Validation of the Watt module of DL-Light using ASHRAE Standard 140-2011.

DL-Light is the software suite developed by De Luminæ to help the evaluation of the intake and distribution of natural light in architectural and urban spaces.

The main **focus** of DL-Light is to help designers and engineers in the design of luminous ambience in Daylighting.

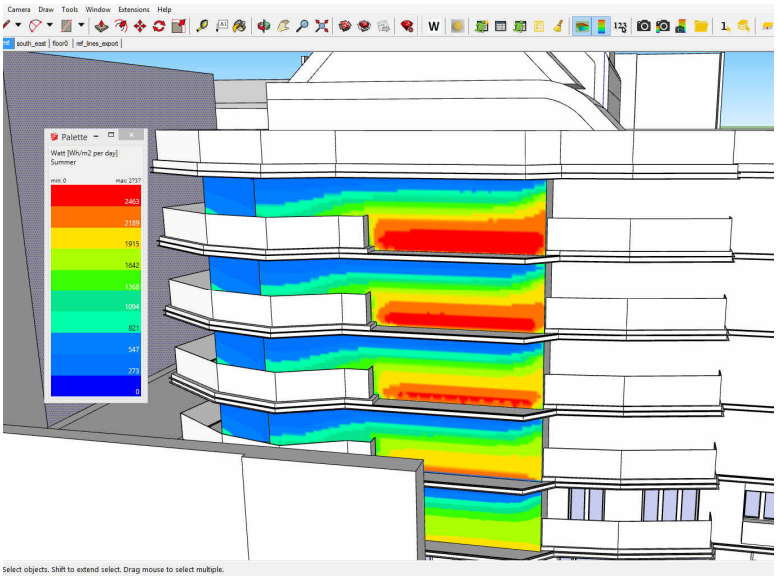
The **luminous ambience** in natural light influences various points of view like energetic and scientific, poetic, sensitive, qualitative.

As light and heat are both conveyed by the energy flux from the sun and the sky, the study of a project needs information on luminous and thermal aspects of the project, in particular as luminous and thermal anbience are **related**.

In that respect, the **Watt module** has been developed in DL-Light in order to provide information on the irradiation from the sky and the sun on exterior surfaces of the 3D model.

The Watt module of DL-Light calculates the quantity of energy from the sun and the sky that is received by the external surfaces of a 3D model for a given location over a given period of time.

On the image below, Watt module shows that the red part of the facades receive between 2.4 and 2.7 kWh/m² over the summer period in Paris.



In order to validate the results of the simulation of our watt module, we decided to compare its results to results given by the main software of building engineering.

We used the procedure defined in norm ANSI/ASHRAE 140-2011 and compared our results to the ones of other software.

As we use a ray-tracing simulation to be coherent with all DL-Light module, we analysed the differences with the results obtained by other software, building upon the published paper : David JOSEPH et al., 2011, *Calcul des flux solaires pour le Bâtiment par méthode de Ray-Tracing*, 2011 congress of the "Société Française de Thermique" (In French).

This analysis shows that the watt module of DL-Light is efficient and precise to calculate and analyze the energy arriving on the project.

Test procedure BESTEST in ASHRAE Standard 140-2011 (case 600).

A test procedure called BESTEST has been defined and adopted ASHRAE in order to compare tools for thermal simulation in buildings.

As the solar irradiation plays an essential role in these simulation the first test in BESTEST defines calculation procedures.

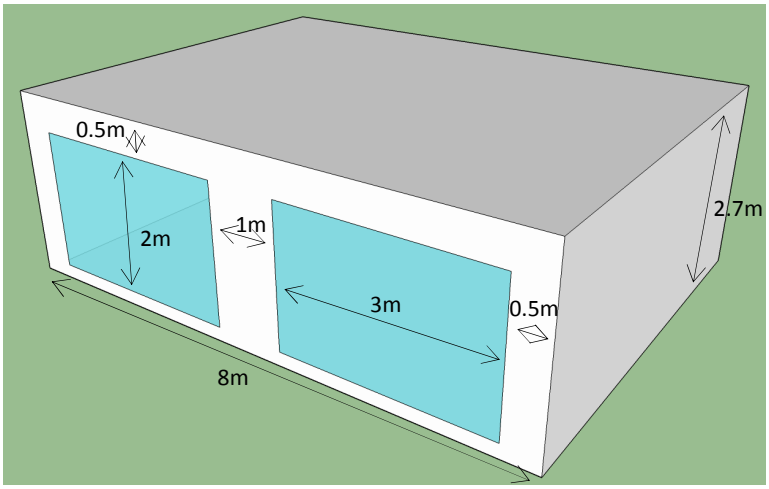
It is based on a simple model and a meteo file.

The objective of the test is to calculate the quantity of energy irradiating the facade over the whole year.

The first basic case of BESTEST (case 600) answers our needs of validation.

The calculation is run over a simple model as shown below and results are shown for the different façades.

In order to assess the results, we build upon a published paper and present the results below with the comparison with other software and their average results.



Kwh/m2/an	Roof	South	East	North	West
ESP	1797	1456	959	427	1086
DOE	1831	1566	1155	434	1079
SRES/SUN	1832	1476	1083	456	1003
S3PAS	1832	1474	1082	457	1002
TRNSYS	1832	1522	1101	367	1012
TASE	1832	1468	962	453	1090
SERIRES (Suncode)	1832	1468	1217	407	856
ArchiWIZARD	1826	1440	1132	393	864
Average	1826.75	1483.75	1086.375	424.25	999
DL-Light	**1818**	**1514**	**1115**	**359**	**955**
Difference %	**0%**	**2%**	**3%**	**-15%**	**-4%**

Analysis of the difference for the North Facade.
The North Facade shows a difference of 15%. As DL-Light uses a ray-tracing algorithm it takes into account with more accuracy the impact of the building itself via ground reflexion. To understand the difference, we place a sensor Norht oriented (far from the building) and we gt the following result:

DL-Light	**1818**	**1514**	**1115**	**418**	**955**
Difference %	**0%**	**2%**	**3%**	**-1%**	**-4%**

These results (difference between 0 and 4% compare to the average of other software) show that DL-Light is accurate for the calculation of energy received on a building over a period of time. It further stresses the potential of the ray-tracing approach to take into account all aspects of the environment.

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De Luminæ is a technical and research office in natural and artificial lighting, its impacts on energy consumption and the improvement of comfort and pleasantness for sustainable buildings and cities.

De Luminæ produces and distributes the software DL-Light, based on Radiance, for the design and evaluation of architectural and urban ambiances in Daylighting. De Luminæ has developed expertise in software Radiance, internationally renowned for the scientific quality of its results and that allows to simulate the most complex situations.

As it comes from the research field, De Luminæ keeps a strong R&D activity in order to maintain a high level of expertise and a constant innovative strategy.

De Luminæ was founded by Ljubica Mudri and Jean-Dominique Lénard. Ljubica Mudri is Architect, PhD in Energetics from the Ecole Nationale Supérieure des Mines de Paris, specialist in Daylighting. She has been teaching Daylighting in various universities in France. Jean-Dominique Lénard, PhD in Applied Maths from University Paris-Dauphine, MSc Applied Mathematics from the London School of Economics (LSE), specialized in simulation techniques. They have published the results of their researches in many international journals and congresses.

De Luminæ has developed a strong expertise in Daylighting in order to contribute to the most varied questions: highly complex architecture, specific interior and exterior spaces, luminous discomfort, subjective questions, etc.

De Luminæ accompanies architects, consultants, building buyers and users to answer 3 main questions, essential to energetics and comfort:

- *Quantity of light, is there enough natural light in the spaces for the intended activities ?*
- *Comfort/discomfort, how is natural light distributed in the spaces or why do users complain ?*
- *Pleasantness, does natural light contribute to create a pleasant space that corresponds to the intentions?*

Examples of intervention

National French Bank :	Luminous discomfort in natural/artificial lighting and improvement project.
French Television :	Conformity to French environmental certification for visual comfort.
Toulouse Hospital :	Luminous discomfort in Post-anesthesia recovery rooms.
Office Towers :	Impact of flooring on energy consumption, environmental certification.
Orléans Private Hospital:	Study of color profile in interior spaces & conformity to environmental certification.