Example name: PV/T roof collector

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For installations

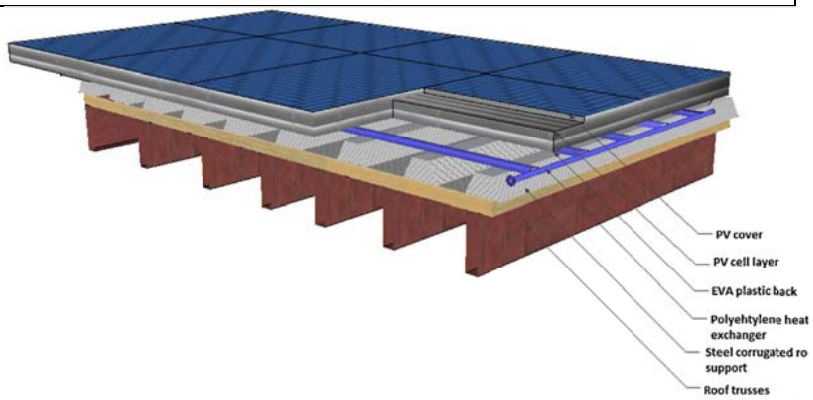
BISTS Location: *United Kingdom, 53°N,1°W*
Climate Type: *Cfb*
Building Use: *comercial*

Level of BISTS integration
Determining architectural image
O New Build
~~O~~ Refurbishment
O Other: ……..

Type of BISTS:

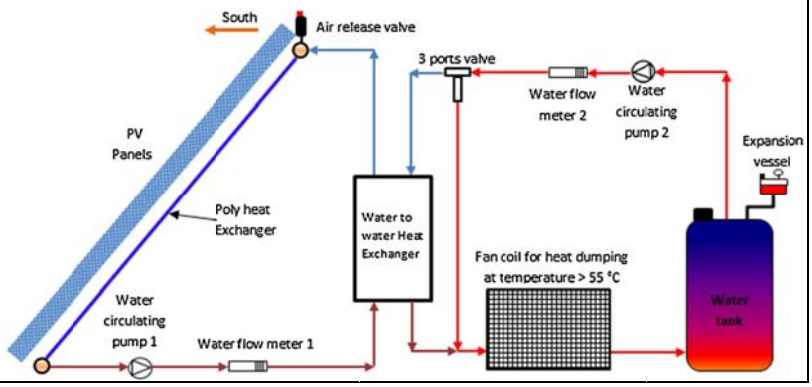
Active

Function(s):
O Air heating
~~O~~ Water heating
~~O~~ Combi-system
~~O~~ Cooling/ventilation/shading
~~O~~ PV/T
O linked to another system (e.g., heat pump)
O Other:
……..



Building element:

O Facade
~~O~~ Roof
O Other: ……..



BISTS characteristics:
Total area of PV arrays is 140 m^2. Area of PV with heat exchanger is 40 m^2. Tilt angle: 10°. Orientation: south. Generally 1°C rise in temperature of PV cells will reduce 0,4-0,5% of power energy efficiency for crystalline Si based cells and 0.25% for amorphous silicon (a-Si) cells. The use of heat exchangers made of polyethylene, underneath PV modules can increase the efficiency of PV and the waste heat is obtained. System can achieve up to 20.25% overall thermal efficiency.
Heat from cooling PV can be used for cooling, heating, domestic hot water supply or natural ventilation inside the building.
Evaluations show that the estimated annual energy savings of the overall system is 10.3 MWh/year.

Stage of Development:		**Responsible:** *Owner of the building*
O	Idea/Patent	……..
⊖	Prototype	*Institute of Sustainable Energy Technology, University of Nottingham*
O	Demonstration	……..
O	Integral building element	……..
⊖	Commercially available	*SHARP*

BISTS description and context

Type of building is agricultural barn. Building was specially use to test prototype of BIPVT with unusual polyethylene heat exchangers. Total roof area covered with PV is 140 m2. Orientation of the roof is south. Tilt angle: 10°.
Hot water tank: 120 litres.

System viability

The solar energy generation is roughly 28 kWh/day. The power generated by the system is partly (about 80%) used by the homeowner for home appliances and agricultural barn at feed-in-tariff rate, and the excess power(20%) is fed into the electricity grid at export tariff rate.

Modelling and simulation tools developed/used

Numerical simulations have been carried out by using Engineering Equation Solver (EES) in terms of climate conditions of Nottingham and design parameters of the building integrated PV/T roof collector.
The adapted version of existing model was first developed and this model was well-suited for the physical structure of the tested system. After making experiments on real system this model was verified by comparing results from simulations and results from experiment.

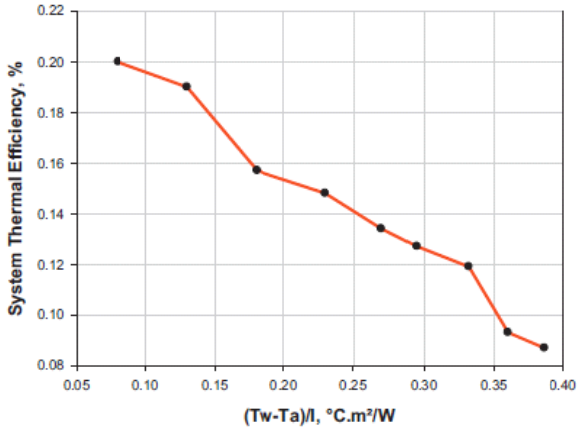
BISTS Performance data

Based on:
O Estimation
Ø Detailed simulation:
Engineering Equation Solver (EES)
Ø Measurement/testing
O Long-term monitoring

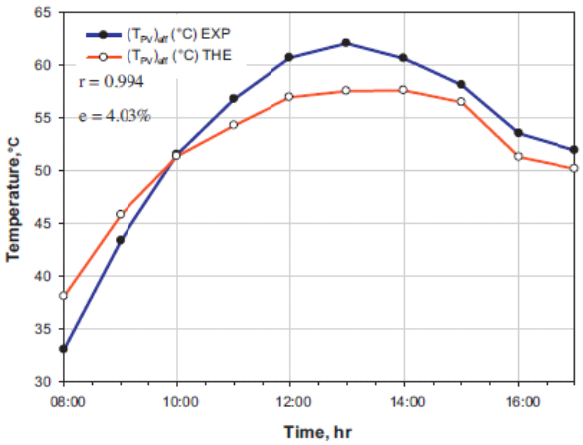
Performance parameters

For integrated systems:
key performance indicators -

Absorptance: 0,9
Emissivity: 0,96
Thermal conductivity: 149 [W/(m2°C)]
Electrical efficiency: 14,9%
Packing factor: 0,91
Thermal efficiency: up to 20,25%



Effect on fluid temperature on the overall thermal efficiency



Hourly variation of PV module temperature – theoretical and experimental

Additional information:

Described system was developed and tested by the University of Nottingham, and supported financially by Geo Green Power Ltd. and the Sustainable Construction iNet, Project Number: CR&D 106154.

Sources and references:

Buker M.S., Mempouo B., Riffat Saffa B.: **Performance evaluation and techno-economic analysis of a novel building integrated PV/T roof collector: An experimental validation**, Energy and Buildings 76 (2014) 164-175