Façade Integrated Solar Thermal Collectors

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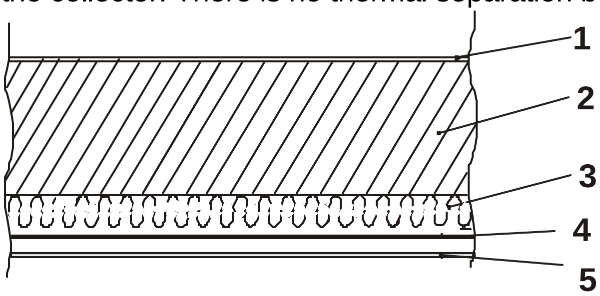
1. Abstract

In the main solar thermal systems are used to prepare hot water in small-scale plants. When it comes to applications in the field of solar space heating, large-scale plants in urban building projects, hotels and solar local heating networks, there are not always sufficient suitable and oriented roof areas available for the installation of solar c ollectors. When installing these on existing roofs or joining them to flat roofs, the plants often form a foreign body since they are not an integral part of the architecture. For this reason solar plants are still rejected by some architects and town planners. For a wide market penetration it is, therefore, necessary to develop collector systems with which it is possible to integrate the collectors in façades.
As the development of façade systems for photovoltaic modules has shown, these open up a large and new market segment.
Within the framework of a project financed by the Austrian ministry for traffic, innovation and technology, system-, structural- as well as building physical basis theories will be elaborated, which will serve as a basis for constructional and aesthetically attractive solutions for the production of façade integrated solar collectors without thermal separation. The recyclability of the materials used and resource efficiency play a central role when it comes to the development of constructional solutions.
The results of this project are used by the two solar engineering companies participating in this project as a basis for the production of test façades and subsequently for the transfer to manufacturing and series production

2. Direct Façade Integration

In this context a collector element directly integrated in the Façade is understood by the façade-integrated solar collector in which heat insulation is a component both of the building as well as of the collector. There is no thermal separation between both of these in the form of rear ventilation.



1: interior finish
2: wall
3: insulation
4: absorber
5: glas cover

Fig. 1: Integrated collector without rear ventilation

The collector which comprises a fluid-cooling absorber, a glass disk, glass bearer profiles, sealings and covering sheet metals, therefore, assumes different functions:

- Function as a thermal flat collector
- improvement in heat insulation of the building respectively the attainment of passive gains
- protection against atmospheric conditions
- a structural design element for the façade

In accordance with this the advantages of façade integrated collectors are:

- cost savings as a result of joint use of building components
- replacement of the conventional façade

- suitable both for new buildings and for the renovation of old buildings

Therefore façade collectors are:

1. Integral part of the architecture
2. Energy Converter

3. Architectural Aspects

Façade collectors can be used as an element for design for buildings. By varying the surface grid dimensions, the kind and colour of the cover strip and the colour of the absorber the look of the façade can be changed. To determine the demand from the architects a survey among architects has been carried out (see Fig. 2, Fig. 3 and Fig. 4).

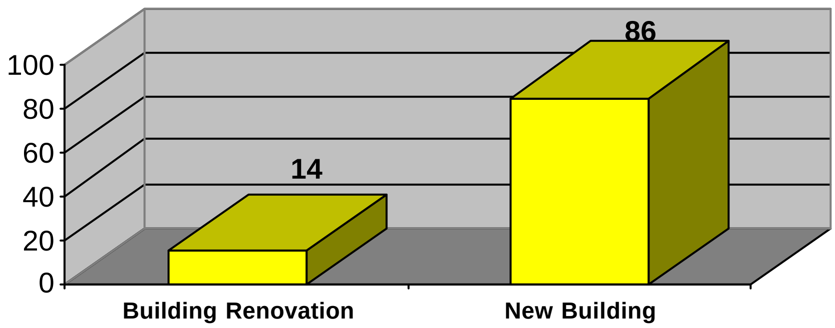


Fig. 2: Primary fields of application of façade collectors, survey amongst 52 Architects

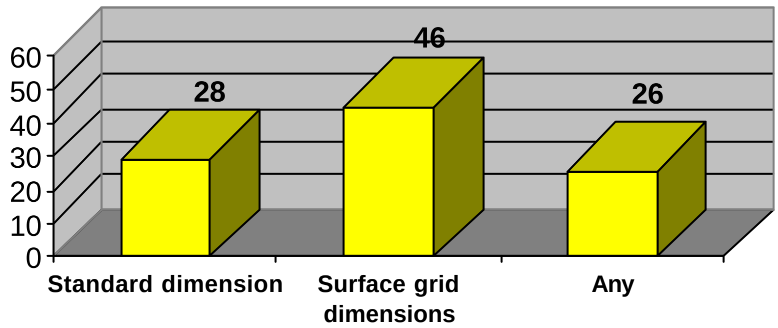


Fig. 3: Preferred dimensions, only 29% of the questioned architects are content with standard dimensions.

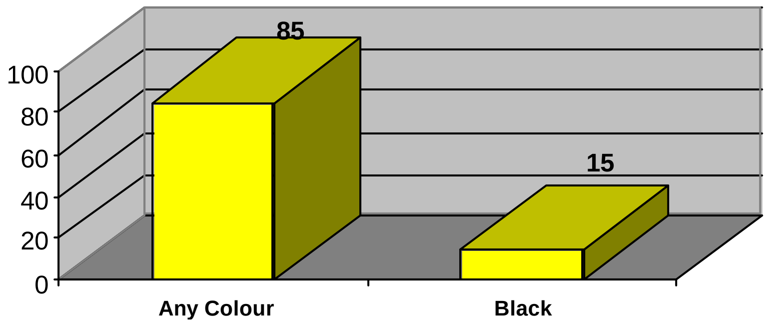


Fig. 4: Colour of Collectors. 85% of the architects would prefer different colours besides black (taking a lower yield into account)

Consequences of the architectural integration:

- Standard collector sizes are not or only very rarely possible
- The architect determines the surface grid of the façade !!!
- In most cases the surface grid does not correspond to the size of the absorber
- Co-operation is necessary between the architect and the designer at a very early stage

- There is a need of façade design know-how
- The collector is often „only“ part of the façade
- Connection to other parts of the façade (with windows, doors, roof...)
- The façade constructor has to also build the „rest“ of the façade

Coating of absorbers:

- Solar varnish
- Selective layers
  Coil coating
  Maxorb layer

Critical items

- The fixing of the glass cover (cover strip)
- The fixing of the absorber in the collector
- Thermal bridges
- The ventilation of the collector, air tightness
- The collector’s hydraulic scheme
- The adaption of the system as a whole

Demands from Façade Collectors

- Flexible means of production
- The co-ordination of interfaces: close contact to architects, close contact to plumbers and HVAC engineers
- Know-how in the field of solar engineering: hydraulic schemes, systems engineering
- Know-how in the field of façade construction: building physics, a knowledge of standards and regulations in the field of façade construction

Fig. 5: 28 m² collector area in the façade of a wooden building, DHW and Space Heating. Wooden cover strip.

4. Dimensioning of façade collector systems

Collector area in façades compared to collectors mounted on roof for systems for DHW production and for combi-systems (DHW and space heating).

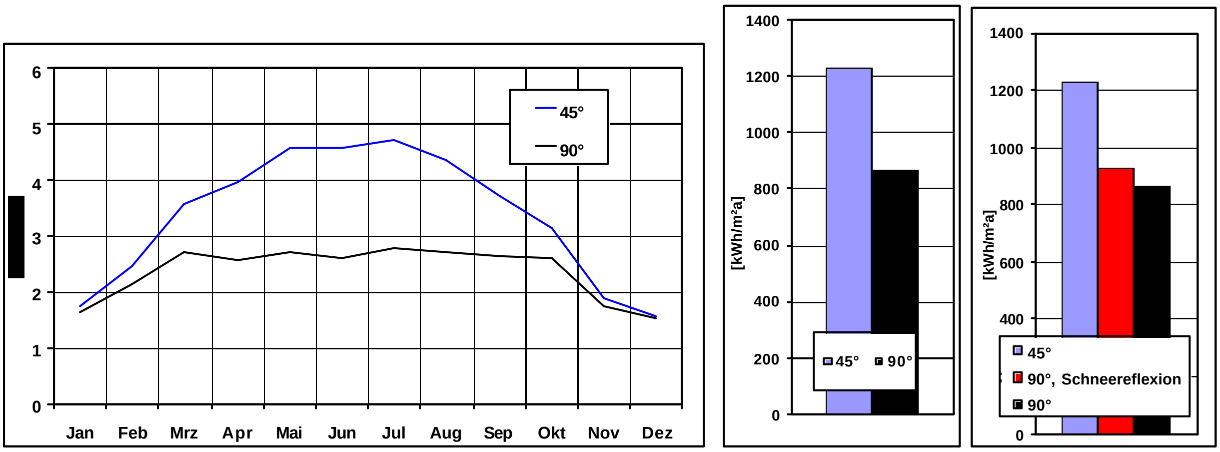


Fig. 6: Irradiation on vertical and horizontal surface

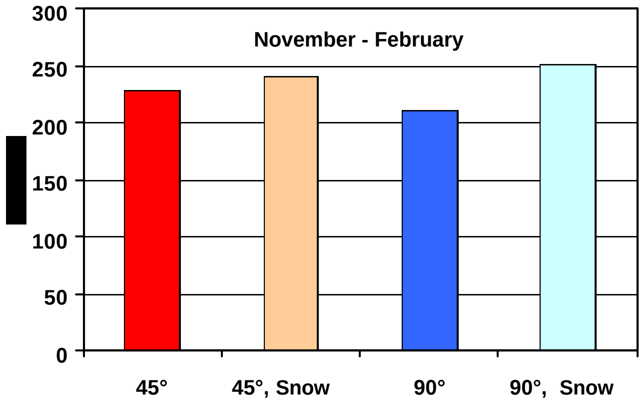
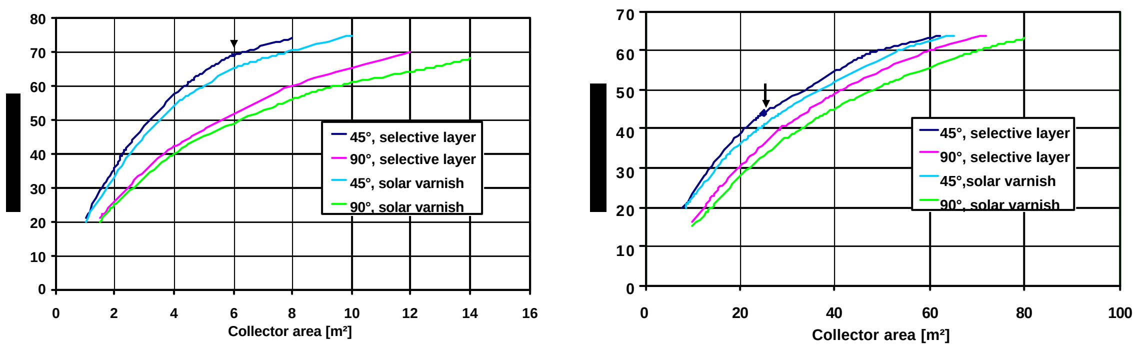


Fig. 7: Increase of irradiation because of snow reflexion



DHW DHW+Space heating

Fig. 8: 2000 l energy storage tank, 300 l DHW storage tank, 160 l/d hot water demand, 8 kW heating energy demand

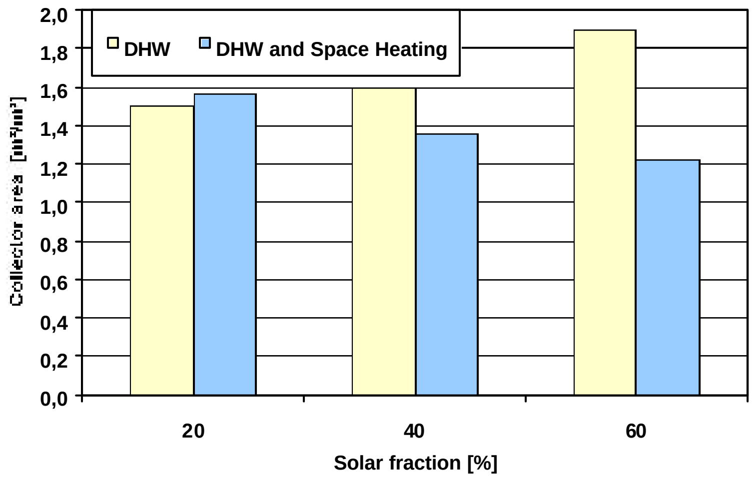


Fig. 9: Collector area in fassade versus collector area on roof (45°)

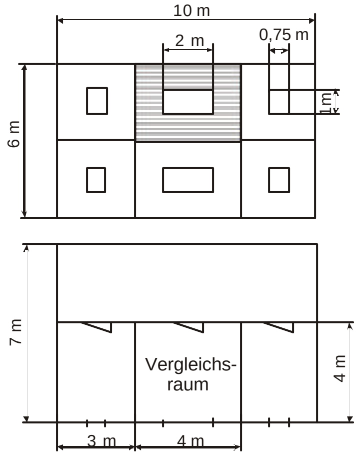
Consequences:

- Only dhw production: up to doubled collector area in façade
- Space heating: higher solar fraction means less extra collector area
- Systems with façade collector for dhw + space heating

5. Building physics

5.1. Heat transfer in wall

- Insulation thickness
- Overheating in summer, Increase of temperature less than 1 K
- Winter: minimizing losses because of heat transmission, U-value
- Comparison of wall with collector and without collector



Boundary conditions, room:

- 16 m² floor space
- 12 m² façade (south oriented)
- 10 m² collector respectively wall without collector
- 2 m² window (100% shading)

Fig. 10: Compared room with and without façade collector

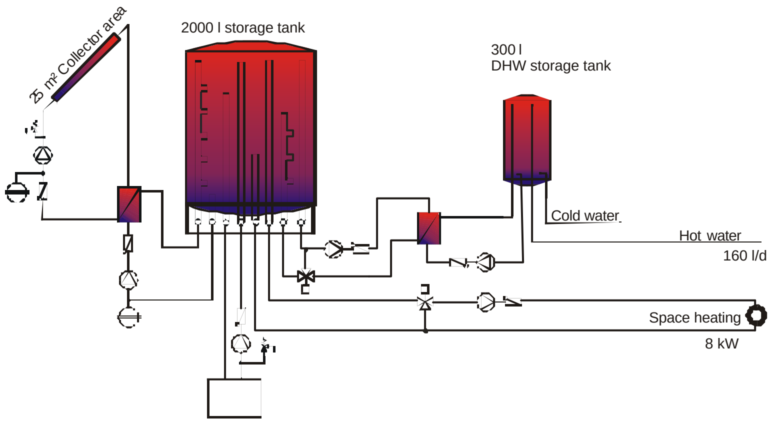


Fig. 11: System

Boundary conditions, system

- Single family house
- 2000 l storage tank
- 300 l dhw storage tank
- 160 l/d dhw
- 8 kW
- Klimate data: Graz

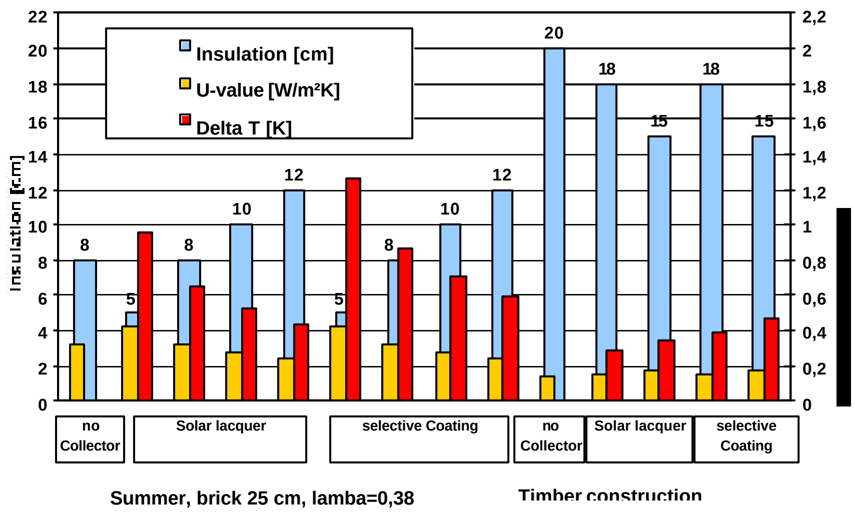


Fig. 12: Raise of air temperature in a room with façade collector on the outside compared to a room with no façade collector by means of the thickness of the insulation.

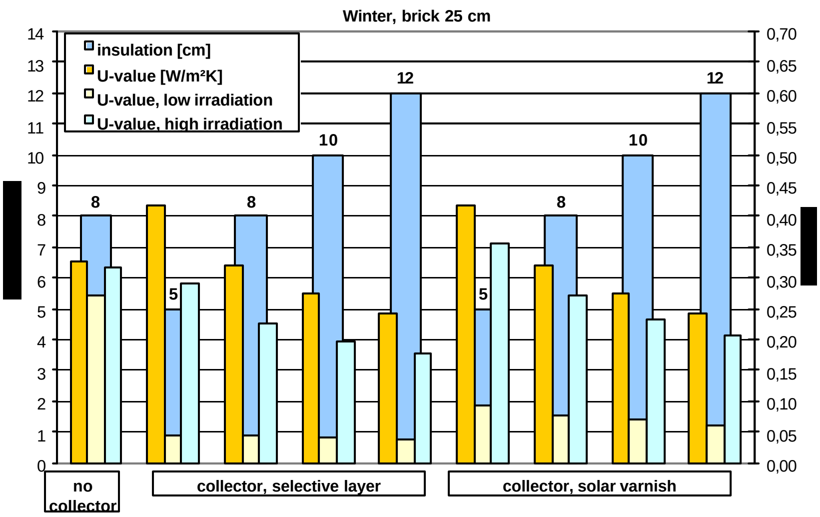


Fig. 13: U-value at high and low radiation. Brick wall

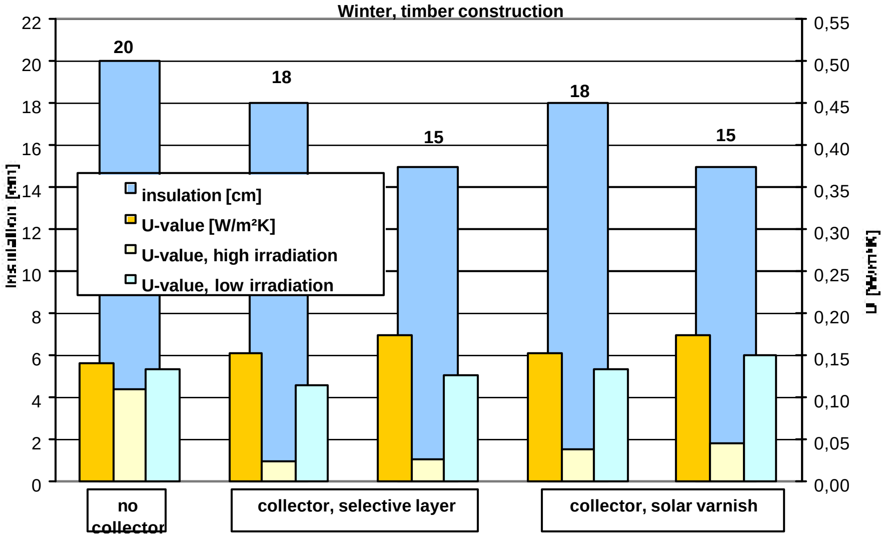


Fig. 14: U-value at high and low radiation. Timber construction.

6. Test façade

55 m² collector area, 3570 l heat storage tank, 500 l DHW storage tank, 12 kW heat demand, 240 l/d DHW, 60°C

Fig. 15: Erection of test façade with the help of a crane

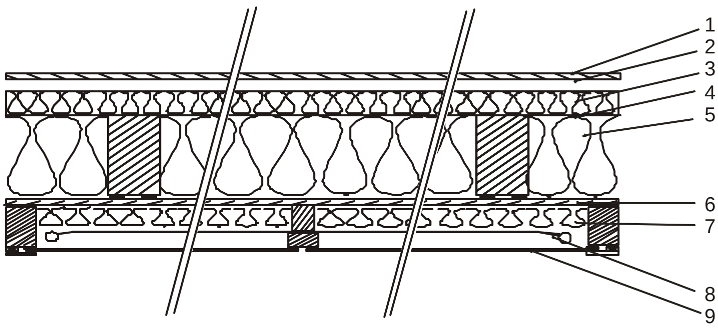


Fig. 16: Testfaçade, Timber Construction. Zwo familie house, 55 m² collector area, 3570 l heat storage tank, 500 l DHW storage tank, 12 kW heat demand, 240 l/d DHW, 60°C

	Construction	dimension [mm]
1	plaster board	15
2	form work	24
3	insulation	50
4	vapour barrier	-
5	insulation	160
6	panel	15
7	insulation collector	40
8	absorber	11
9	glas cover	4

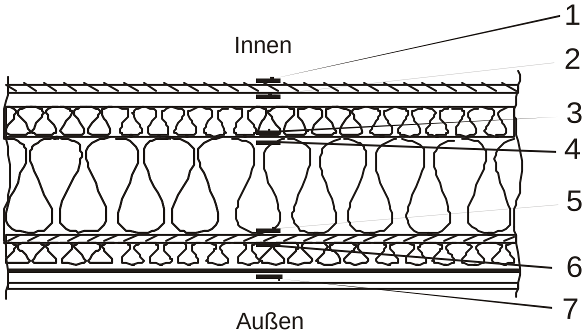


Fig. 17: Position of measuring instruments in construction: temperature and humidity

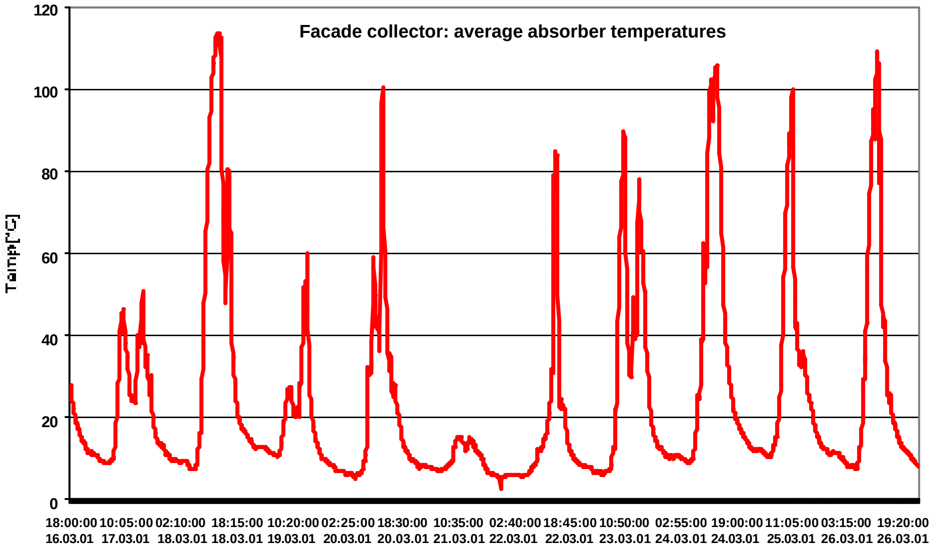


Fig. 18: First results of measurementes of the test façade. Average absorber temperatures.

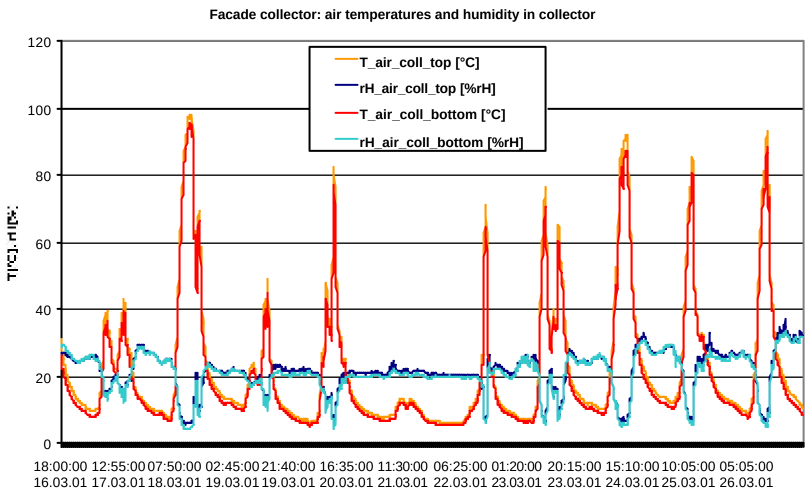


Fig. 19:. Air temperatures and humidity in collector.

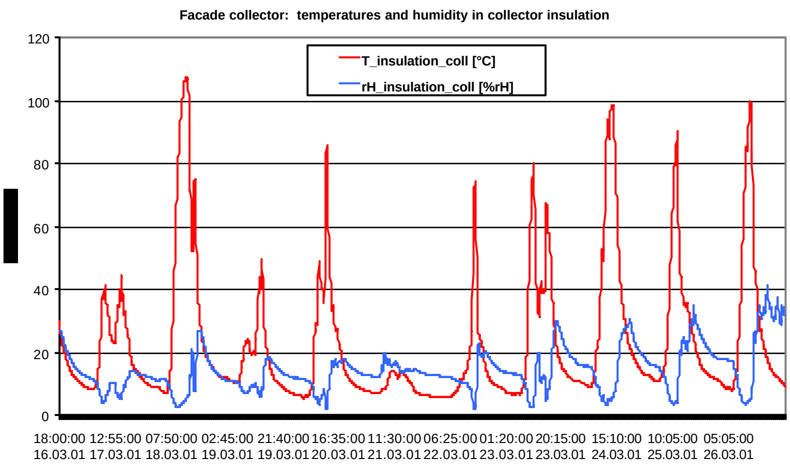


Fig. 20: Temperatures and humidity in collector insulation

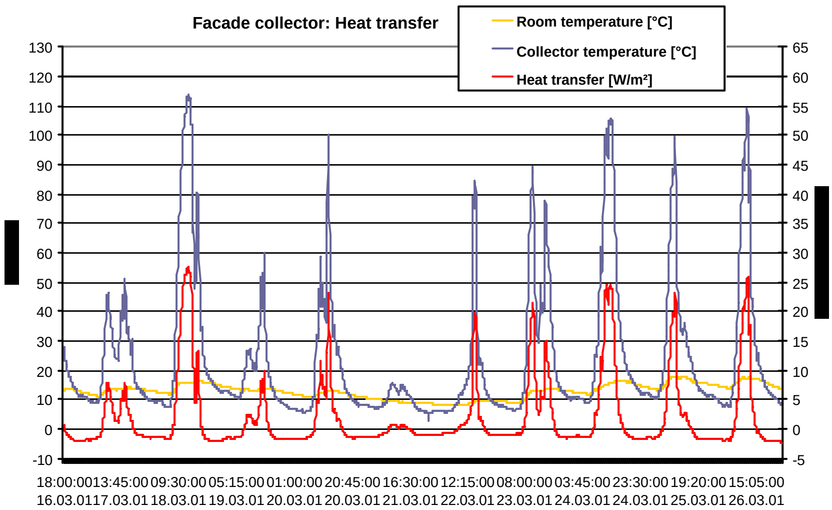


Fig. 21: Heat transfer in wall construction

7. Heat Storage Management

To guarantee the production of hot water outside of the heating season without auxiliary heating, a new storage load management has been developed.

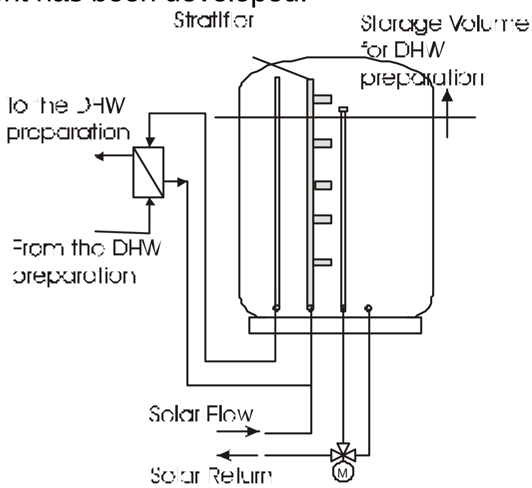


Fig. 22: Division of storage tank to guarantee domestic hot water preparation in summertime without auxiliary heating

8. References

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