

Example name: Building Space Heating with a Solar-Assisted Heat Pump Using Roof-Integrated Solar Collectors

Template completed by: Simon Paul Borg (University of Malta) simon.p.borg@um.edu.mt	Photographs
For installations	
BISTS Location: <i>Tianjin, China</i>	
Climate Type: <i>Köppen Dwa</i>	
Building Use: <i>Residential</i>	Refurbished Villa
Level of BISTS integration: <i>Reijenga classification: 1</i>	
Type of activity: * Refurbishment in 820m² villa	Source: Yang, Z., Wang, Y. and L. Zhu. "Building Space Heating with a Solar-Assisted Heat Pump Using Roof-Integrated Solar Collectors". Energies (2011).4(504-516)
Type of BISTS:	Drawings/Sketches/Cross-sections
Active System	concrete profiled strip conductive glue copper pipe aluminum mesh EPS board
*Linked to another system (heat pump)	
Building element:	The arrangement of the solar collector
*Roof	B Image: Constraint of the structure of the aluminum mesh plate and profiled strip. (a) Aluminum mesh plate; (b) Profiled strip Source: Yang, Z., Wang, Y. and L. Zhu. "Building Space Heating with a Solar-Assisted Heat Pump Using Roof-Integrated Solar
	Collectors". Energies (2011).4(504-516)



BISTS characteristics:

Solar-Assisted Heat Pump Using Roof-Integrated Solar Collectors

"System consists of the solar roofing collector, which features high solar utilization efficiency and complete roof integration, a radiant heating floor end system, which guarantees the lower energy demand and more comfortable indoor environment, and a compressor and related devices, which couple the source and end part". The solar roofing collector within the roof structure serve as the evaporator end of the heat pump whilst the radiant heating floor serves as the condenser part, rejecting heat into the desired indoor space of the building.

"The test building is a three-story villa located in Tianjin city, with an overall floor area of 820m²"

"The east-west aligned roof is sloped at an angle of 25° and finished with ceramic tiles. Heat collecting devices were installed underneath the roof tiles, so from outside the solar collector is invisible and totally integrated into the building envelope as part of the roofing structure. After the EPS board was added to the roof structure, an aluminium mesh layer was laid, then the copper tube was arranged and covered with profiled aluminum strips, afterwards, a concrete layer was paved and finally finished with the ceramic tiles."

Item	Feature Size (mm)	λ (W/m K)	ρ (kg/m ³)	Cp (J/kg K)
Copper tube	8 × 0.5	398	8954	406
Aluminum mesh plate	3600×1800	227.8	2770	921
Profiled strip		227.8	2770	921
Ceramic tile	$360 \times 270 \times 10$	0.72	2300	879
Conductive glue		7	1755	545
EPS	$2000 \times 1000 \times 80$	0.035	30	
Concrete paving		0.93	2400	920

Source: Yang, Z., Wang, Y. and L. Zhu. "Building Space Heating with a Solar-Assisted Heat Pump Using Roof-Integrated Solar Collectors". Energies (2011).4(504-516)

Stage of Development:

Responsible:

*Demonstration (Already Built)

Tianjin University

BISTS description and context

Project motivation: House refurbishment towards style retrofitting, a desire for low energy consumption and willingness to experiment with new ideas related to building integrated solar thermal



System viability

Modelling and simulation tools developed/used

"eQUEST software tool was used to calculate the hourly building energy consumption. The eQUEST program is the latest official version of DOE-2 derived user-interface, which also extends and expands DOE-2's capabilities in several important ways: eQUEST calculates hour-by-hour building energy consumption over an entire year (8760 hours) using hourly weather data for the location under consideration"

"The geometric model of the building created by eQUEST is shown in Figure 2. Results include the calculated hourly heating load obtained by inputting the building construction information, climate conditions, indoor thermostat temperature, system operation mode and related information"



eQuest model

Source: Yang, Z., Wang, Y. and L. Zhu. "Building Space Heating with a Solar-Assisted Heat Pump Using Roof-Integrated Solar Collectors". Energies (2011).**4**(504-516)

COST Action TU1205 "Building Integration of Solar Thermal Systems (BISTS)" BISTS Examples





Sources and references:

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