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Designing Architecture with Solar Building Envelopes

Among the general public, solar thermal energy is currently associated with dark blue, rectangular collectors on building roofs. Technologies are needed for aesthetically high quality architecture which offer the architect more room for manoeuvre when it comes to low- and plus-energy buildings. With the “ArKol” project, researchers at Fraunhofer ISE together with partners are currently developing two façade collectors for solar thermal energy generation, which permit a high degree of design flexibility: a strip collector for opaque façade sections and a solar thermal blind for transparent sections. The current state of the two developments will be presented at the BAU 2017 trade fair.

As part of the “ArKol – development of architecturally highly integrated façade collectors with heat pipes” project, Fraunhofer ISE together with its partners is developing two new-style façade collectors from the concept through to readiness for application. Both developments are intended to be much more flexibly integratable into the building envelope than standard collectors currently on the market, and in this way make the architectural integration of solar collectors in façades more attractive. Through the multifunctional nature of the building envelope and the use of mass-produced sub-components, the costs of solar generated heat are however far lower than those of conventional solar thermal collectors. In recent months, the project team has been able to specify two highly promising approaches to the problem. On the one hand, it is working on a strip collector for which the distance and the material between the strips can be freely selected. On the other, a solar thermal blind is created which can be inserted between glass panels. Both developments use heat pipes with a dry thermal connection to the collection duct, and in so doing enable a flexible design of the solar collector. As a result, the collectors can be optimally integrated into standard building envelopes.

Architectural design diversity: strip collector

The first product concept consists of strip-shaped heat pipe collectors which are variable in length and which can be attached flexibly. The heat pipe concept is designed to enable all alignments, including in the horizontal direction. Due to the particular connection to the heat collector, researchers anticipate that a reduced thermal resistance will be possible. The collector connection is provided in the form of a heat pipe which engages in a form-fit manner with a corresponding extruded collection duct. It also enables an infinitely variable, flexible distance of the individual heat pipes,

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thus further contributing to the individualization of the application. “The strip collector combines a high level of efficiency with architectural design diversity”, says Dr.-Ing. Christoph Maurer, Head of Team Solar Thermal Facades, at Fraunhofer ISE. “Classic materials such as wood or plaster, structures and colours can be used in the area between the glazed collector strips.” Through the use of heat pipes based on string-pressed profiles, the project team anticipates a realization of different collector string lengths at a low production cost. In contrast to collectors through which fluid flows directly, the connection of heat pipes of different lengths to a shared collection duct is hydraulically unproblematic. The modular structure of the collector and the “dry” connection of the heat pipe to the collection duct also lead to simpler maintenance of the collector and to lower installation costs.

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Energy efficiency and transparency: solar thermal blind

The second product concept is a solar thermal blind which for the first time enables the energetically optimal regulation of the energy flows through the façade. In order to achieve this effect, blind slats can be used with spectral selective coating. Heat is transported via a heat pipe from the slat to the side collection duct. If external blinds are not required or are not possible, blinds are already now being inserted between two glass panes. “These blinds reach high temperatures, which increase the cooling requirement of the building. The solar thermal blinds can move just as freely as a normal blinds, but at the same time, they deliver heat and reduce the amount of energy entering the interior of the building”, says Maurer. The switchable connection to the collection duct enables the use to turn and gather up the blind. In this way, the sun protection and heat gain functions can be regulated depending on the position of the sun. If the connection is opened and the blind is gathered up, the passive solar yields can reduce the heat requirements of the building. Compared to the opaque or semi-transparent collectors used to date, this means switchable energy management. The use of heat pipes for thermal coupling makes the use of movable lamella technically possible for obtaining energy in the first place. Due to the ability to regulate and if necessary the complete removal of shading, together with the design of the collector as a blind, this façade collector is highly suitable for use in ecological multi-storey buildings.

The **“ArKol” project** started work at the beginning of 2016, and is funded by the Federal Ministry for Economic Affairs and Energy (Bundesministerium für Wirtschaft und Energie). During the first 18 months, the project partners are in the process of developing detailed cost-optimal sub-functions for the façade collectors. In 2017, the sample collectors will undergo the first laboratory tests at Fraunhofer ISE. In 2018, the simulation models will be measured and calibrated. On their basis, it will be possible to precisely forecast the advantages of the technology. By the project completion date in 2019, a demonstration façade will be completed for each of the two technologies. A follow-up project immediately afterwards is already planned for 2020, with which the technologies will first be realized on a commercial basis. Interested architects, building owners and planners are welcome to contact Dr.-Ing. Christoph Maurer now.

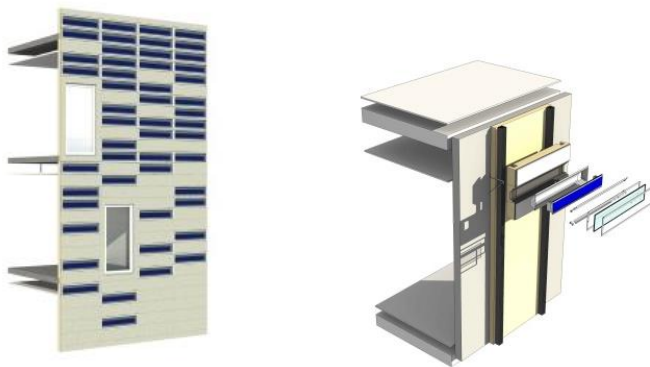
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At the BAU trade fair from 16 to 21 January 2017 in Munich, the Fraunhofer ISE will present its new developments within the scope of the “ArKol” project. Visit us at the Fraunhofer-Allianz BAU stand in Hall C2, stand 538.

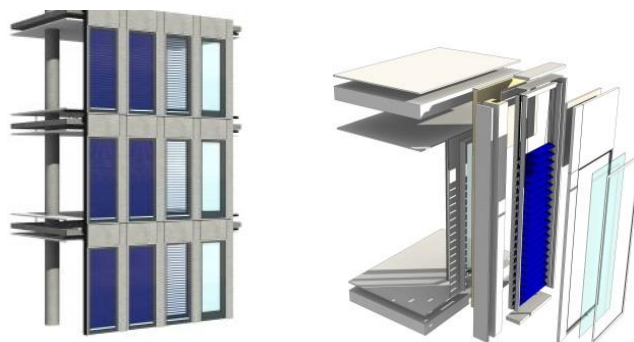
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<https://arkol.de/en>



Visualization of a façade with strip collectors and a diagram of the structure of a collector strip.
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Visualization of a façade with a solar thermal blind and a diagram of the structure of such a blind with a vertical collection duct. ©Facade-Lab