Example name: Solar window

Template completed by:
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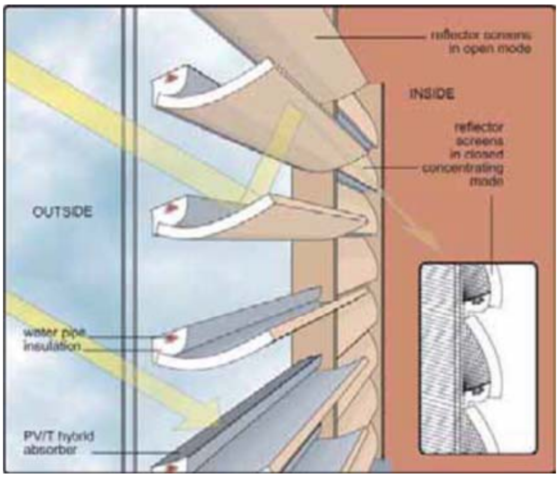


For installations

BISTS *Location: Lund, Sweden 55.7N, 13.2E*
Climate Type: *Cfb*
Building Use: *residential*

Level of BISTS integration
Rush level 4 / Reijenga level 4

O New Build
~~O~~ Refurbishment
O Other: ……………………

Type of BISTS:

~~Active/Passive~~/Hybrid

Function(s):
O Air heating
O Water heating
O Combi-system
~~O~~ Cooling/ventilation/shading
~~O~~ PV/T
O linked to another system (e.g., heat pump)
O Other: ……………………….

Building element:

O Facade
O Roof
~~O~~ Other: Window

BISTS characteristics:

The Solar Window provides PV electricity and heated water, in addition to passive space heating and day lighting. The integral reflector screens also provide shading and additional envelope insulation. The reflectors have an optical concentration factor of 2.45. The system is a visible element in the exterior and particularly in the interior, and its performance is directly connected to the user behaviour, due to the operation of the reflectors, which can be switched between a closed, concentrating mode or an open, transparent mode.

Stage of Development:		**Responsible:**
~~O~~	Idea/Patent	Department of Construction and Architecture, Lund University
~~O~~	Prototype	Department of Construction and Architecture, Lund University
O	Demonstration	…………………………………..
O	Integral building element	…………………………………..
O	Commercially available	…………………………………..

BISTS description and context

The presence of the hybrid PV/T system inside a window makes it highly visible from the exterior as well as the interior. One of the basic ideas behind the design was to express the building integrated solar energy system architecturally in an attractive, maximally exposed way. The curved concentrating geometry is decorative and expresses the capturing nature of a solar energy system. The backside facing the interior could be covered with any surface material suitable for the interior context. The modular nature of the reflectors, with no connection to the energy distribution, makes it possible to exchange them for alternative surface, thickness or reflecting geometry. The concave front facing the window will be highly visible from the exterior, and the mirror like surface might be the most critical aesthetical property for a wider acceptance. However, the curved mirror can generate interesting optical expressions in the façade. The overall impression of the façade will hence change when approaching it. The mobility of the reflectors also contributes to a dynamic façade expression.

System viability

Performance of a 1 m^2 prototype of the system, regarding its sun shading and U-value properties and its photovoltaic and active thermal output, has been monitored. For a two-pane anti-reflective window, the U value is reduced from 2.8 to 1.2 W/m^2K with the reflectors closed, calculated from measurements in a guarded hot-box, according to ISO 8990. The annual transmittance through the window is estimated to 609 kWh/ m^2, of which approximately 10% is expected to be delivered by the PV modules. About 20 % will be delivered as active solar heat and 30% as net passive space heating.

Performance of the system has been analysed separately for passive gains, active thermal gains and PV electricity yield. According to a proposed regulating schedule, passive gains are estimated to 210 kWh/m^2 annually. The performance of the fully concentrated PV/T absorber is estimated to 79 kWh/m^2 of electricity, and at least 155 kWh/m^2 of heat for domestic hot water. Production costs for the Solar Window excluding the glazing are estimated to approximately €250/m^2.

Modelling and simulation tools developed/used

The visual shading effect of the reflectors was determined using a two-dimensional ray-tracing analysis, made by hand in a CAD program.

The solar shading effect of the reflectors on the building was determined by using the computer tool Parasol.

Simulation software, MINSUN, estimated the annual output of electricity using the optical efficiencies at different angles of incidence.

BISTS Performance data

Based on:
O Estimation
~~O~~ Detailed simulation
~~O~~ Measurement/testing
O Long-term monitoring

Performance parameters

For integrated systems:
key performance indicators -

U value 2.8 to 1.2 W/m^2K

For separate collectors:
performance rating coefficients -

Other:

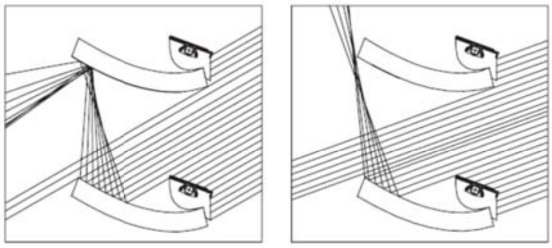
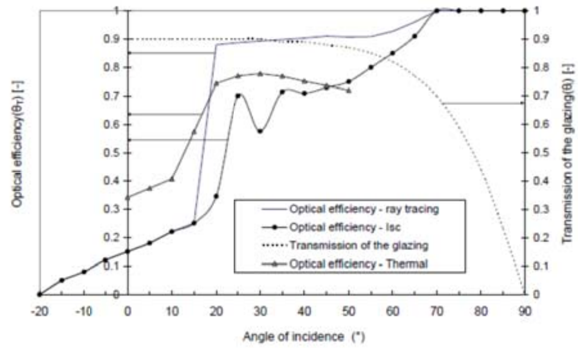
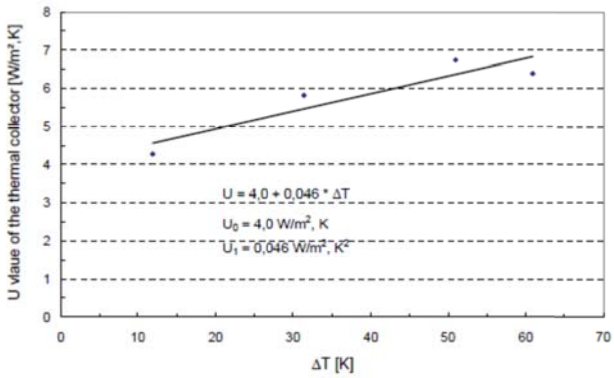


Figure 5: Ray-tracing illustrating the distribution of direct radiation with the reflectors opened at a solar height of 30° (left) and 20° (right).





Additional information:

Sources and references:

(Fieber 2003) A. Fieber, H. Gajbert, H. Håkansson, J. Nilsson, T. Rosencrantz, B. Karlsson, Design, Building integration and performance of a hybrid solar wall element. Proceedings of ISES Solar World Congress 2003 Gothenburg, Sweden

(Fieber 2004) A. Fieber, J. Nilsson, B. Karlsson, PV performance of a multifunctional PV/T hybrid solar window. Proceedings of 19th European photovoltaic solar energy conference and exhibition 2004, Paris, France