Multi-functional Lightweight PV Louvres

- Results from the European fp5 project "PV-Light"

Technology sheet

Technology

- Lightweight PV generation
- Sun shading
- PV louvre solar control tracking system

General information

- Technology developer:
  - Zentrum für Sonnenenergie- und Wasserstoff-Forschung Baden-Württemberg (ZSW), Germany
  - COLT INTERNATIONAL HOLDING B.V. , The Netherlands
  - GSS GEBÄUDE – SOLARSYSTEME GMBH, Germany
  - WÜRTH SOLAR GMBH & CO. KG, Germany
  - ISOVOLTA AG, Austria
- Date of issue (year): 2006

Aims and Objectives

In contrast to the common solitary add-on approaches, the 'PV-light' project aimed mainly at the development of lightweight PV solar control systems with an enhanced PV integrated in solar lourvre systems, in order to offer to building market a high level of functional and architectural integration of the PV element into façades and roofs.

It was expected that the weight reduction could permit the substitution (at least in part) of glass components of PV modules by flexible membranes; and the application of self-regulating thermohydraulic solar tracking systems could optimise both temporal (daytime, seasons and weather) shading and PV energy generation.

The technical target defined in the project was to reach a louvre weight without frame < 2.5 kg/m² (c-Si technology, short term) and < 0.5 kg/m² (CIS technology, long term).

As project's testing activities, a PV solar control demonstrator system with the ZSW-patented Counter-Tracking Louvres (CTL) technique should be fabricated for further indoor and outdoor experimental evaluations of the daylighting, thermal, and PV performance. Based on the experimental data, a validated parameter set will be extracted for dynamic building simulation of different building types in different climatic conditions.

A Short Description of the Technology :

PV in buildings is an attractive way to achieve renewable energy generation. PV louvres fulfil several functions such as efficient shading of the direct portion of the sunlight to prevent overheating of the building, sufficient daylighting to avoid artificial lighting, and PV energy generation through the embedded cells.

The basic configuration of a PV louvre solar control system is the classical way as a curtain façade covering the full glass façade/window. One disadvantage of the PV's application in solar lourvre system is the need to encapsulate these PV cells into thick glass louvres so that they can be supported over wide spans. In fact, conventional glass louvres (6/4 mm laminated PV glass louvre) have a weight of around 30 kg/m². Therefore, conventional PV solar louvers can impose heavy loads on the building and require a larger supporting structure. Moreover, the relatively thick glass means also that the amount of light falling onto the cells and the consequent power output is reduced.

For new PV lourvres developed by the project, weight reduction is achieved by substituting glass components of PV modules (at least in part) by flexible membranes; In other word, crystalline silicon as well as CIS thin-film photovoltaic cells are embedded in foils and textile membranes to obtain lightweight solar-control louvres. Glass can be totally avoided for c-Si technology, while for CIS technology a substrate glass is still needed in the medium term. However, although even in this case the membrane approach gives access to more than 50% of glass and thus weight-reduction.

In addition, the following technical targets were defined by the project:

- Louvre weight: <2.5 kg/m^2 for c-Si technology (crystalline Silicon), <0.5 kg/m^2 for CIS technology (CuInSe2-based thin-film PV)
- Power to weight ratio: 60 Wp/kg for c-Si technology, 200 Wp/kg for CIS technology
- PV system cost: <4 euro/Wp

Further, solar control systems were designed for façade and roof integration, which shall be applicable for new buildings as well as for retrofit of all kinds of buildings.

In order to give the access to the highest specific energy harvest possible for flat plate PV, the ZSW-patented Counter-Tracking Louvre (CTL) technique has been adopted, and the inherent self-shading effect of conventional synchronous tracking PV louvres can be overcome by two sets of counter-tracking louvers.

The kinematics and the support structure for the Counter-Tracking Louvre technique has been developed. n fact, the use of CTL-technique permits to obtain an energy harvest advantage of 18% - 33% over the conventional synchronous tracking mode depending on climate and application.

European Project "Eco-Building International Club for advanced European sustainable energy technology dissemination in Europe and China"

Project partners:

ENEA (IT), ISNOVA (IT), FINCO (IT), ADEME (FR), AIMCC (FR), DTI (DK), DI (DK), CRES (GR), EBHE(GR), GPREC (GR), SEC(B), ZERI (CN), CBEEA (CN)

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A further advantage of this new lightweight PV lourvre is that the solar energy control can be realised with the very simple and robust thermohydraulic solar tracking system. Due to its thermohydraulic working principle, the CTL system moves solar shading louvres to their optimum position without the use of electrical power or a sophisticated electronic control system. In practice, There are two absorber tubes fixed to the top and bottom of a louvre blade (see picture on the right side) and filled with a special CFC-free thermo-hydraulic fluid. Moreover, each tube has a limited "field of vision" targeted towards the sky and are connected with a hydraulic cylinder. As the sun moves across the building, if the louvers are not optimally aligned to the sun, one tube is more strongly irradiated and heats up whilst the other will cool down, thus the difference in temperature generates a difference in pressure, which causes the fluid expands or contracts in each tube to rotate the louvres. Both tubes are linked to an actuator which will operate the louvers depending on the optimum shading position.

PV-BI	Façade	Façade	Roof	Flat-roof
System orientation	South	West/ East	South	Hori-zontal
System. Inclination	Vertical	Vertical	30°	0°
Axis orientation	Horizon tal	Horizon tal	North-South	North-South.
Central European Climate 100% = 1145 kWh/m²a				
Fix integrat.	69 %	54 %	**100 %**	89 %
STL	79 %	64 %	103 %	90 %
CTL	98 %	76 %	**122 %**	**112 %**
CTL advantage (in percent)				
CTL vs STL	**23 %**	18 %	20 %	**24 %**
CTL vs Fix	**42 %**	41 %	22 %	27 %
South European Climate 100% = 1807 kWh/m²a				
Fix integrat.	65 %	52 %	**100 %**	88 %
STL	69 %	56 %	102 %	91 %
CTL	92 %	70 %	**125 %**	**114 %**
CTL advantage (in percent)				
CTL vs STL	**33 %**	26 %	22 %	24 %
CTL vs Fix	**42 %**	35 %	25 %	30 %

Results and Achievements

First PV membrane louvres have been manufactured. A final version of the PV louvre system has reached a total weight of 17.2 kg/m^2 for the entire system, including PV louvres, kinematic components, drive and mounting parts, compared to a similar conventional glazed Shadovoltaic louvre system of approximately 45 kg/m^2.

Simulations have demonstrated that the CTL-Technique permits the lourvres system to have a 20% higher specific PV energy gain compared to any other fixed or movable PV system concept, and meanwhile a 20% higher daylighting potential. Therefore it is possible to obtain the same energy harvest per m² with only 80% of PV cell power.

The table on the lift side reports the simulation results the irradiance at the PV cell. The 100% (normalised) value is a fixed tilted system 30° inclined to South. Two European climates have been taken into consideration.

Possible application area:
Façade and roof integration, applicable for new buildings as well as for retrofit of all kinds of commercial and public buildings.

Reference: the project was supported by EU DG TREN under the EU 5th Framework Program.

The project aims at promoting and widespread disseminating EU innovative Research and Technology Development and Demonstration results, as well as eco-sustainability criteria in building sector, which include:

- energy efficient building materials, components and systems not yet introduced into the building market or in their first market phase;
- innovative applications of heating/cooling and power supply technologies, combined with the use of renewable energy sources, in building sector;
- best EU demonstration eco-building projects.

Contact person for further information

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