















**DIVA:** Lighting schedules are defined differently in DIVA. Lighting schedules are detailed schedules generated by DAYSIM from annual daylighting simulation. Energy simulation in DIVA is linked to the daylighting simulation results generated by DAYSIM.

**Honeybee:** Similar to DIVA, in Honeybee it is possible to use the detailed lighting schedule generated by DAYSIM in energy simulation and accurately account for the impact of daylighting in terms of electric lighting reduction (see Figure 3).

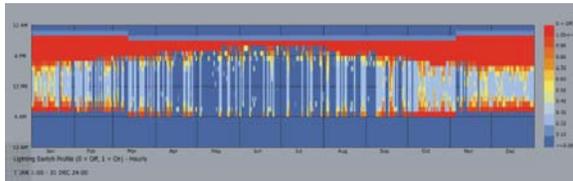


Figure 3 DAYSIM- based lighting schedule in Honeybee

**Insight360:** Daylighting simulations with LAR are totally disconnected from energy simulations in Insight360. Based on the engine picked for energy simulation, the built-in tool in DOE.2 or EnergyPlus is used for accounting the impact of daylighting in energy simulation.

## CONCLUSION

Table below summarizes pros and cons of the simulation tools studied in this paper.

Table 6 Summary of pros and cons

TOOL	PROS	CONS
<b>DB</b>	<ul style="list-style-type: none"> <li>- Detailed HVAC design option with user-friendly GUI</li> <li>- Quick and easy single-point-in-time Radiance DL analysis</li> </ul>	<ul style="list-style-type: none"> <li>- Knowledge about mechanical plants and heating/cooling systems, HVAC loops, system control types and operation</li> </ul>
<b>DIVA-Rhino</b>	<ul style="list-style-type: none"> <li>- Quick and easy Radiance single point and annual daylighting with user-friendly GUI</li> <li>- Integrated DL and energy for a single zone</li> </ul>	<ul style="list-style-type: none"> <li>- Lack of advanced HVAC design and energy simulation settings</li> <li>- Lack of multizone thermal analysis</li> </ul>
<b>HB</b>	<ul style="list-style-type: none"> <li>- Free</li> <li>- Flexibility</li> <li>- Integration of DL and energy for multiple zone</li> </ul>	<ul style="list-style-type: none"> <li>- Requires Grasshopper background</li> <li>- Complexity of the tool in multizone thermal settings</li> <li>- Lack of a user-friendly GUI for energy simulation</li> </ul>
<b>Insight</b>	<ul style="list-style-type: none"> <li>- Quick energy analysis with no background required</li> <li>- Quick and user-friendly single-point daylight analysis</li> </ul>	<ul style="list-style-type: none"> <li>- Lack of advanced HVAC design option</li> <li>- Lack of connection between daylighting and energy simulation</li> </ul>

Although each tool offers special features for daylighting and energy simulation, it is concluded that none of them provide a convenient and user-friendly process for integrated daylighting and energy analysis for medium to large projects with the detail required at design development (DD) and construction document (CD) phases of design.

DesignBuilder is unique for its HVAC GUI for EnergyPlus engine and importing gbXML models is a smooth process. However, annual daylighting simulation with DAYSIM is disconnected from energy simulation.

Honeybee has extensive potential, as it provides flexibility and customization for inputs and outputs, but the tool needs prior experience with Grasshopper. Detailed level of energy modeling and gbXML import is not possible.

DIVA for Rhino is very limited in terms of energy simulation. Only a single zone thermal simulation could be performed and energy inputs options are limited via DIVA GUI. Additionally, DIVA is not capable of importing or exporting gbXML files.

Insight360 is a useful tool for Revit users; however, LAR daylighting engine is not connected to energy simulation. Detailed energy simulation is not possible.

In the future, the results of these tools will be compared by simulating an example project. The authors would like to investigate daylighting and energy modelling workflow in other programs such as IES and OpenStudio.

## ACKNOWLEDGEMENT

The authors would like to dedicate special thanks to Luis Sousa from DesignBuilder; Ian Molley, Krishnan Gowri, Stephanie Egger from Autodesk; Mostapha Sadeghipour from Honeybee, and Alstan Jakubiec from DIVA support team.

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