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Final report

November 24th. 2010

LESOSAI-POLYSUN simulation tools for architects

Optimisation of active and passive solar use

E4tech

polysun SIMULATON SOFTWARE

LESO-PB LABORATOIRE D'ENERGIE SOLAIRE PHYSIQUE DU BÂTIMENT

EPFL ÉCOLE POLYTECHNIQUE FÉDÉRALE DE LAUSANNE

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1. Abstract

Solar energy, in its various forms of passive solar, active thermal and photovoltaics, will be more and more used by architects in their buildings. Computer tools to simulate the thermal behaviour of buildings and solar systems are mostly used by engineers and thermal energy experts, while only some architects use these tools.

The goals of this project were twofold:

- combine in one tool the building energy model and all passive and active “solar” gains (windows, thermal collector, photovoltaics), allowing the user to optimise his project by testing complete solar variants at once.

- simplify the user interface, by reducing the need of data by providing “intelligent” default values for solar systems and building elements, to broaden the use of this tool to the architects community

Each of the 3 project partners reached their projected goals with very satisfactory results:

Vela Solaris have produced a “Polysun inside” module that has been designed and used for this project within LESOSAI-P. The design of this module has allowed it to be also used with other computer simulation programs.

E4Tech has successfully launched the 7th. release of LESOSAI, which includes both the “Polysun inside” module and the newly developed “wizard” to ease and simplify the work of entering a building in LESOSAI, mainly addressed to architects.

The LESO-PB has coordinated the whole project and developed the ergonomic concept and the graphical interface of the new “wizard” for LESOSAI described above. The new concept includes recommendations collected from a user’s survey designed and conducted with the help of E4Tech, within this project.

2. Project goals

Solar energy, in its various forms of passive solar, active thermal and photovoltaics, is more and more needed to allow substitution of non-renewable energy in buildings and reduce the impact of the buildings to the environment.
Computer tools to simulate the thermal behaviour of buildings, as SIA380/1 tools, include today passive solar gains but have crude or none implementation of active solar thermal. On the other hand solar thermal system simulation tools are very specialised and accurate, but not well linked to building models.
Both tools are mostly used by engineers and thermal energy experts either to check the compliance with (SIA) Norms or to dimension the solar thermal system. Only some architects presently use these tools.

The goals of this project were twofold:

- combine in one tool the building energy model and all passive and active “solar” gains (windows, thermal collector, photovoltaics), allowing the user to optimise his project by testing complete solar variants at once.

- simplify the user interface, reducing the need of data by providing “intelligent” default values for solar systems and building elements, to broaden the use of this tool to the architects community.

Two leading software programs were used to implement these ideas (LESOSAI and POLYSUN), resulting in an enhanced tool (LESOSAI 7) which empowers architects to consider solar systems in an early planning stage based on automatic performance calculation of the solar system through POLYSUN.
Furthermore, the project results include the publication and discussion of the default values and recommendations as well as the modification of POLYSUN allowing it to be adapted as a plug-in for other software programs.

The global goal was to increase and facilitate the use of the various forms of solar energy in buildings, especially for architects, by providing the software tools needed.

3. Organization of the report

This project implied a close collaboration between 3 different entities.

To reach the desired goal(s) in due time and within budget, one main issue was the determination of working packages each institution could conduct independently, and the way to coordinate these works:

The LESO conducted a comprehensive survey of architects' softwares and identified users' interface strategies that could be used for the new interface. The new interface strategy was then globally defined and the graphical concept chosen and implemented

E4Tech and LESO collaborated in elaborating and conducting a web survey among LESOSAI users, and established a concatenated wish list from the results, with various priorities and feasibilities. E4Tech implemented the wizard developed by LESO and modifications that were requested by users. The Polysun module was implemented as to work both from the wizard and from LESOSAI proper.

Vela Solaris concentrated on developing an "enclosed" part of code, called "Polysun inside", and its interface with the "client" software. Together with E4Tech, they established a list of interface parameters to be transmitted, list that was the key to a clear separation of work. As this work was done mostly in parallel and with fewer interactions for the GUI, this whole part, written by Vela Solaris, has been kept as a separated report.

4. Lesosai user's survey

To understand the needs of their users, E4tech had a long list of wishes of Lesosai customers that was collected during the last 10 years.

To have a better picture of the present situation of Lesosai, a questionnaire was prepared and mailed to more than 400 customers. Around 40% of them answered, showing the interest of the clients for the project and their will to have an impact and participate.

The most important results were:

Fig. 1 Evaluation de la qualité ergonomique du programme pour les différentes phases du projet ? (all users)

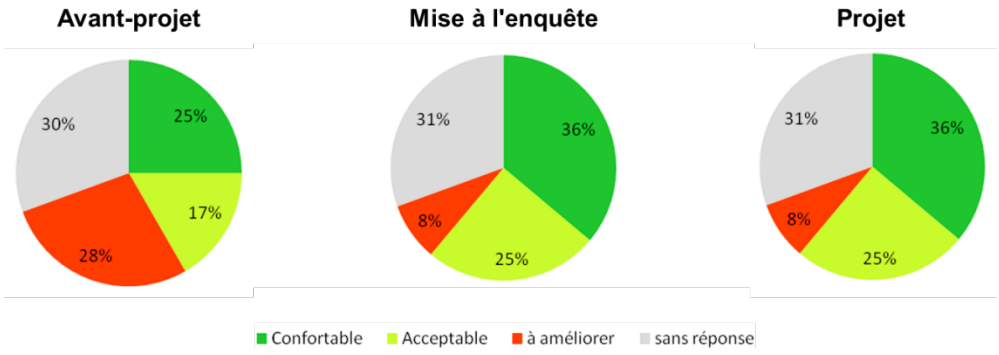


Fig. 2 Evaluation de la qualité ergonomique du programme pour les différentes phases du projet ? (architects only)

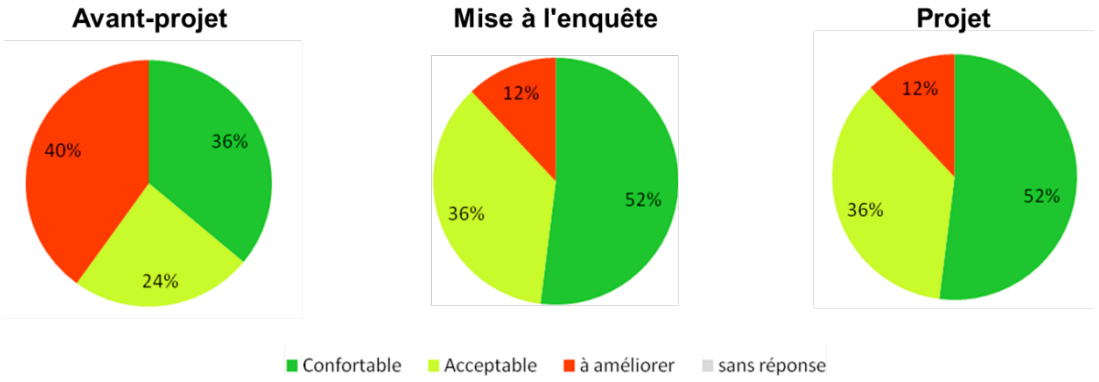


Fig. 3 Est-ce que vous aimeriez disposer d'une version du programme avec <u>entrée simplifiée des données</u> pour évaluer rapidement plusieurs variantes dans la <u>phase d'avant projet</u>?

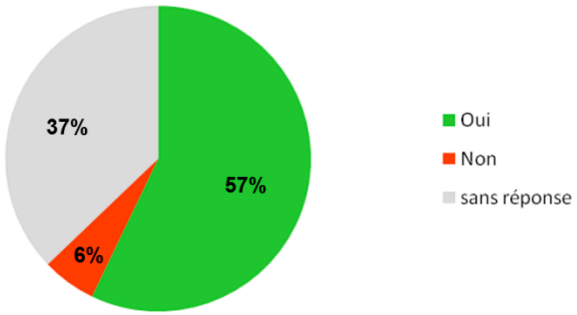
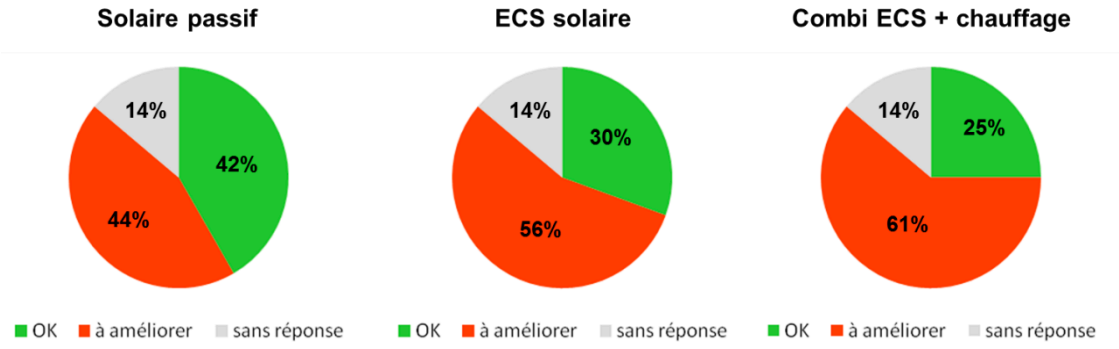


Fig. 4 Dans quelle mesure le programme vous aide-t-il à utiliser/dimensionner les systèmes <u>d'énergie solaire</u> suivants?



All these answers showed clearly that an improvement in Lesosai, in particular for the pre-project, was needed.

5. Existing programs survey and strategy

A comprehensive survey of existing programs in the same domain provided several insights on the way architects used to work with softwares, and on specific approaches to make them comfortable when entering data in a familiar way.

A pre-selection stage covering 22 programs led to the extensive analysis of 7 softwares, thoroughly described in the Annex 1 document: "*Analysis of 7 Energy in Buildings softwares*".

Following this stage and after all partners had "digested" the information collected in the document, the global strategy for the wizard was defined.
To reduce the work in the pre-project phase it was decided to limit the number of data to be introduced for the building and for solar systems. As Lesosai and Polysun are both multilingual programs, the wizard had to be multilingual as well

It was decided to use as many default values as possible, values that can be changed and adapted within Lesosai in a second stage but that can be realistically estimated at the pre-project level. For examples lighting scenarios, envelopes constructions, door compositions etc. were offered as simple choices, from which all the detailed values were inferred.

All the data that had to be transmitted, both ways, between LESOSAI and POLYSUN, were also defined at this stage.

The 2 diagrams here below (Figs. 5 & 6) show the extensive analysis and simplification work that has been necessary to generate the wizard ergonomy.

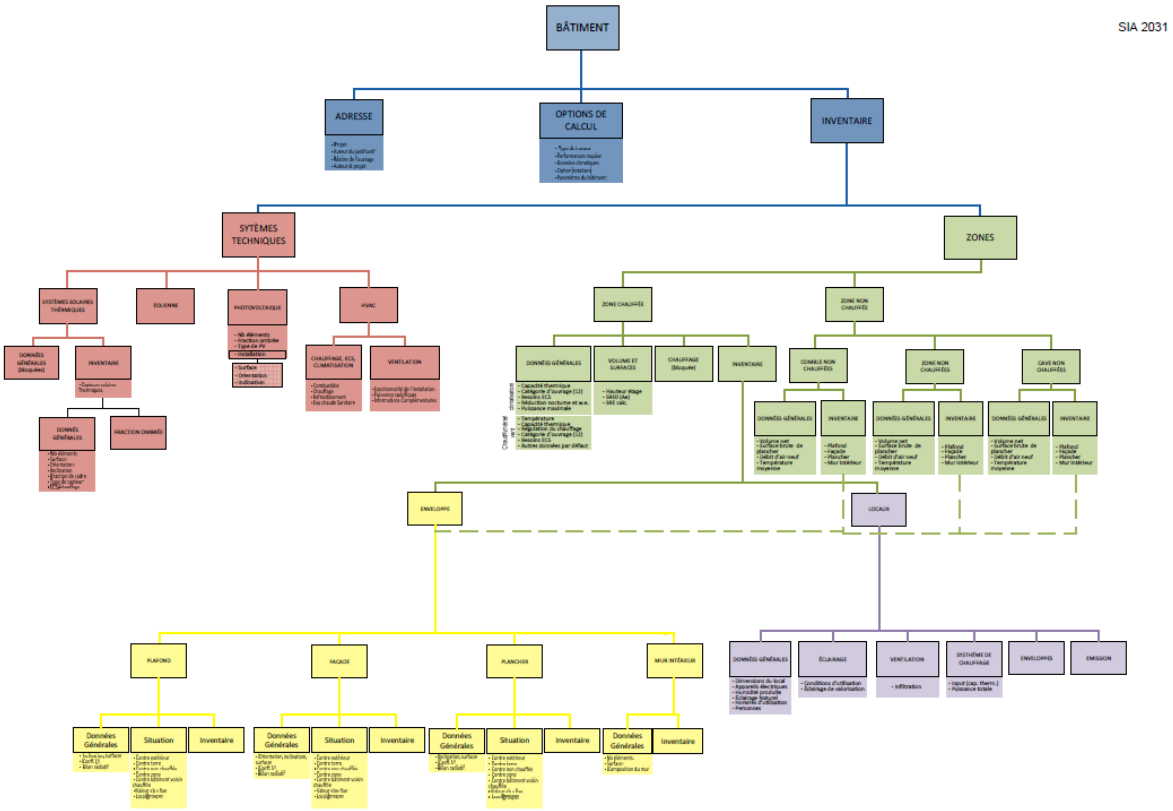


Fig. 5 Lesosai 6 Flowchart (shown only for its complexity)

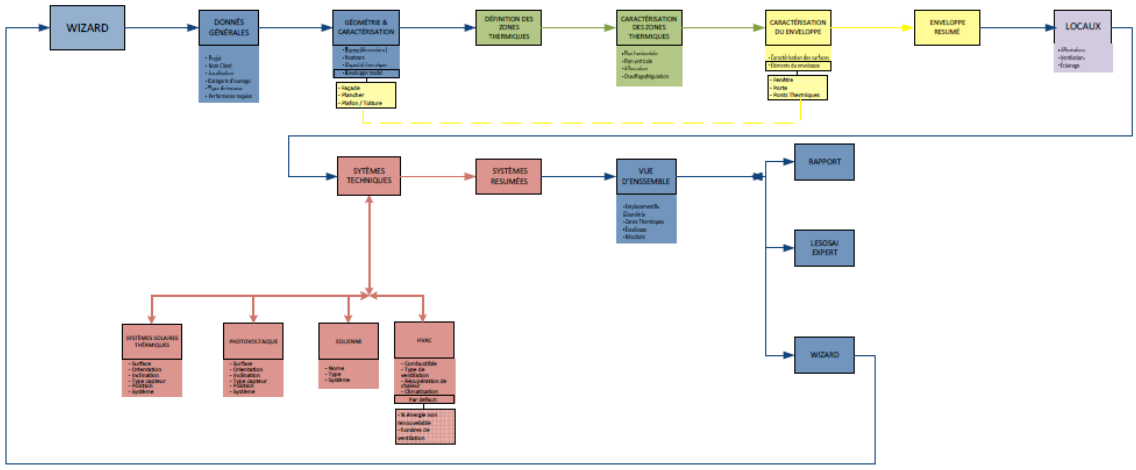


Fig. 7 Lesosai 7 wizard flowchart (shown only for its simplicity)

6. Interface description

This chapter does not present an extensive description of all screens and screens configurations that may appear, but is rather an insight on the principles that were applied and the graphical concept behind.
The best way to get a comprehensive feeling of an interface ergonomy is to use it!
All the screen prints were taken when working under the SIA2031 standard.

Performance requirement are not always an easy topic for an architect, therefore this screen was divided into 3 easy steps, energy usages (heat, domestic hot water,…), country selection, and finally performance standard to comply with (every standard is explained on the right):

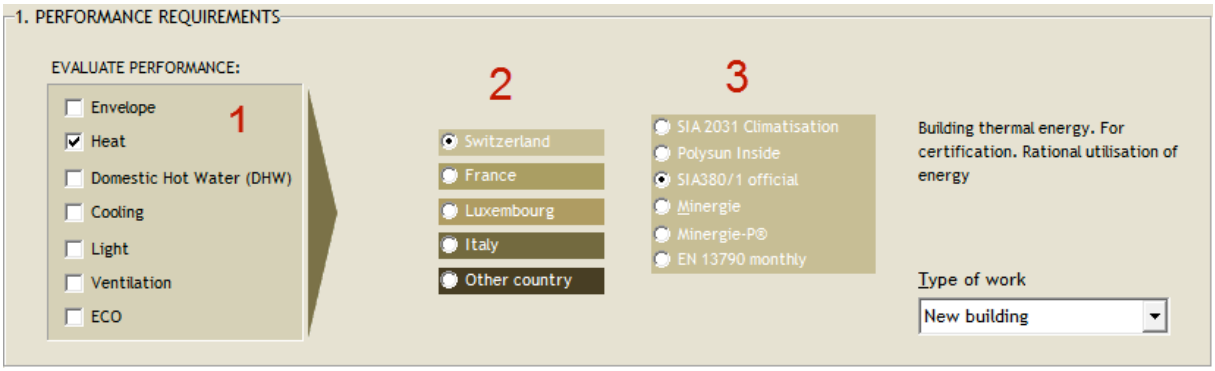


Fig. 8 Performance requirements

As another point that can be difficult to assess on the pre-project, particularly when sitting at the office, is the shading from mountains and building, some standard situations are presented that can be easily selected by the user:

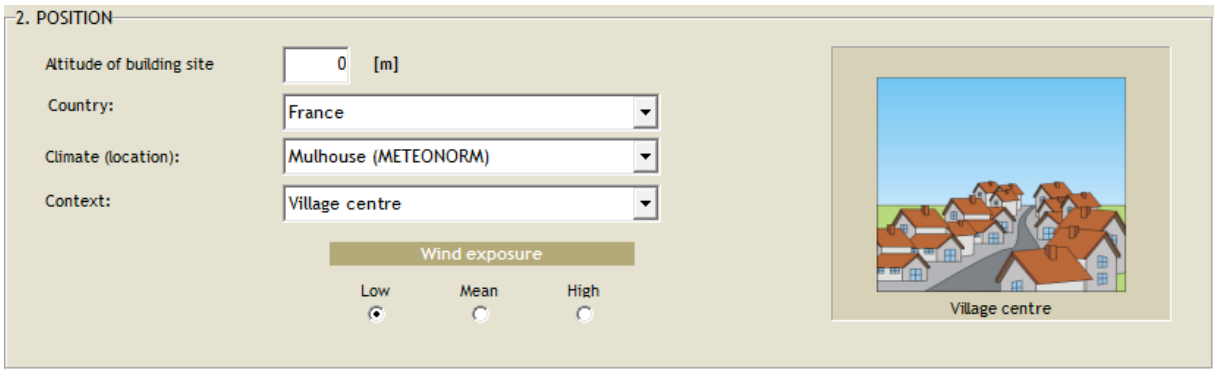


Fig. 9 Localisation

In the pre-project phase usually only the general form of the project is chosen; to accelerate the geometry build, pre-selected forms are proposed:

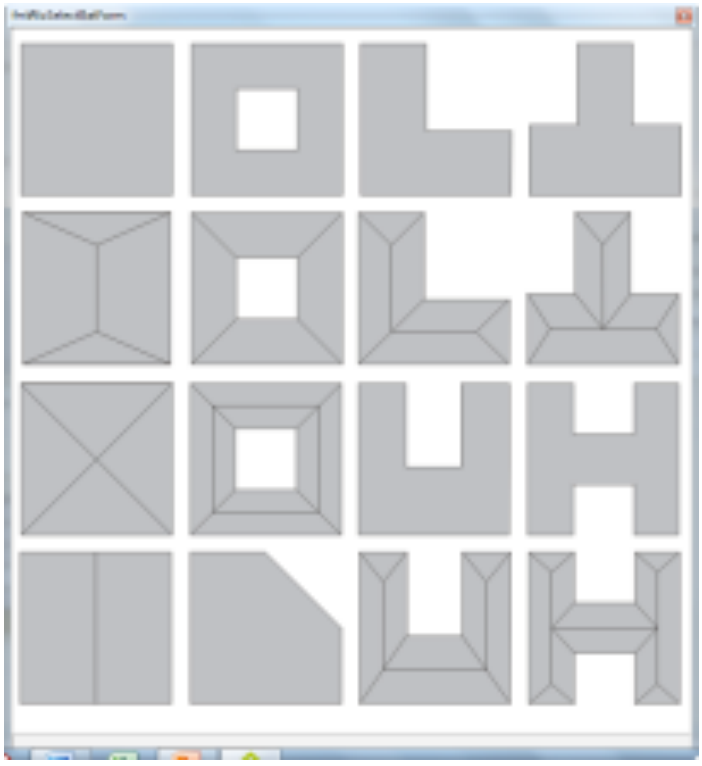


Fig. 10 Building general geometry

In the following screen, dimensions information to complete the definition of the building form (length, width, height, roof,…) is entered.

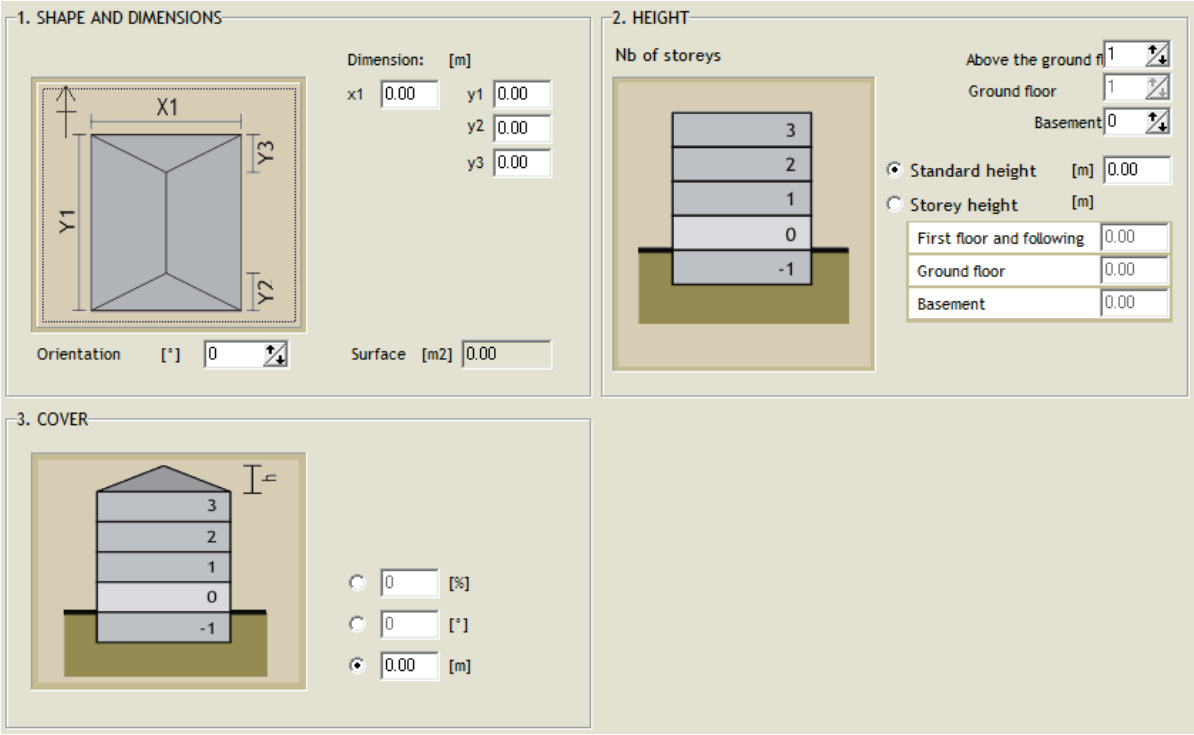


Fig. 11 Dimensions, storey & roof.

To define the external envelope of the building, over 80 different elements compositions (for walls, floors, roofs) are proposed, depending on the desired quality for the building and the situation of the component (against external, earth,…). All these elements are composed from materials that can be easily changed/adapted when in the final project:

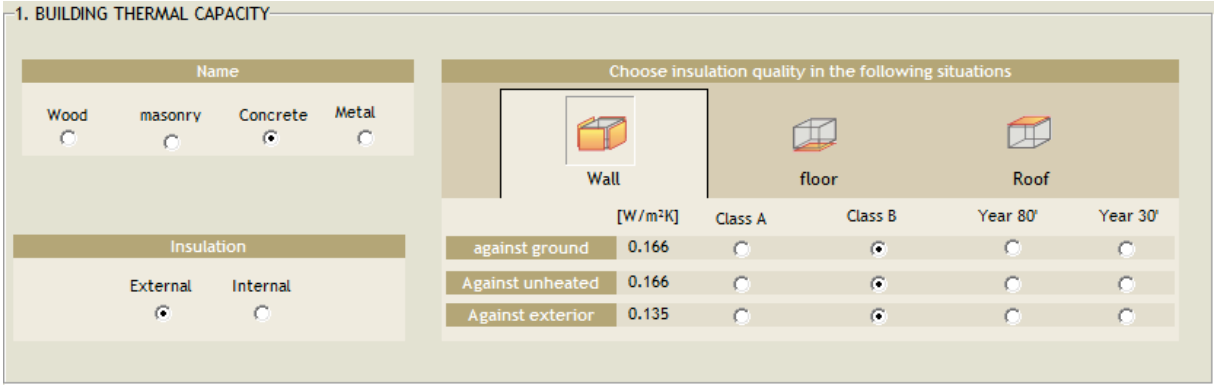


Fig. 12 Thermal capacity and insulation levels

The internal walls organization when in pre-project or in a retrofit situation are usually not precisely known. In Lesosai, three kinds of situations are proposed according to the density of the internal walls. This solution will be probably used in the future Minergie Eco label too.

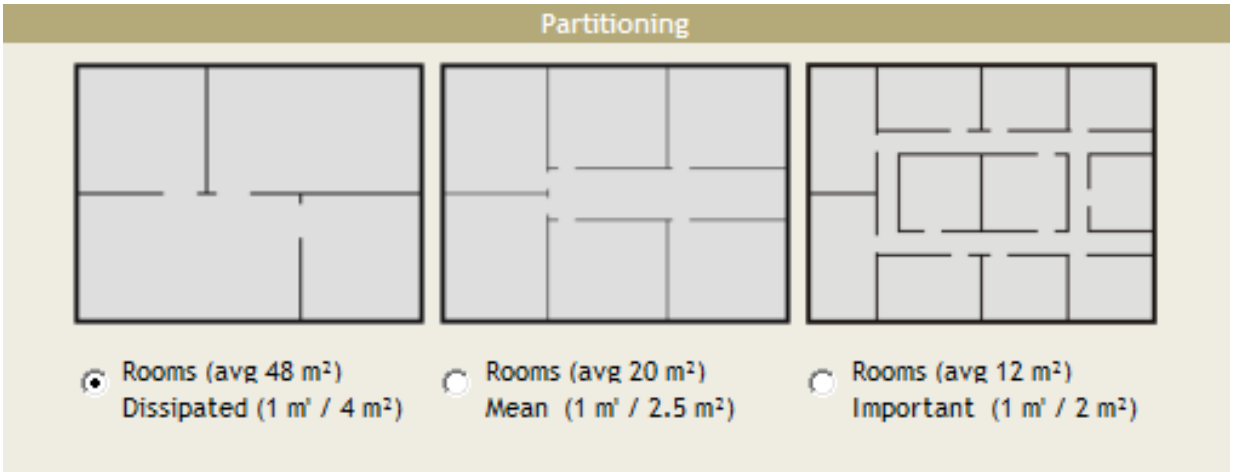


Fig. 13 Wall densities

For energy calculation it is crucial to define which zones are heated and which are not, this having a big impact on the results. In this screen, the user selects the part of the building he works on and just clicks on the zones that are heated.

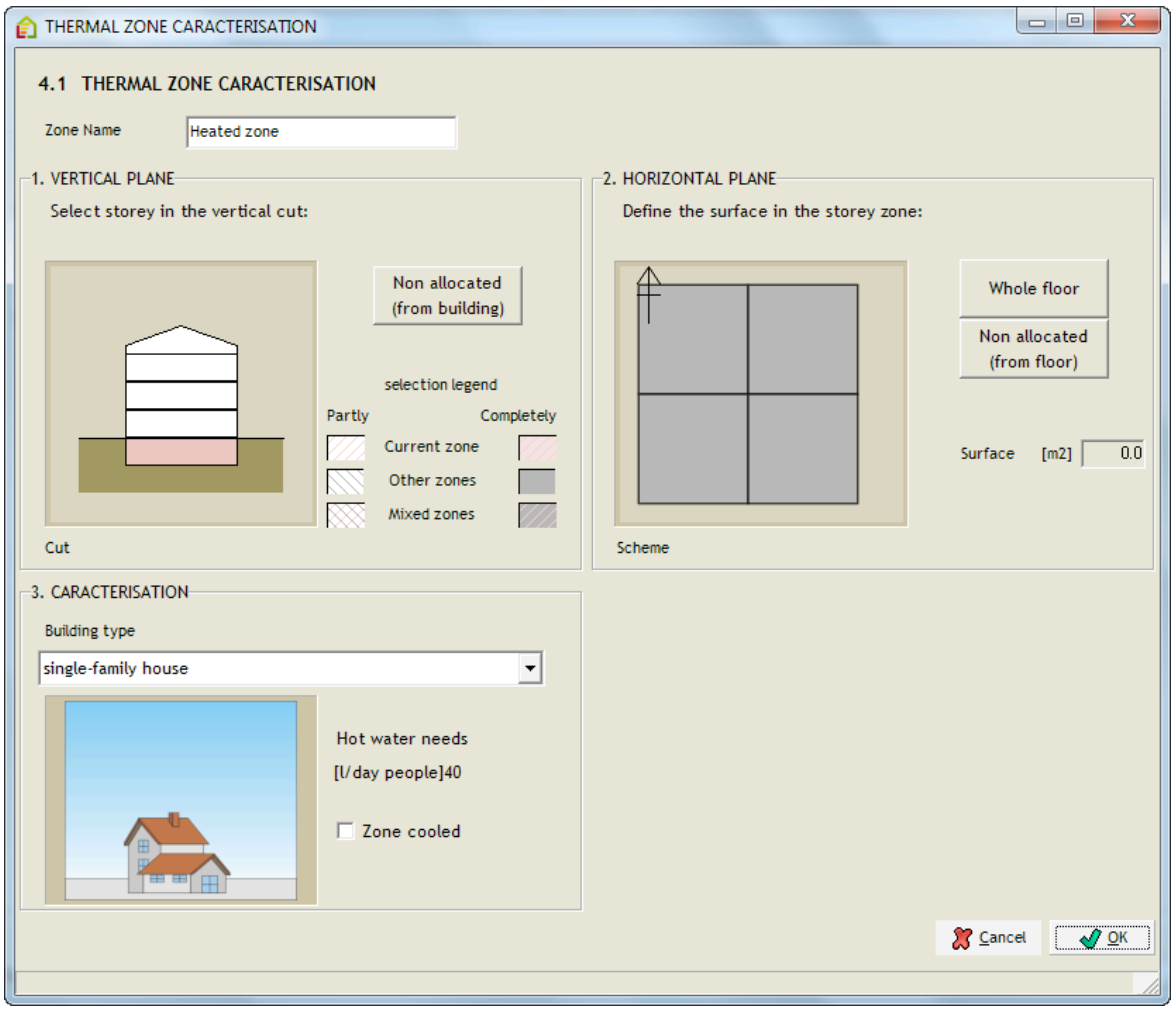


Fig. 14 Thermal zones, per floor level

Windows

The introduction of elements in the envelope can be really time consuming. This time has been reduced thanks to the following features:

- the official thermal bridge catalog (Federal Office of Energy)
- a windows catalog
- a frames catalog

In the window screen, several key elements are presented in an attractive and easy to understand graphical way. Glazing type, frame, spacing, thermal bridge U and G values are entered in one single screen.

The possible thermal bridges associated with each window types are proposed automatically for selection.

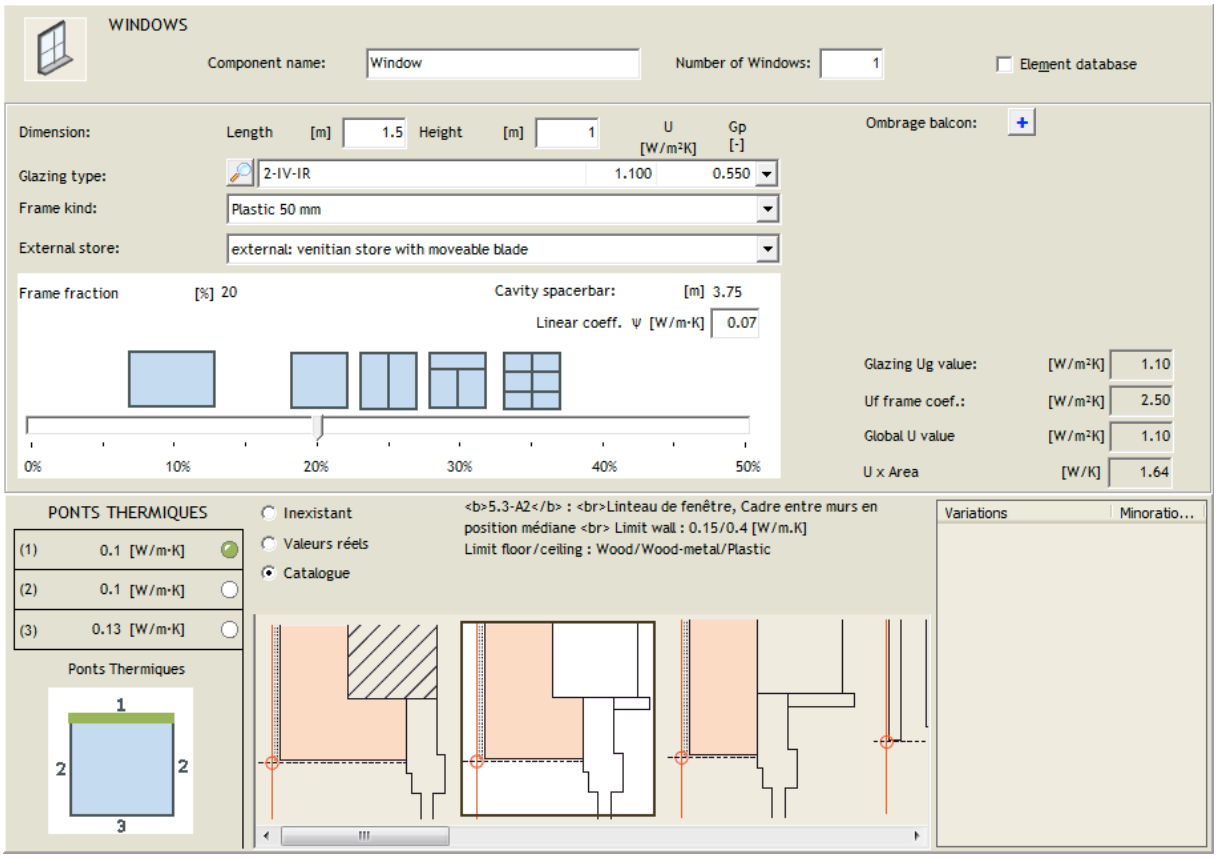


Fig. 15 Window definition / selection screen

Thermal bridges

The new thermal bridges screen has been completely redesigned by integrating the BEW catalog, hopefully bringing for the first time the possibility for architects to enter realistic thermal bridges values, by simply indicating their location and type.

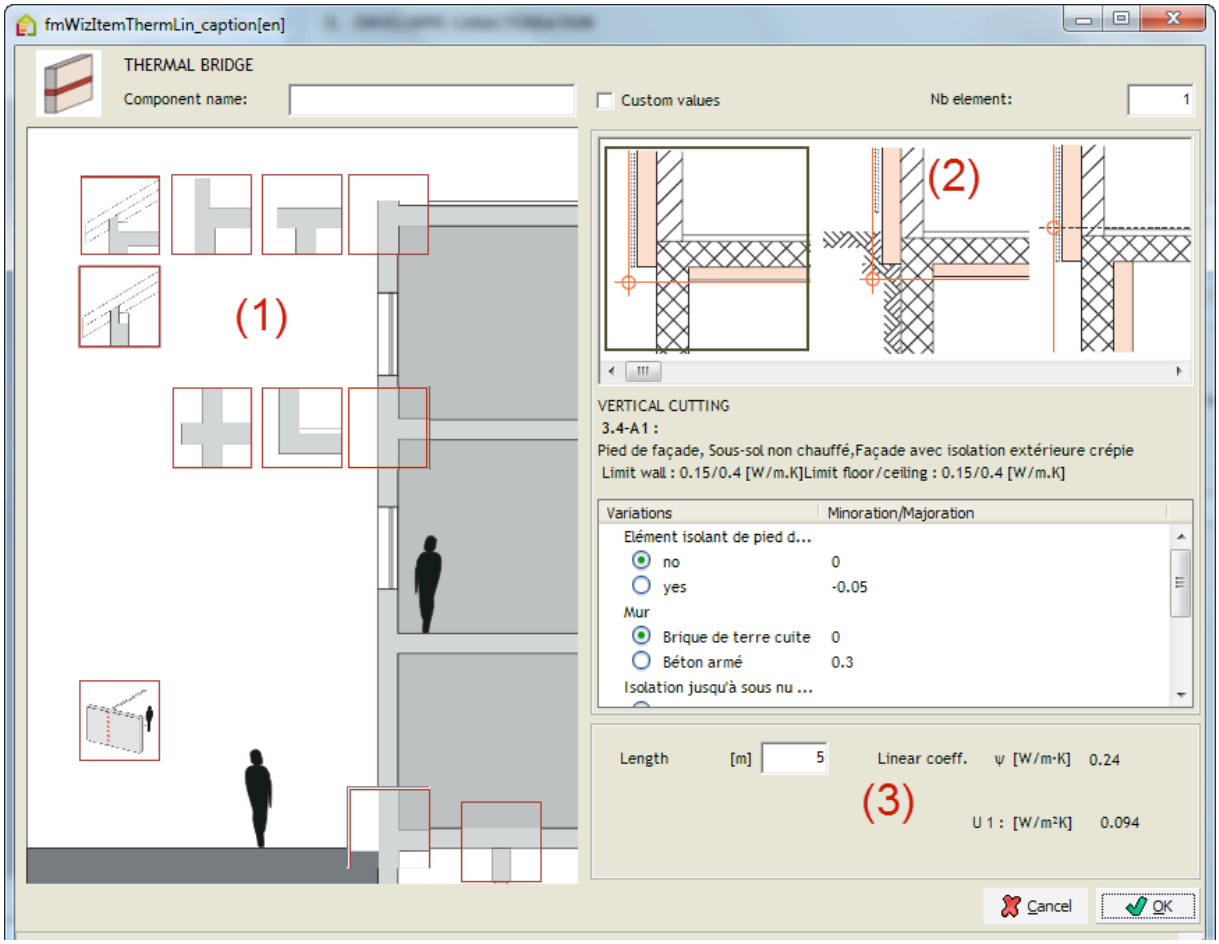


Fig. 16 Selection of thermal bridges locations and values

Visual feedback

For the first time in LESOSAI, there is a visual feedback on the actual situation of the façade part you are entering elements into, eliminating several potential mistakes.

Additionally, there is always the option to copy elements between façades and between storeys.

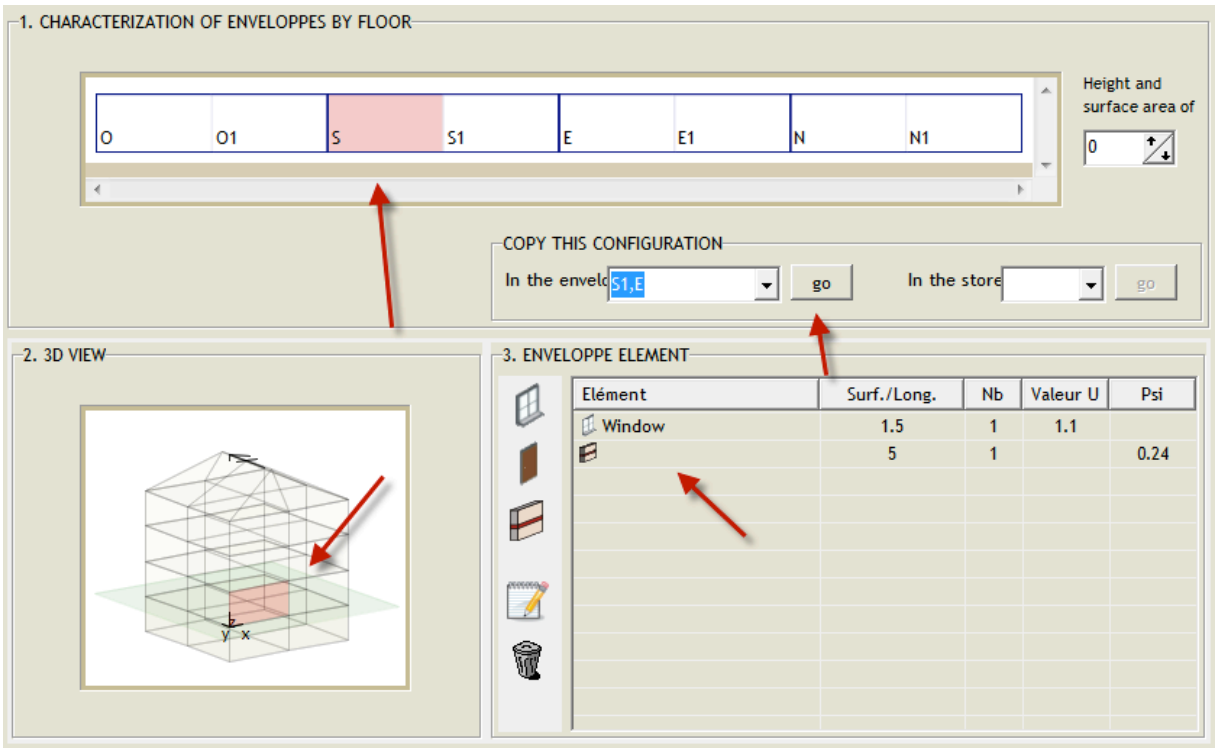


Fig. 16 Visual feedback on façade portion under work

If lighting and air conditioning are needed in the chosen standard, lighting schema defining average rooms' situations inside the concerned zone is possible.

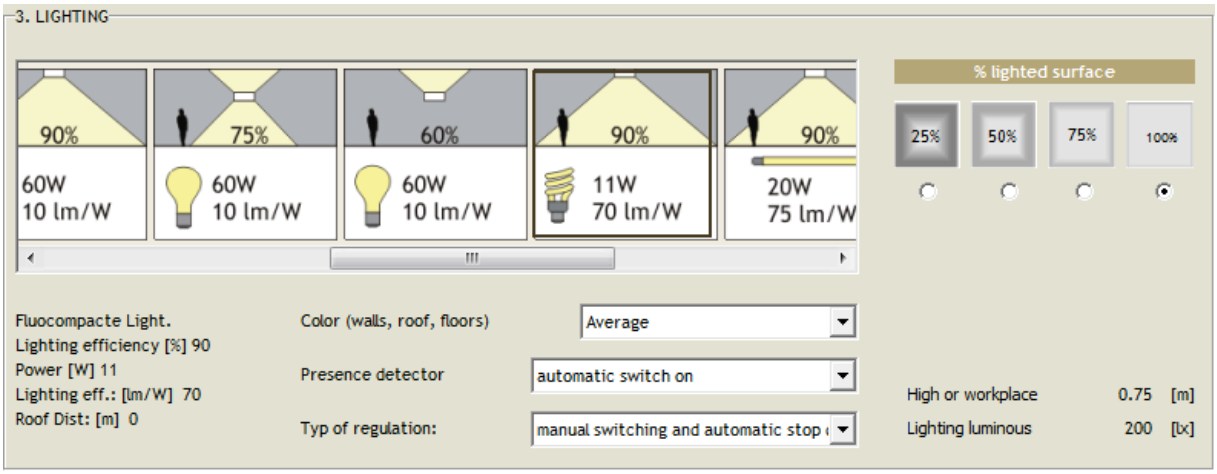


Fig. 17 Lighting strategies and technologies ready to be selected

Technical systems

The choice of technical systems is simplified in the wizard by using solutions inspired by a mixed of Luxembourg and Swiss standards.

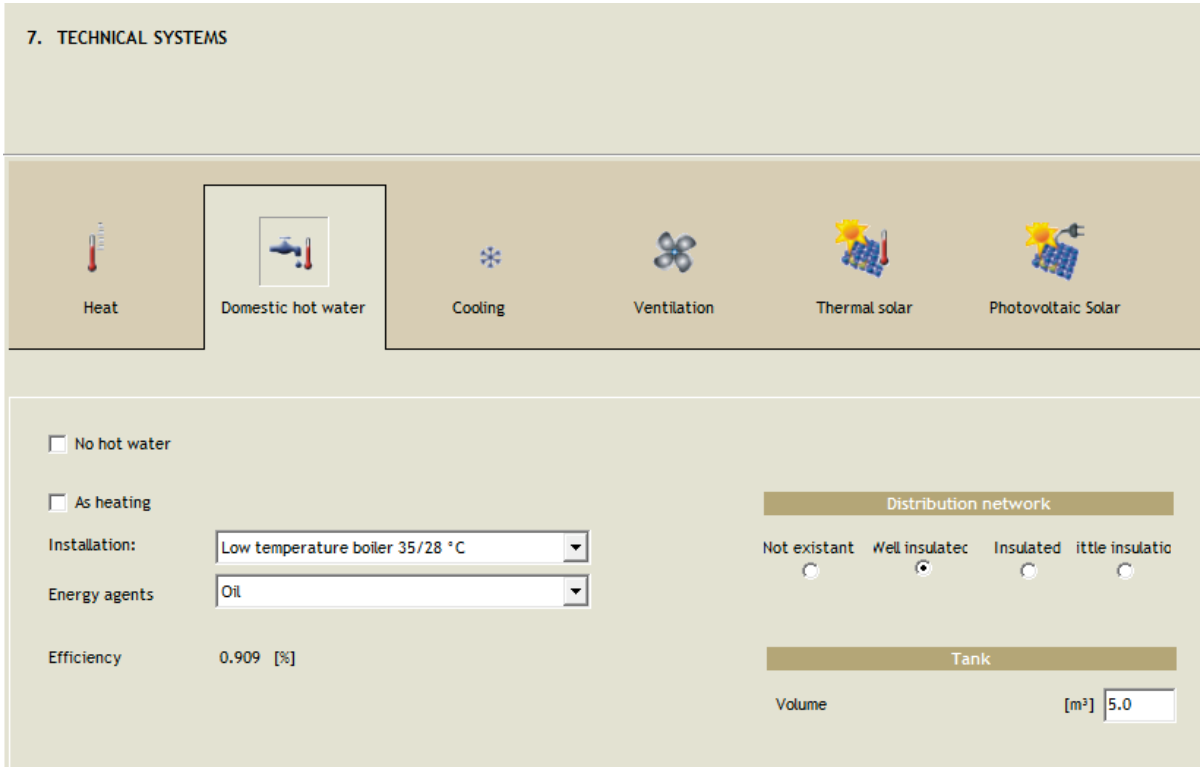


Fig. 18 Selection of technical systems

The wizard has also included the new part, the screen dealing with Polysun Inside, again drastically simplified when compared with the complete Polysun version.

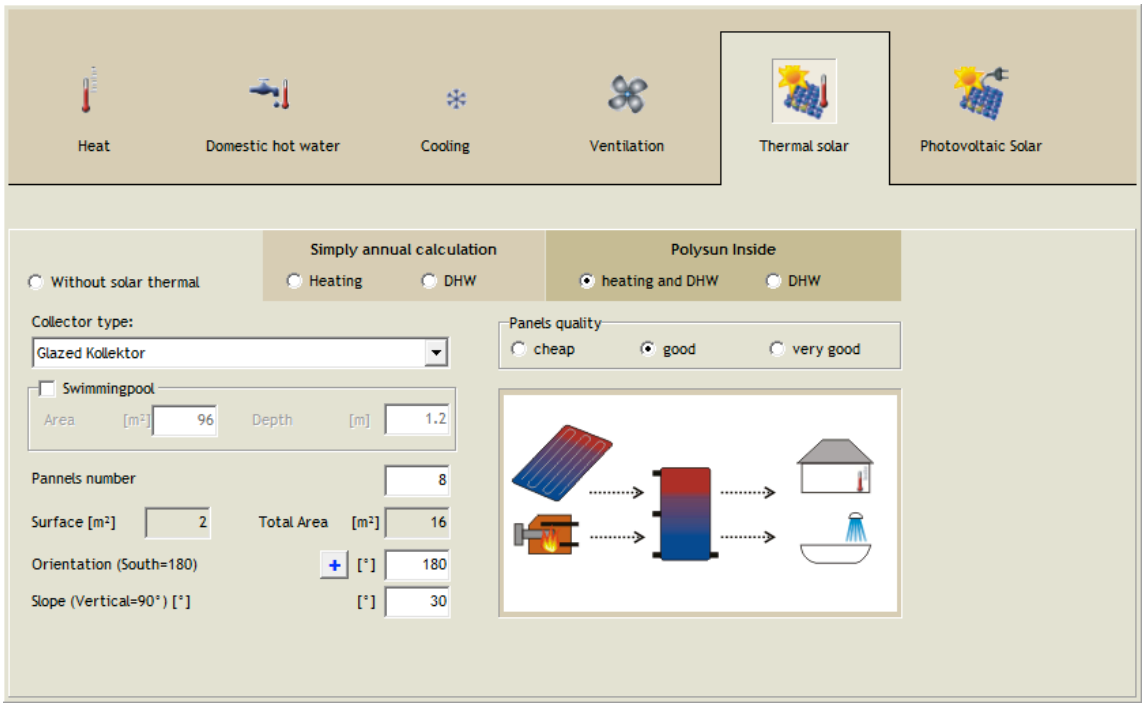


Fig. 19 Simplified interface for solar thermal

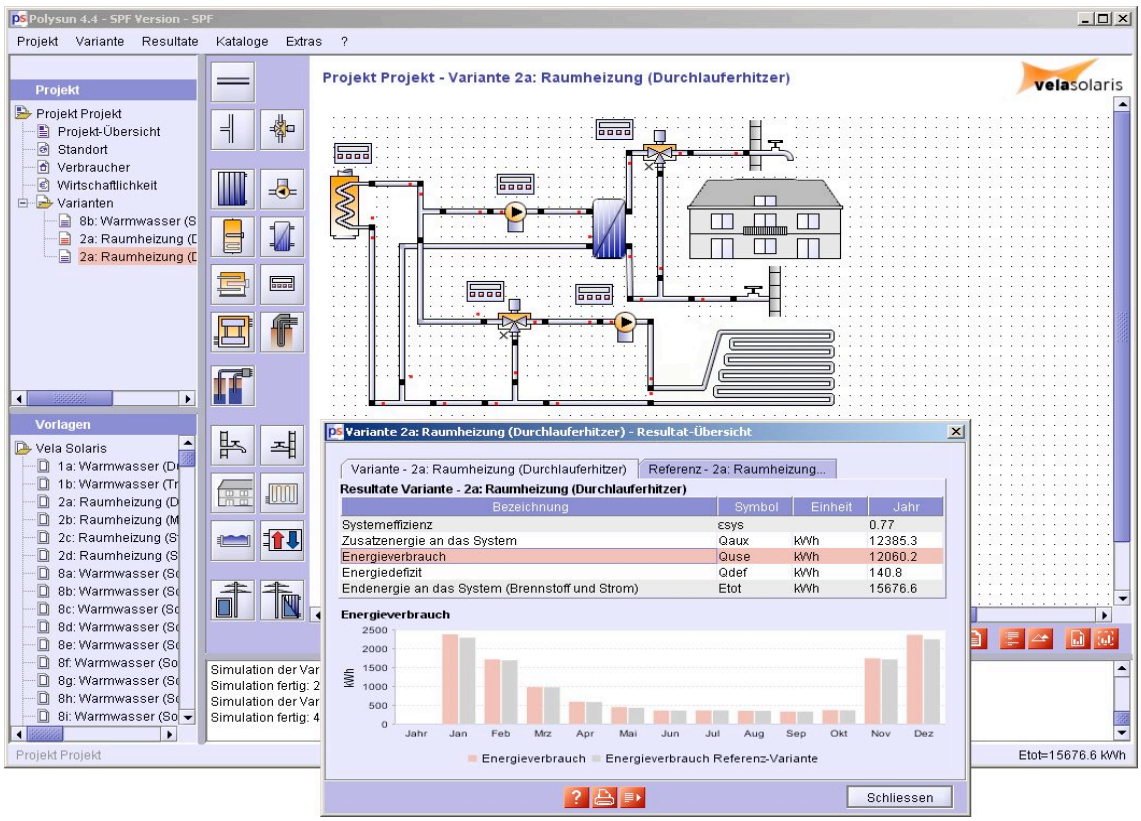


Fig. 20 Polysun screen for specialists as a comparison

After completing these screens, the user can view the calculation results, prepare another variant in the wizard or proceed to Lesosai 7.0 and fine tune the project.
For architects, when satisfied with one variant, they can transmit the completed wizard file to their engineering department people or external specialist who can adjust the needed element without re-entering the whole building:

Fig. 21 End of the wizard

And the results in Lesosai 7.0 from Polysun Inside:

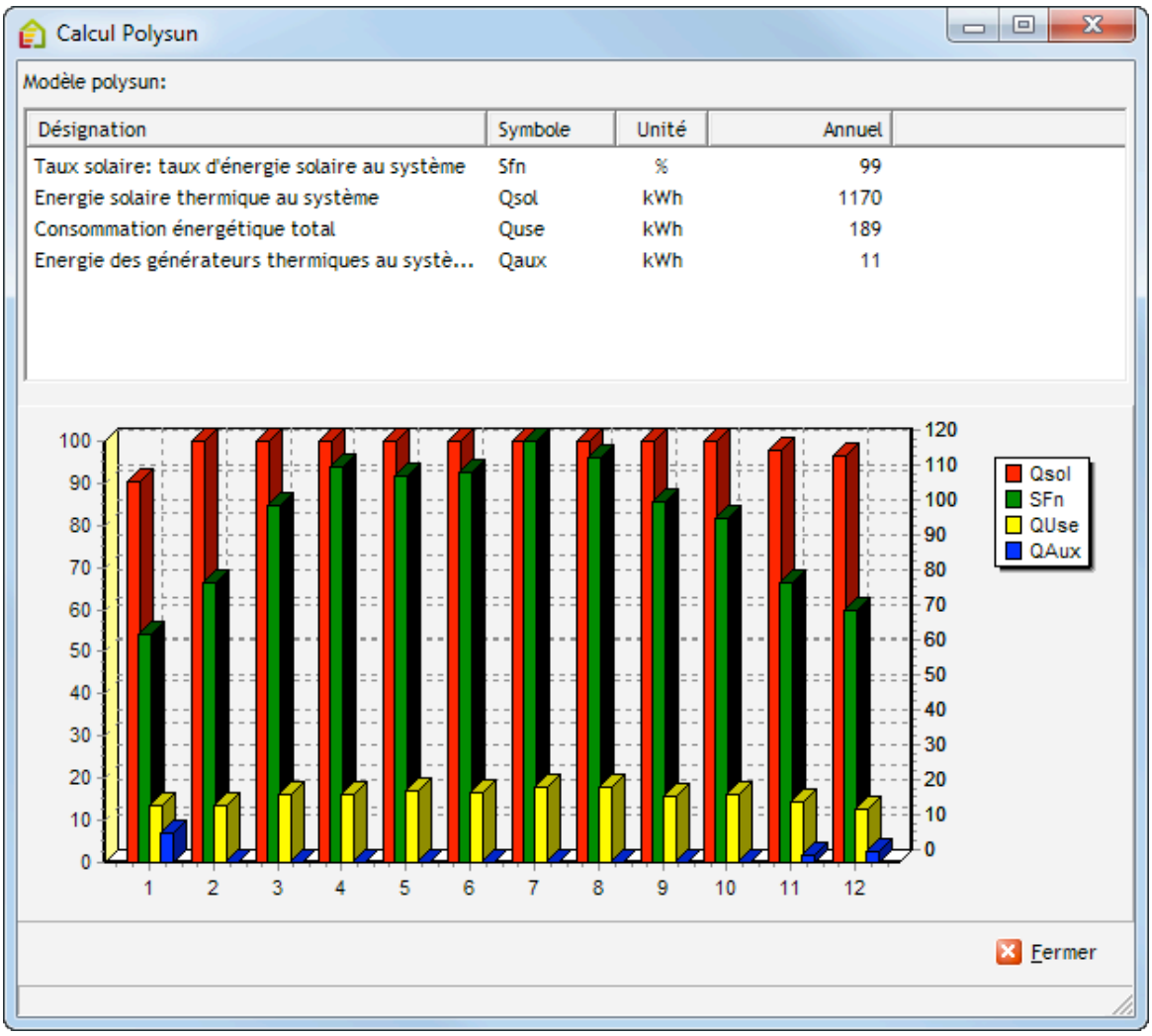


Fig. 22 Results from Polysun Inside module

Concerning solar use, another important point in this project is passive solar. In this release, the results for solar gains in the monthly and the hourly calculations have been improved. In the case of the monthly data, a table reports specifically gained and lost energy through the windows (particularly useful for SIA380/1 projects):

4.1b Fenêtres et portes-fenêtres

n°	désignation	Nb élém.	A [m²]	Atot [m²]	inclin. [°]	orient. [°]	$g_\perp$	Fs [-]	Uw [W/m²K]	Ug [W/m²K]	Uf [W/m²K]	Gains [MJ]	Pertes [MJ]
0	Fenêtre toit.1	1	246	246	0	S	0.540	0.85	1.41	1.50	1.20	313681	126899
0	Fenêtre sud	1	436	436	90	S	0.540	0.82	1.20	1.20	1.20	413266	191414
0	Fenêtre Heizkörper	1	65.6	65.6	90	S	0.540	0.82	1.20	1.20	1.20	62179	64796
0	Fenêtre est	1	625	625	90	E	0.540	0.74	1.20	1.20	1.20	384574	274389
0	Fenêtre ouest	1	730	730	90	O	0.540	0.68	1.20	1.20	1.20	438700	320486
0	Fenêtre nord	1	3	3	90	N	0.540	0.90	1.20	1.20	1.20	1175	1317

Fig. 23 Gains and losses through windows

For the hourly standards (EN ISO 13790, SIA2031,…) a special screen has been added providing an easy way to analyze the yearly and monthly gains of a windows (the hourly option is in form of a text file that can be exported):

This table can help see which windows and which blind situations can provide heat in winter while avoiding overload cooling in summer. In Lesosai 7.0 (outside this project) it is even possible to mix the solar gains with natural ventilation through a window in a room (following the SIA2028).

Finally, when the wizard part is completed, it is very easy to transfer the project in Lesosai 7.0. for further work.

Global changes can be made, for example by modifying the project database. In the screen below, changing the U value data in the model will change all the green walls in the 3D picture:

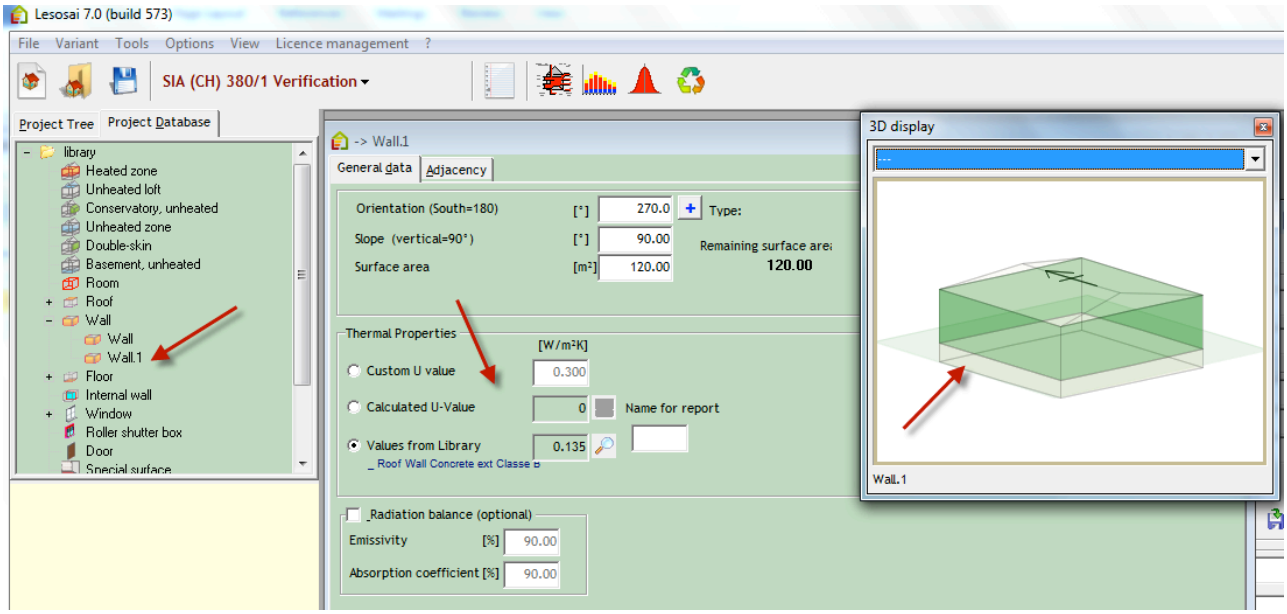


Fig. 24 Library element change in Lesosai 7.0

Moreover, Lesosai 7.0 has also added many more improvements that aren't described in this report but can be tested by downloading the software.(*www.lesosai.com*)

As explained in the introduction, the last part of the report describing the activity of Vela Solaris is contained in a specific part of the report, written by Andreas Witzig, with its own numbering and references, attached at the end of this document.

6. Conclusions

The official release on September the 29th of the new version of Lesosai 7.0, including the "wizard" and the module "Polysun Inside" is the best proof of the project's successful completion. Both industrial partners have reached their goals in improving their offer, while serving the general interest in helping to make a better and increased use of solar energy and building efficiency. The LESO has brought an innovative way to help architects dealing with these issues at an early design stage, when major decisions are taken. Diffusion of this concept will be done at Conferences (PLEA 20011,…) and within IEA Task 41 "Solar Energy and Architecture", to further spread this approach on an international level.

All three partners wish to thank the Federal Office of Energy to have made this progress possible.

7. Publications

– A. Witzig, U. Stöckli, S. Geisshüsler, J. Thaler: *Solarsimulation in verschiedenen Anwendungsbereichen: Polysun als universelles Plugin.* Publikation im Tagungsband des 19. Symposiums für Thermische Solarenergie des OTTI, 6. bis 8. Mai 2009, Kloster Banz, Bad Staffelstein, Deutschland. http://www.velasolaris.com/vs2/files/2009-05-otti-solarthermie-polysun-plugin.pdf

– A. Witzig, F. Foradini, M.-C. Munari Probst: *Simulation Tool for Architects: Optimization of Active and Passive Solar Use.* Published in the proceedings of the international conference CISBAT, 2-3 September 2009, Lausanne, Switzerland. http://www.velasolaris.com/vs2/files/2009-09-cisbat-polysuninside.pdf

– Vela Solaris AG and Data Design Systems GmbH: Pressemitteilung "DDS-CAD Polysun Inside: Ertragsberechnung und Wechselrichterzuordnung direkt aus der CAD Software" http://www.velasolaris.com/vs2/files/presseinformation_dds-polysuninside.pdf

-- Presentation by Flavio Foradini at BiSol workshop in Lugano, 16-17 Nov. 2009 **"***Lesosai 7.0: Les outils de simulation dédiés aux architectes"*

-- Presentation of the wizard concept and GUI, in "LESO Lunchtime Lectures", by Marja Edelman, EPFL Sept. 3rd.2010

-- Presentation by Flavio Foradini at EPFL in Lausanne, 29-09-2010 **"***Lesosai 7.0: official release"*