Guideline to coupled energy and daylight simulations

This is a guideline on how to perform coupled energy and daylight simulations using Radiance and EnergyPlus. Coupled in the sense that the annual daylight and energy simulations relies on the same description for the window, uses the same weather data and relies on the same platform for geometry generation. The main idea behind the workflow is to use shared assumptions and thereby avoid using diffent assumptions for especially solar shadings in energy and daylight simulations. As an example the workflow can model dynamic shading systems using the same control strategy for both energy and daylight simulations. At the same time state of the art tools are used to produce results in a minimum of time.

EnergyPlus

EnergyPlus is a building simulation tool capable of simulating energy consumption, indoor climate and window temperature distributions. The output can for instance be used to predict occupancy satisfaction in accordance with European standard EN 15251. It is released by the U.S. Department of Energy. Further information on EnergyPlus can be found at https://energyplus.net/

Radiance

Radiance is the industry standard for daylight simulations in rooms and buildings. With Radiance it is possible to predict conditions regarding illuminance, luminance and radiation. The output can be used to quantify daylight availability using simple metrics, such as daylight factor, or annual metrics such as UDI, DA and sDA. In accordance with EN 17037 the output can also be used to quantify sDA within daylight hours, as opposed to occupancy hours. It is recommended to use annual metrics since it provides more in-depth information about the daylight availability. Further information on Radiance can be found at https://www.radiance-online.org/

Workflow

The Rhinoceros – Grasshopper – Ladybug Tools interface is used as a common ground for geometry generation and data visualization. The interface provides a link between Radiance and EnergyPlus to perform the coupled daylight and energy simulations, while simultaneously enabling parametric capabilities.

MicroShade A/S has developed a coupled workflow called BPC® Workflow. This workflow is intended for calculation of energy, indoor climate and daylight in rooms and buildings. It has a special focus on calculation with passive and dynamic shading solutions. The BPC® Workflow can be downloaded for free here.

In the following video tutorials, it is shown step by step how to perform coupled simulations, while simultaneously providing example files. Watch the videos here:

BPC® Workflow 1 - Shared Assumptions
BPC® Workflow 2 - Daylight with Passive Shading
BPC® Workflow 3 - Daylight with Dynamic Shading
BPC® Workflow 4 - Thermal calculation with Passive Shading
BPC® Workflow 5 - Thermal calculation with Dynamic Shading

About MicroShade®

About MicroShade®

MicroShade® is a highly effective shading product consisting of an almost invisible film combining UV and IR coatings with a structured micro-lamella. The shading efficiency depends on the incidence angle of the sun on the lamellas. When the sun is high in the sky during the summer, MicroShade® provides the strongest shading and during winter when the sun is low more heat is allowed into the building. Similarly, the shading efficiency also varies during the course of the day due to the different positions of the sun morning, noon and evening.

Selection of glazing with MicroShade®

For façade applications[1] MicroShade® is commonly combined with either a low energy coating or an extra low energy coating. An extra low energy coating provides a stronger shading, whilst a low energy coating allows more daylight inside. For roof applications an extra low energy coating is typically used, and for even stronger shading it is possible to combine MicroShade® with a hard coated solar control coating (SCH) on the front glass. For more information on selection of MicroShade® type please see our selection guidelines on www.microshade.com/for-professionals

Rotation of MicroShade®

A rotation of MicroShade® can be done to optimize the g-value. For vertical facades MicroShade® are never rotated, while MicroShade® in roof windows can be rotated depending on the orientation and tilt of roof. Rotation should be considered for orientations between northeast (45˚) and northwest (315˚) for roof windows at tilts between 25˚ and 70˚. The rotation angle is always 90˚. Please contact MicroShade A/S at support@microshade.com to confirm if rotation is beneficial.

MicroShade® BSDF files

BSDF (BI-directional-Scattering-Distribution-function) files of the first layer of glass including the UV and IR film and structured micro-lamella has been developed.

Usage of MicroShade® BSDF files

BSDF files of four variations of the first layer of glazing, containing the MicroShade® structure, has been made available in a range of glass thicknesses. First click on the link of the desired variation, from there you can select the appropriate glass thickness.

- – MS-F 60/14
- – MS-F 60/14 Rotated 90º
- – MS-F 60/14 + Hard coated solar control (SCH)
- – MS-F 60/14 + Hard coated solar control (SCH) Rotated 90º

In case you do not find the needed variation please contact us at support@microshade.com

To construct your own custom window with MicroShade® using the files above please see the section *"Creating BSDF & IDF files for a glazing with MicroShade® in Window 7"* in this document.

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[1] Facade application means glazing mounted in a near vertical position.

As a supplement to constructing your own window using a BSDF of MicroShade® with the first layer of glazing, a selection of common window constructions are available for download. For roof applications, the link will take you to a list of glazings, where standard constructions together with variations of rotated MicroShade® structure and hard coated solar control (SCH) coating are available.

- – 2-layer MS-F 60/14 for facade
- – 3-layer MS-F 60/14 for facade
- – 2-layer MS-F 60/14 for roof
- – 3-layer MS-F 60/14 for roof

In case you do not find the needed variation please contact us at support@microshade.com

MicroShade® IDF files

IDF (Intermediate Data Format) files of the same window constructions as the BSDF files are also available for download. For roof applications, the link will take you to a list of glazings, where standard constructions together with variations of rotated MicroShade® structure and hard coated solar control (SCH) coating are available.

- – 2-layer MS-F 60/14 for facade
- – 3-layer MS-F 60/14 for facade
- – 2-layer MS-F 60/14 for roof
- – 3-layer MS-F 60/14 for roof

In case you do not find the needed variation please contact us at support@microshade.com

In the section "*Creating BSDF & IDF files for a glazing with MicroShade® in WINDOW7*" in this document, it is described how to produce IDF files using the BSDF files of the first layer of glazing with MicroShade®.

Creating BSDF & IDF files for a glazing with MicroShade® in WINDOW7

About WINDOW 7

WINDOW 7 is a window program that calculates specifications (U-value, transmission, reflection etc.) for glazings and complex glazing systems with shadings. WINDOW7 is developed at Lawrence Berkeley National Laboratory (LBNL) in California, USA and contains the international glazing database (IGDB) with more than 3800 glazings.

WINDOW7 can be used to build-up any glazing including shading systems to be used for energy or daylight analysis in other programs like e.g. Radiance or IESVE. For complex fenestration systems like MicroShade® the output is a XML BSDF file containing the angular depended transmittance and reflectance of the glazing including MicroShade® and an IDF file for energy calculations. Programs that can read XML BSDF and IDF files can also use the files created in WINDOW 7.

Glazing build up with MicroShade®

To implement MicroShade® in a window, the coatings of the glazing need to be placed on the correct surfaces in the glazing. The BSDF files provided contains the first pane of the glazing, where MicroShade® is installed on the interior surface referenced to as surface "2" in Fig. 2. Low-E coatings should be places on surface 3 and 5.
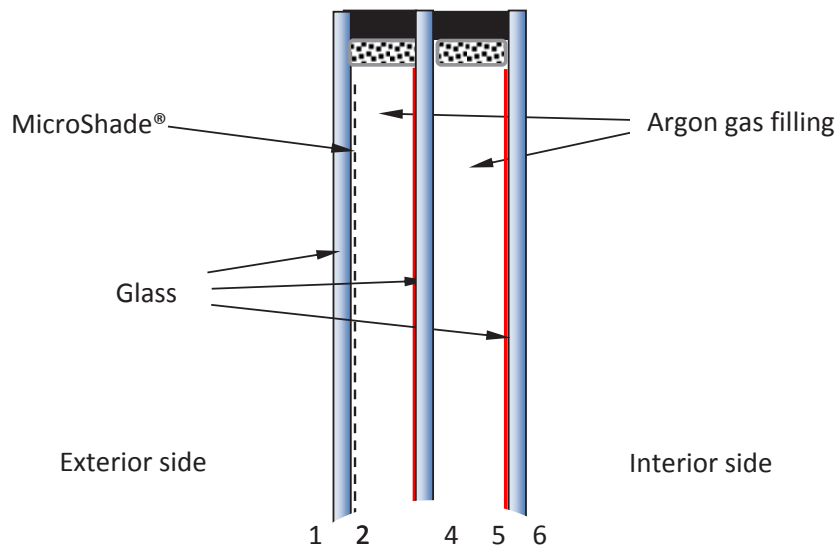

Figure 2. A glazing composition of a 3-layer LowE glazing with MicroShade®. The numbers indicate the indexing of the glazing surfaces.

Import the MicroShade® BSDF   o Window 7

1. Go to the shading layer Library; "Libraries" > "Shading Layer" or click on the Shading Layer Library icon in the menu bar.

2. In the left menu bar click on "New". A new window will open up and prompt for an ID number for the new record. Just use the number suggested and press "OK".

3. The new record you just created will show on the last line in the list. Double click on it and a new window will open up. See figure 3
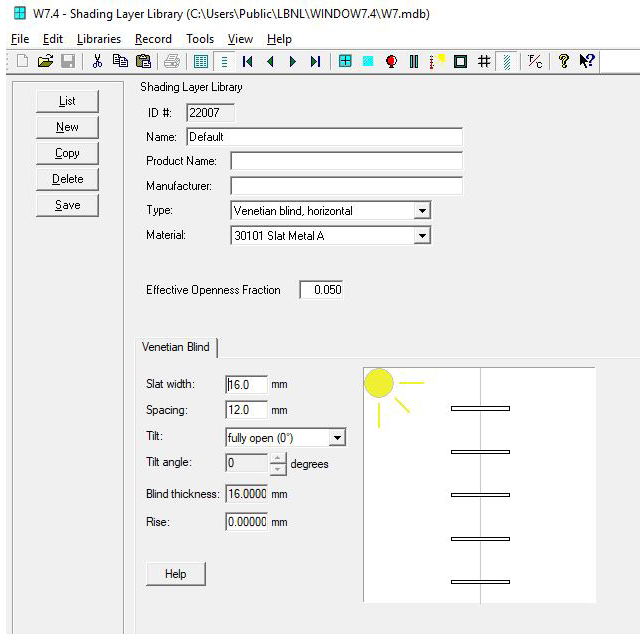

Figure 3: New Shading Layer Record.

4. In the "Type" drop-down menu choose the "Shade with XML data".

5. Click "Browse" and choose the MicroShade® BSDF file you want to import. Values will now appear in the table. See figure 4

Please note: The thickness is allways 0.05 greather than the selected pane size, which accounts for the MicroShade® product installed.
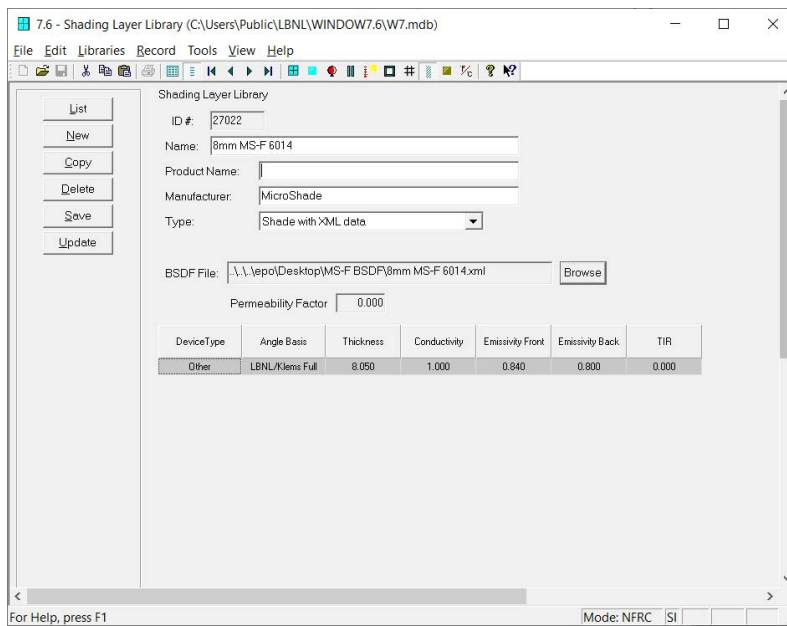
Figure 4: MicroShade® BSDF file has been imported.

6. Save the new shading layer you just created.

Create a glazing with MicroShade® BSDF

1. To get LBNL WilNDOW to produce .xml files the following preferences must be set in File/Preferences/Optical Calcs:
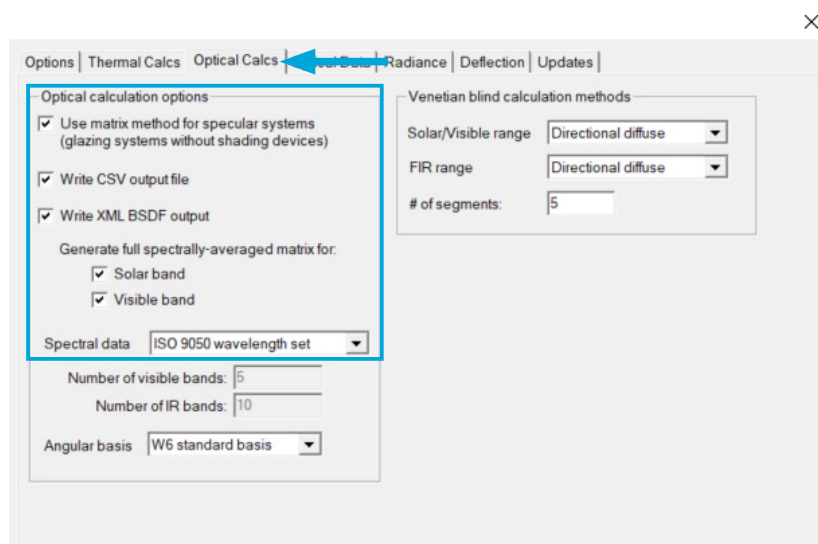

Figure 5: This tells the program to create XML outputs for solar and visible wavelengths. The BSDF in XML format is necessary for using BSDF files in Radiance.

2. Go to the Glazing System Library; "Libraries" > "Glazing System" or click on the Glazing System icon in the menu bar.

3. In the left menu click on "New". A new window will open up and prompt for an ID number for the new record. Just use the number suggested and press "OK". The new record you just created will show in a pop-up window.
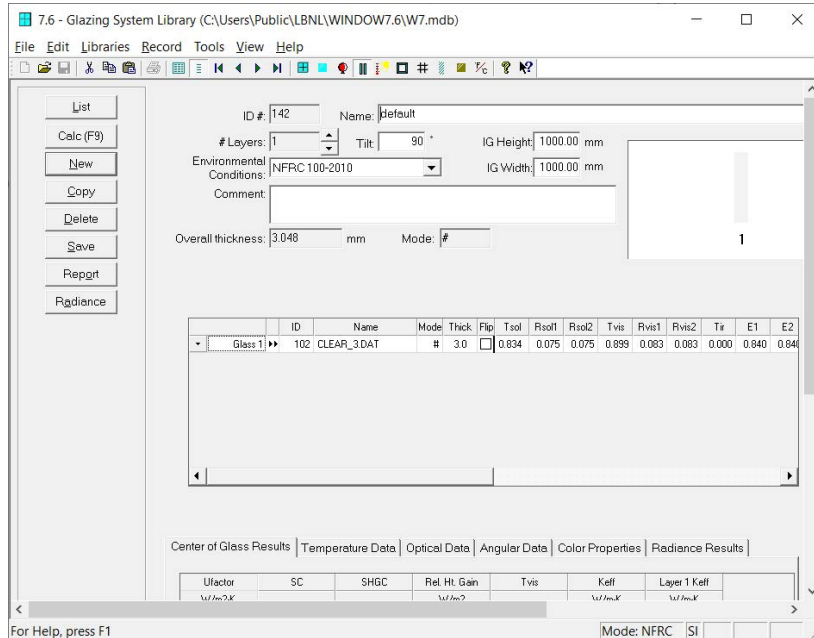

Figure 6: New Glazing System record.

4. Type in the name of your new glazing and choose the number of layers. The MicroShade® layer is incorporated with the first pane of glazing in the BSDF files, thus no extra layer should be added to account for the MicroShade®.

5. Each layer can now be modified to the desired glazing build up. The first layer should be changed to a *''Shade or frit'',* after that the newly created shading layer can be selected by double clicking on the name of the layer.

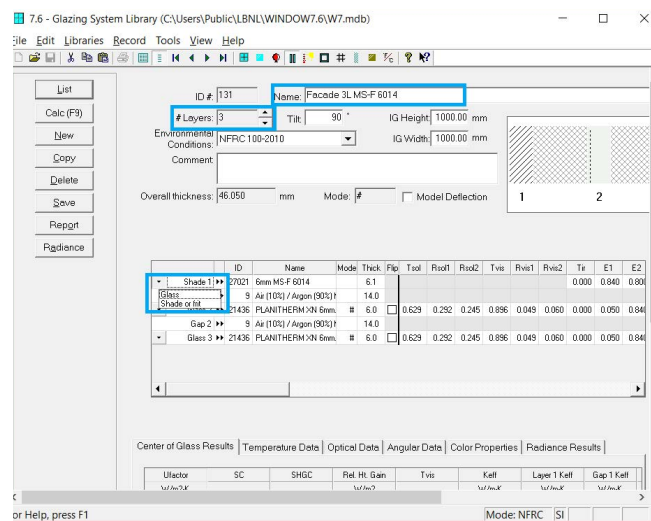Please note: Remember to place the low-e coating on side 3 (and 5) in the MicroShade® glazing.

Figure 7: Example of a 3-layer MicroShade® glazing. Please note the position of the low-e coating on side 3 and 5. The blue areas indicate where to change the name, the amount of layers and the first layer to a ''Shade or frit''.

6. Once you have build-up your glazing, you are ready to calculate the value for the glazing including MicroShade®. As default boundary conditions the standard NFRC 100-2010 is used. The boundary conditions are only relevant for U- and g-value calculations and are not important for generation of the new BSDF/IDF file

7. Go to the left menu bar and click "Calc". A pop up window will show up while the values are being calculated.

8. Save the record, when the values have been calculated.

9. To generate the new BSDF/IDF file with MicroShade® included in the glazing go to the left menu and press "Report". Chose "Energy Plus BSDF IDF File" in the drop down menu and save the file on your desired location. The file format is ".IDF" and can be used directly in EnergyPlus.

10. If your preferences are set as described above, the XML file will be located here: C:\Users\Public\LBNL \WINDOW7.6\BSDFs. The XML file can be viewed in a text editor.