Example name: Building integrated solar collectors for district heating systems

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Fig. 1 The large façade-integrated collectors at Kockum Fritid in Malmö. (Photo: Martin Råberg, Grontmij) [2]

For installations

BISTS Location:
Malmö, Sweden
Latitude: 55° 33'N
Longitude: 12° 59'E

Climate Type: Cfb
(Marine West Coast Climate)

Building Use:
Commercial

Level of BISTS integration:
Rush classification: 3

O New Build
Ox Refurbishment
O Other: ……………………

Type of BISTS:

Active

Function(s):
O Air heating
Ox Water heating
O Combi-system
O Cooling/ventilation/shading
O PV/T
Ox linked to another system (district heating)
O Other:

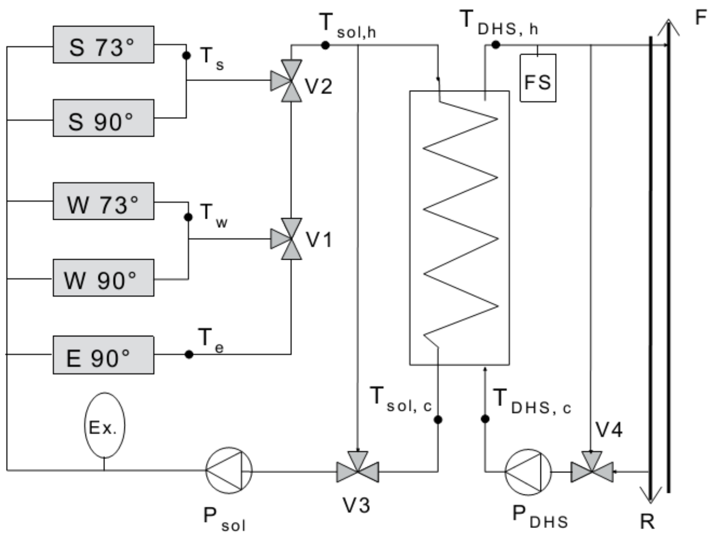


Fig. 2 An overview of the system design, [2]

Building element:

Ox Facade
O Roof
O Other: ……………………..

BISTS characteristics:

The installation of the 1050 m^2 large flat plate collectors with antireflection treated and frosted glass was carried out as a replacement of the old façade and they have been given an interesting design, well integrated in the building.
The five collectors are divided into three subsystems, which are integrated in the façades in directions close to east, south and west and tilted at 90° and 73°. The control system allows cooperation of the five collectors. The areas, azimuth angles and tilt angles of the collectors are shown in Table, [2].

Direction	Azimuth angle, α_z	Collector tilt, β	Collector area (m^2)
East	-98°	90°	181,6
South	-8°	90°	371,2
South	-8°	73°	221,6
West	82	90°	112,4
West	82	73°	163,4

Stage of Development:Responsible:

O Idea/Patent …………………………………..
O Prototype …………………………………..
O Demonstration …………………………………..
O Integral building element …………………………………..
Ox Commercially available E.ON and Grontmij / former Carl Bro*,

***** The owners and involved designers of the investigated solar thermal

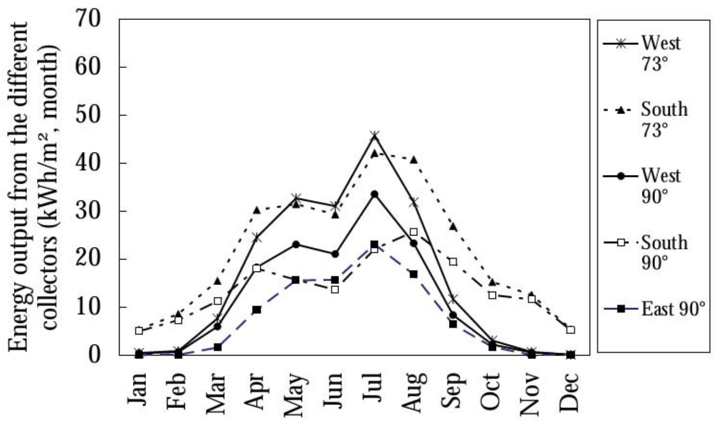
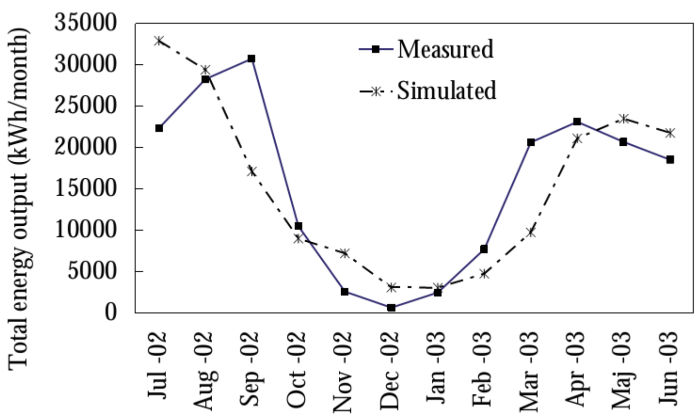
BISTS description and context

The solar thermal system works as any other conventional production unit in the district heating system in Malmö, with the exception that the production cannot be predicted. It is therefore very important that the system is robust and provides a high availability, in order not to cause disturbances like the discharge of low-temperature water into the district heating net. The system is therefore highly automated, remote-controlled and requires minimal maintenance. A condition for the success of this solar thermal system is the carefully planned location, which makes it possible to keep the heat losses from the system very low. The solar system is situated in the outer parts of the district heating system where only relatively low temperatures are required. Also, it is very close to an area where the buildings were designed to maintain thermal comfort using the minimum temperature of 65°C from the district heating system.

System viability

Modelling and simulation tools developed/used

Simulations of the energy output of each of the collectors were performed using WINSUN, a simulation program for solar collectors. The TRNSYS based simulation program WINSUN was used for the simulations of solar gains from the different collectors. The program calculates the theoretical monthly energy output from the solar collectors using climatic data from Meteonorm as input data. The program also uses the monthly operation temperatures of the collectors, parameters of the collector performances and orientations, climatic data and certain other surrounding conditions. It returns the monthly energy output for the period.

BISTS Performance data Based on: O Estimation Ox Detailed simulation Ox Measurement/testing O Long-term monitoring **Performance parameters** For integrated systems: key performance indicators - *Solar savings fraction: %* *Light transmittance: %* *Solar transmittance:%* *Total solar energy transmittance: %:* *Solar heat gain factor: %* *Building fabric U-values: W/m²K* *Noise, fire, etc ratings* *Other:* For separate collectors: performance rating coefficients - (EN12975, a0,a1,a2), ASHRAE, etc c_0=0.81 (0.83) W/m²K c_1=2.7 W/m²K c_2=0.03 W/m²K b_0=0.10	Measured data from the solar thermal system from the period 2002-07-01 to 2003-06-30 have been analysed and used for simulations. Each collector was simulated separately. Input data of the performance parameters of the collectors are received from the manufacturer who had the collectors tested by SP Technical Research Institute of Sweden. Monthly mean flow weighted operation temperatures in the collectors were derived from measurements and used as input in the simulation program. The average operation temperature over the year was calculated to 63°C. During the investigated period the system delivered 189000 kWh to the district heating system, i.e. 180 kWh/m² collector area, with a peak power of 0.3 MW. The COP, the Coefficient Of Performance, i.e. the thermal energy produced per unit (kWh) electricity used for the system operation, e.g. pumps etc. was 24, according to the measurements. The results from the simulations show an expected energy output of 183000 kWh/a, i.e. 174 kWh/m²a, which is a divergence of only 3% from the measured output.  Fig. 3 The simulated energy output for the different collectors shown as monthly values over the year, [1,2].  Fig. 4 Measured and simulated results of the total monthly energy output from the solar thermal system, [1,2].

Additional information:
Sources and references: [1] Helena Gajbert, Bengt Perers, Björn Karlsson, DESIGN AND PERFORMANCE OF A LARGE SOLAR THERMAL SYSTEM WITH FAÇADE-INTEGRATED COLLECTORS IN SEVERAL DIRECTIONS, CONNECTED TO THE DISTRICT HEATING SYSTEM, North Sun Conference, Villius, Lithunania, 2005-05-25. [2] Helena Gajbert, Solar thermal energy systems for building integration, Licentiate thesis, Department of Architecture and Built Environment, Division of Energy and Building Design, Lund University, Lund, 2008.

INSTRUCTIONS

Please fill in as much information as possible.

Tick where appropriate.

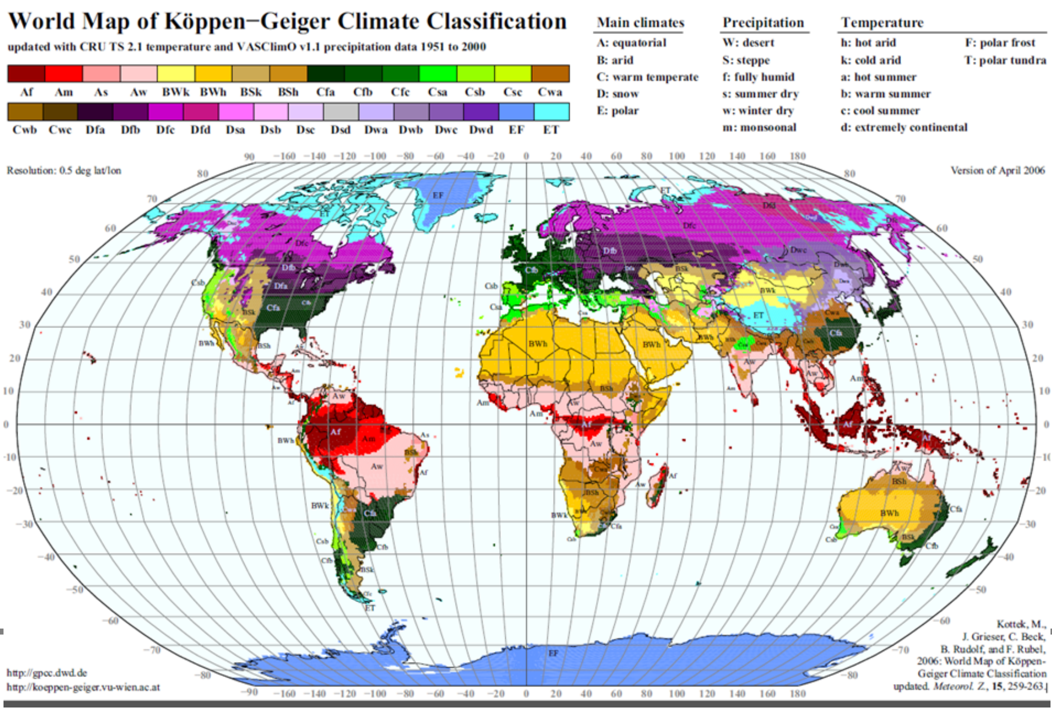
Text in red is suggested guidance. Insertinformation in provided space, removing red text as appropriate

If possible, use metric values.

If necessary, supply additional information on separate sheets

<u>Reference listing</u>

Köppen climate classification



(Kottek, M.,J. Grieser, C. Beck,B. Rudolf, and F. Rubel,2006: World Map of Köppen-Geiger Climate Classificationupdated. Meteorol. Z., 15, 259-263.)

Reijenga classification
The integration of PV systems in architecture can be divided into five categories:

1. Applied invisibly
2. Added to the design
3. Adding to the architectural image
4. Determining architectural image
5. Leading to new architectural concepts.

(Reijenga, TH and Kaan, HF. (2011) PV in Architecture, in Handbook of Photovoltaic Science and Engineering, Second Edition (eds A. Luque and S. Hegedus), John Wiley & Sons Ltd, Chichester, UK)

Rush classification
The architectural/visual expression of building services systems are identified as:

Level 1. Not visible, no change
Level 2. Visible, no change
Level 3. Visible, surface change
Level 4. Visible, with size or shape change
Level 5. Visible, with location or orientation change

(Rush, RD. (1986) The Building systems integration handbook Wiley, New York, USA)

Collector test standards

BS EN 12975-2 2006 ‘Thermal solar systems and components solar collectors - Part 2 test methods’
ASHRAE Standard 93-2010 ‘Methods of Testing to Determine the Thermal Performance of Solar Collectors’
ASHRAE Standard 95-1987 ‘Methods of Testing to Determine the Thermal Performance of Solar Domestic Water Heating Systems’