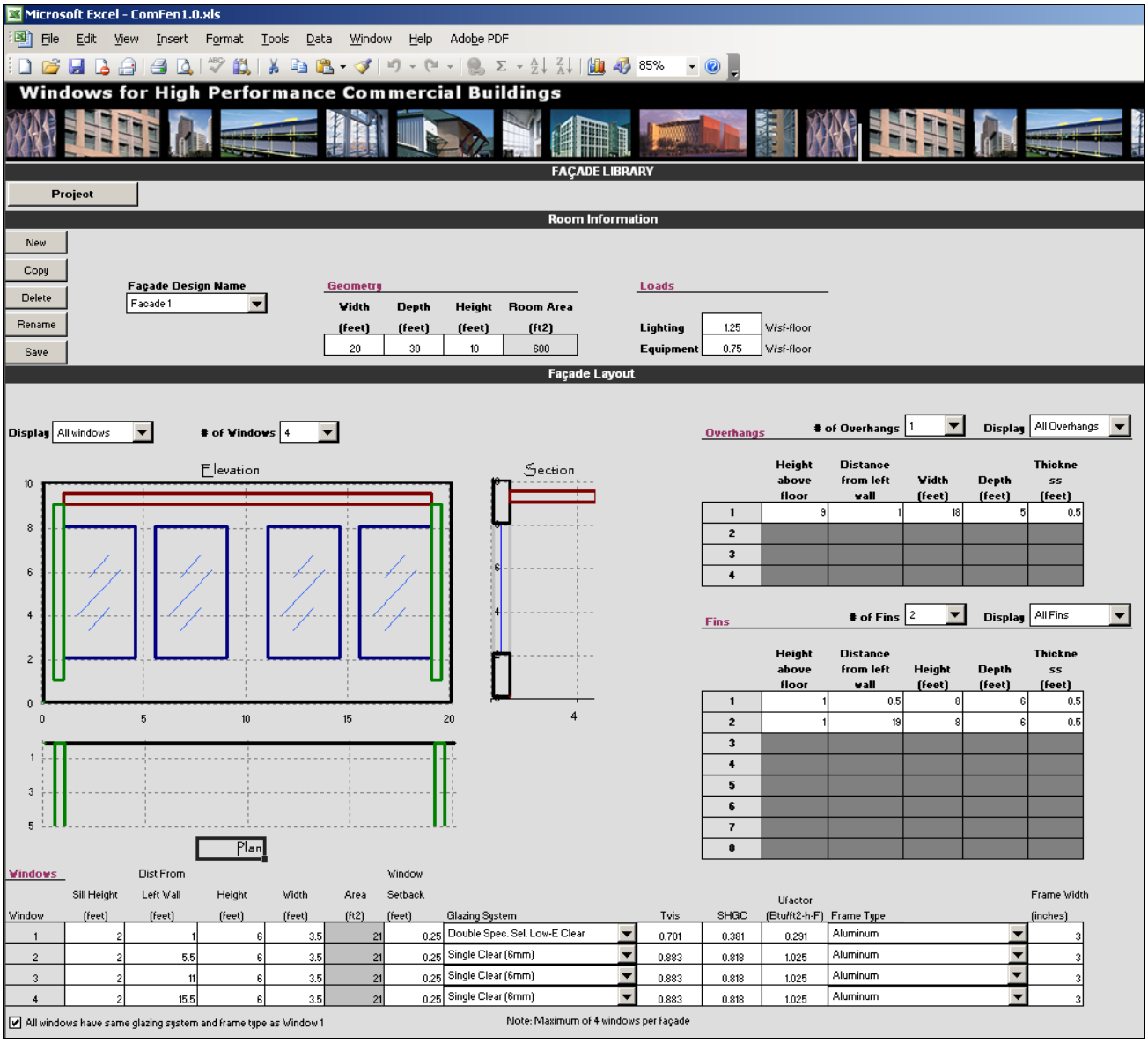


*Figure 4-27. The **Façade Library screen.***

4.4.1. Room Information

The Room Information section is used to define the basic geometry of the "room" associated with the façade, such as the height, width and depth of the room (you can also think of it as a "zone"), as well as the lighting and equipment loads associated with the room.

Buttons

*Figure 4-28. The **Façade Library buttons.***

New	The New button is used to create a new façade. This will cause a small dialog box to open, asking for the name of the new façade.
Copy	The Copy button is used to copy the currently selected façade into a new façade. This will cause a small dialog box to open, asking for the name of the new façade.
Delete	The Delete button is used to delete the currently selected façade.
Rename	The Rename button is used to rename the currently selected façade. This will cause a small dialog box to open, asking for the new name.
Save	The Save button is used to save the currently selected façade.

The Room Information section of the Façade Library has the following input values:

Façade Design Name	Name of the façade design, input by the user. The names of the façade designs will appear in the Façade Design Name pulldown list in the Calculate screen.

Geometry

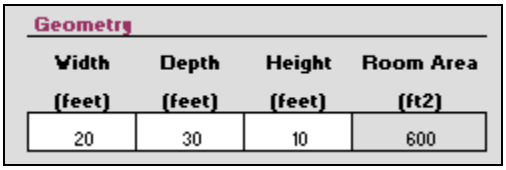


*Figure 4-29. The **Façade Library Room Geometry input.***

Width	The width of the room/zone. **Units:** feet (IP).
Depth	The depth of the room/zone. **Units:** feet (IP).
Height	The height of the room/zone. **Units:** feet (IP).
Room Area	Feedback. Room area based on width and depth dimensions. **Units:** feet (IP).

Loads

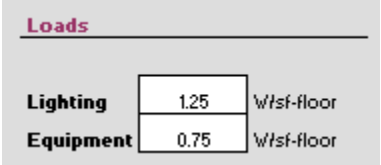


Figure 4-30. The ***Façade Library Room Loads input.***

Lighting	The lighting load for the room/zone. **Units:** W/sf (IP).
Equipment	The equipment load for the room/zone. **Units:** W/sf (IP).

4.4.2. Façade Layout

The Façade Layout section allows you to define windows, overhangs and fins for the façade.

Windows

The upper left section allows you to define the geometry of the window layout. The dimensions assume you are looking at the façade from the outside (exterior elevation), with the lower left corner (0,0) being the starting point of the dimensioning.

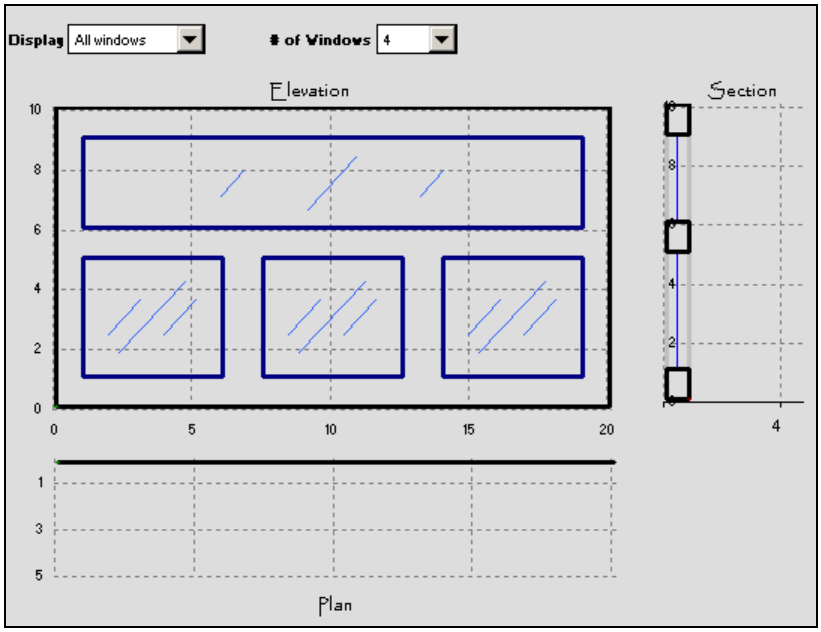


Figure 4-31. The ***Façade Layout display.***

Display	This pulldown list allows you to display all of the windows together, or one at a time.
# of Windows	The number of windows, up to 4, to be defined for this façade. This number will control the number of lines that display under the graphic for defining the façade geometry. **Default:** 1. **Legal values:** 1-4.

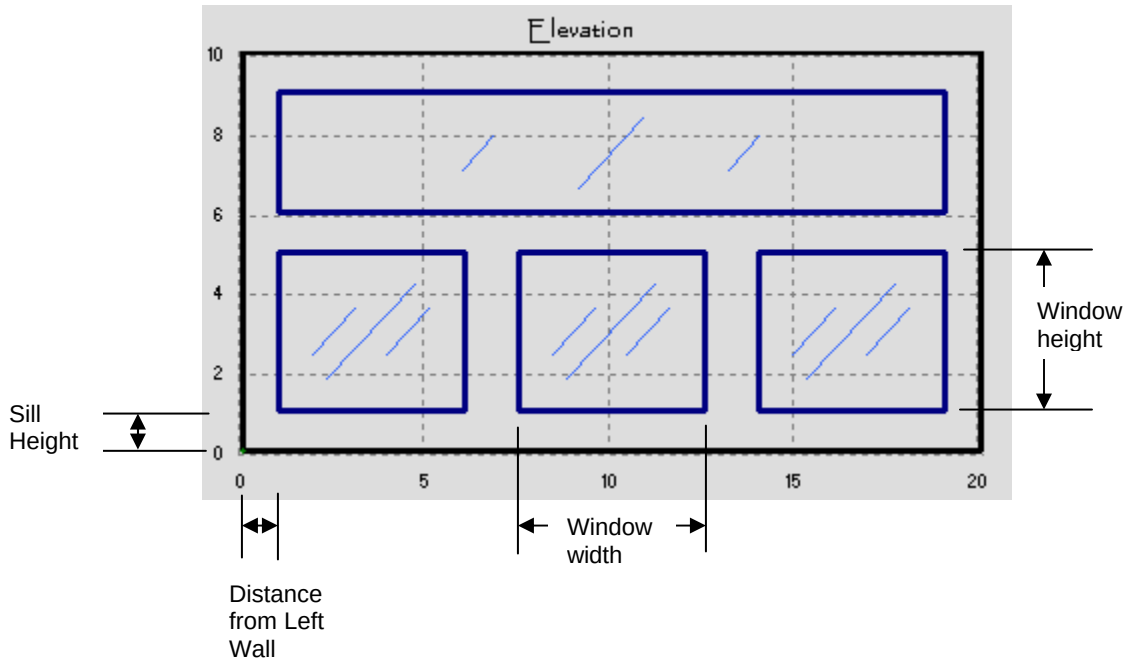


Figure 4-32. Façade geomery definitions.

For each of the windows in the façade, the following must be defined:

Windows Window	Sill Height (feet)	Dist From Left Wall (feet)	Height (feet)	Width (feet)	Area (ft2)	Window Setback (feet)
1	6	1	3	18	54	0.25
2	1	1	4	5	20	0.25
3	1	7.5	4	5	20	0.25
4	1	14	4	5	20	0.25

☑ All windows have same glazing system and frame type as Window 1

Figure 4-33. Window geomery input.

Sill Height	Height of window sill from the interior floor. **Units:** feet (IP).
Dist from Left Wall	Distance of the window from the interior of the left wall, looking from the outside of the façade. **Units:** feet (IP).
Height	Height of the window. **Units:** feet (IP).
Width	Width of the window. **Units:** feet (IP).
Area	Feedback of window area based on height and width input above. **Units:** square feet (IP).

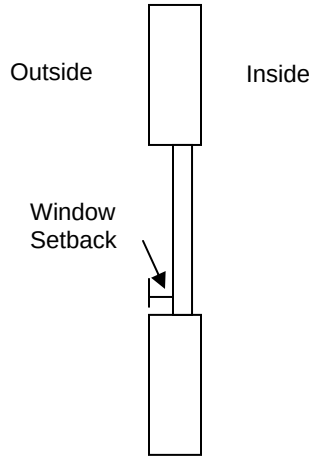


Figure 4-34. Window Setback definition.

Window Setback

The distance from the outside of the façade wall that the outside of the window glazing starts. See figure above. **Units:** feet (IP).

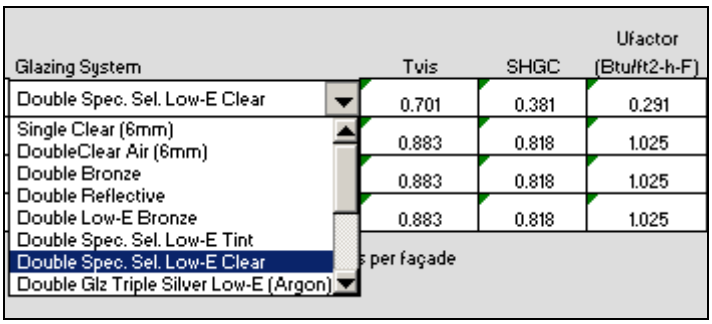


Figure 4-35. Glazing System pulldown list.

Glazing System

Glazing system for this window, based on selections in pulldown list. The current selections are listed in the following table:

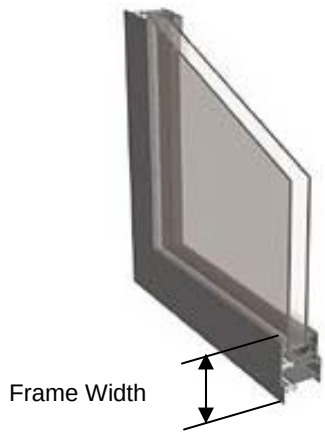
Table 4-3. Glazing Systems

Name	Tvis	SHGC	Ufactor
Single Clear (6mm)	0.883	0.818	1.025
DoubleClear Air (6mm)	0.784	0.704	0.474
Double Bronze	0.477	0.499	0.474
Double Reflective	0.131	0.182	0.399
Double Low-E Bronze	0.443	0.451	0.331
Double Spec. Sel. Low-E Tint	0.521	0.298	0.291
Double Spec. Sel. Low-E Clear	0.701	0.381	0.291
Double Glz Triple Silver Low-E (Argon)	0.639	0.271	0.235
Double Hi VT (Low-Iron) Low-E (Argon)	0.725	0.382	0.244
Double High Performance Tint (Air)	0.607	0.39	0.474
Double High Performance Tint (Argon)	0.607	0.386	0.447
Double Low VT Low-E (Argon)	0.371	0.24	0.251
Triple Spec. Sel. Low-E Clear	0.462	0.263	0.156
Quad Spec. Sel. Low-E Clear	0.423	0.248	0.124

Frame Type Frame type for this window, based on selections in pulldown list. Current list entries area:

Table 4-4. Frame Types

Name	Conductance (Btu/h-ft2-F)
Aluminum	1.9
Aluminum w/Thermal Break	1
Wood/Vinyl	0.4
Insulated	0.25



Frame Width Projected frame dimension. **Units:** inches (IP).

Figure 4-36. Frame Width definition.

Overhangs

The Overhangs section allows you to define overhangs for the facade. The dimensions assume you are looking at the façade from the outside (exterior elevation), with the lower left corner being the starting point of the dimensioning.

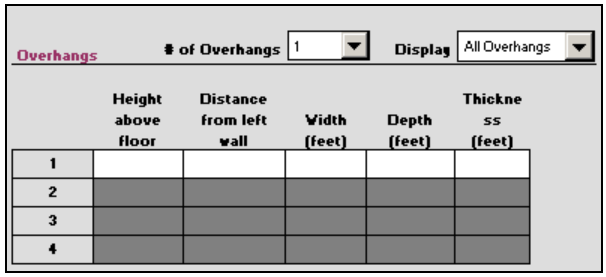


Figure 4-37. Overhang geomery input.

# of Overhangs Number of overhangs on the façade. This number will control the number of lines that can bed edited in the geometry input grid. **Legal values:** 1-4.

Display This pulldown allows you to display all of the overhangs at once, or one at a time. **Default:** All Overhangs.

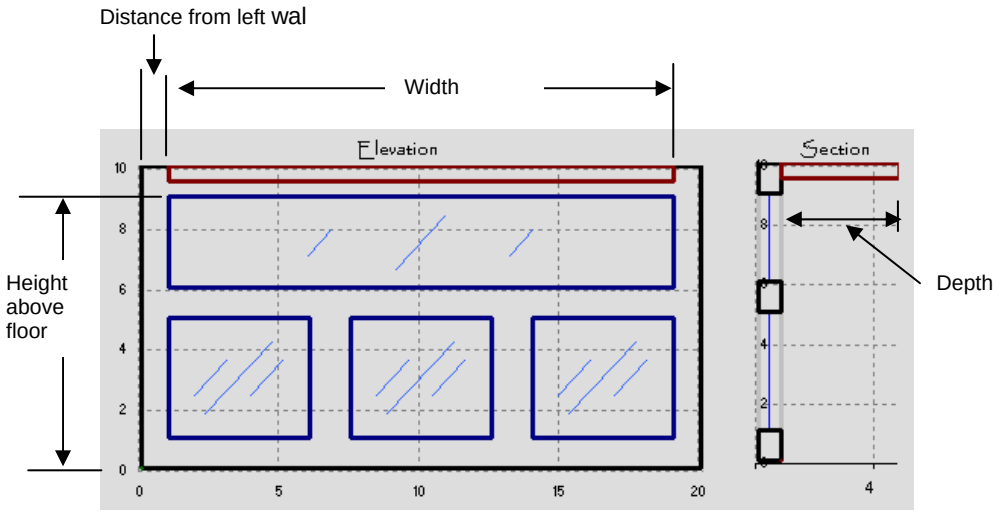


Figure 4-38. Overhang geomery input.

Distance from Left Wall Distance of the left-hand side of the overhang from the left wall. Overhangs that extend to the to the left of the left wall can be defined with a negative value for this distance. However, the graphic display of the overhang will not show this. **Units:** feet (IP).

Width Overhang width. Overhangs that extend beyond the right hand side of the façade can have a width that is greater than the width of the façade. However, the graphic display of the overhang will not show this. **Units:** feet (IP).

Depth Overhang depth. **Units:** feet (IP).

Thickness The thickness of the overhang. **Units:** feet (IP).

Fins

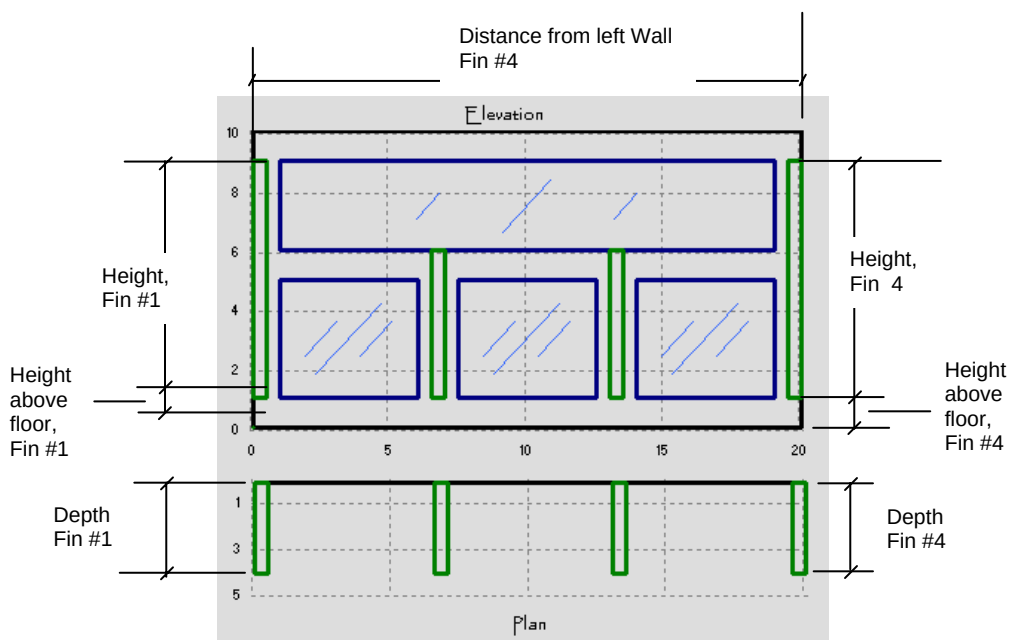
The Fins section allows you to define fins on the facade. The dimensions assume you are looking at the façade from the outside (exterior elevation), with the lower left corner being the starting point of the dimensioning.

Fins # of Fins 4 Display All Fins

	Height above floor	Distance from left wall	Height (feet)	Depth (feet)	Thickness (feet)
1	1	0	8	4	0.5
2	1	6.5	5	4	0.5
3	1	13	5	4	0.5
4	1	19.5	8	4	0.5
5					
6					
7					
8					

Figure 4-39. Fin geomery input.

# of Fins — Number of fins on the façade. This number will control the number of lines that can bed edited in the geometry input grid. **Legal values:** 1-8.



Display — This pulldown allows you to display all of the fins at once, or one at a time. **Default:** All Overhangs.

Height above Floor — Height of the bottom of the fin above the floor. **Units:** feet (IP).

Distance from Left Wall — Distance of the left-hand side of the fin from the left wall. **Units:** feet (IP).

Height — Fin height. **Units:** feet (IP).

Depth — Fin depth. **Units:** feet (IP).

Thickness — Fin thickness. **Units:** feet (IP).