Example name: BIPVT roof collector

Template completed by:
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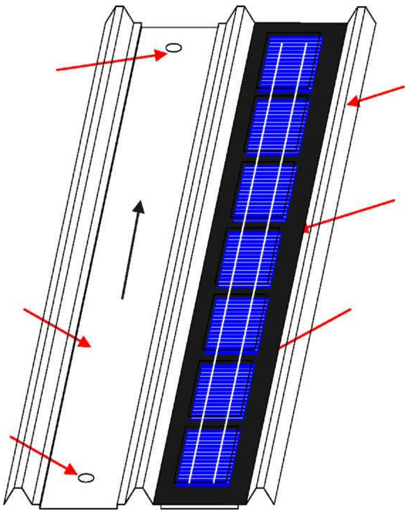

For installations

BISTS Location: Hamilton, New Zealand 37.5S, 175.2E
Climate: Cfb
Building type: Domestic
Level of BISTS integration
Rush level 2 / Reijenga level 2

~~O~~ New Build
O Refurbishment
O Other: ……………………

Type of BISTS:

Active/~~Passive/Hybrid~~

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

Prototype experimental BIPVT physical characteristics

Parameter	Symbol	Value	Unit
Number of covers	N	1 or 0	–
Emittance of plate	ε_p	0.95	–
Emittance of cover	ε_c	0.88	–
Number of tubes	n	2	–
System flow rate	m	2	l/min
Collector Length	L	1.96	m
Collector Breadth	b	0.5	m
Collector Area	$A_{collector}$	0.98	m^2
PV Trans/Abs (de Vries, 1998)	$\tau\alpha PV$	0.74 or 0.78	
Thermal Trans/Abs (Weerakoon, 2008)	$\tau\alpha T$	0.925	
Absorber thickness	t	0.5	mm
PV thickness	L_{PV}	0.4	mm
PV conductivity (Krauter, 2006)	k_{pv}	130	W/m K
Tube Hydraulic Diameter	d_h	8	mm
Tube Spacing	W	0.23	m
Ratio of Tube width to spacing	d/W	0.087	
Heat transfer coefficient from cell to absorber (de Vries, 1998)	h_{PVA}	45	W/m^2 K
Insulation Conductivity	k	0.045	W/m K
Back Insulation Thickness	L_b	0.1	m
Edge Insulation Thickness	L_{edge}	0.025	m
Absorber Conductivity	k_{abs}	50	W/m K
Heat Removal Efficiency Factor	F_R	~ 0.6	
Collector Heat Loss Coefficient	U_{loss}	~ 7 (glazed) ~ 25 (unglazed)	W/m^2 K
Packing Factor	S	0.4	
Mounting Angle	β	37	degrees

BISTS characteristics:

Standing seam and troughed sheet roofs are typically made from aluminium or coated steel, although copper or stainless steel could be used. They are rolled or pressed into a shape that gives the roof product stiffness, strength and when assembled are weather proof. This system utilises the high thermal conductivity materials used in these roofing systems to form the BIPVT collector. During the manufacturing process in addition to the normal troughed shape, passageways are added to the trough for the thermal cooling medium to travel through. In essence, a cover having PV cells laminated to its surface is bonded into the trough. The passageways formed in the trough are subsequently enclosed by the cover; thus forming a tube to which heat can be transferred. The flow ways have an inlet and an outlet at opposite ends of the trough. In addition the design allows a glass or polymer glazing to be added to the collector to create an air gap between the outer surface of the PV module and laminate surface and the ambient air.

Stage of Development: | **Responsible:**

~~O~~	Idea/Patent	University of Waikato, Hamilton, New Zealand
O	Prototype	…………………………………..
O	Demonstration	…………………………………..
O	Integral building element	…………………………………..
O	Commercially available	…………………………………..

BISTS description and context

The roof profile was folded using a CNC folder, holes were drilled to allow fluid into the underside of the coolant trough, nipples were welded to the rear surface to allow a manifold to be attached, the ends were sealed with Silicone and the top absorber sheet was glued into place with the same. Once sealed and watertight, PV cells were laminated to the top absorber sheet and encapsulated in a Poly-vinyl resin. Finally, the ends of the roof trough profile were enclosed and a low-iron–glass cover was placed over the collector to prevent convection losses. The rear surface of the collector panel was insulated with 100 mm of mineral fibre insulation.

System viability

The results showed that key design parameters such as the fin efficiency, the thermal conductivity between the PV cells and their supporting structure, and the lamination method had a significant influence on both the electrical and thermal efficiency of the BIPVT. Furthermore, it was shown that the BIPVT could be made of lower cost materials, such as pre-coated colour steel, without significant decreases in efficiency.

Modelling and simulation tools developed/used

The novel building integrated photovoltaic/thermal (BIPVT) solar collector was theoretically analysed through the use of a modified Hottel–Whillier model and was validated with experimental data from testing on a prototype BIPVT collector.

BISTS Performance data

Based on:
O Estimation
~~O~~ Detailed simulation
~~O~~ Measurement/testing
O Long-term monitoring

Performance parameters

For integrated systems:
key performance indicators -

For separate collectors:
performance rating coefficients -

Other:

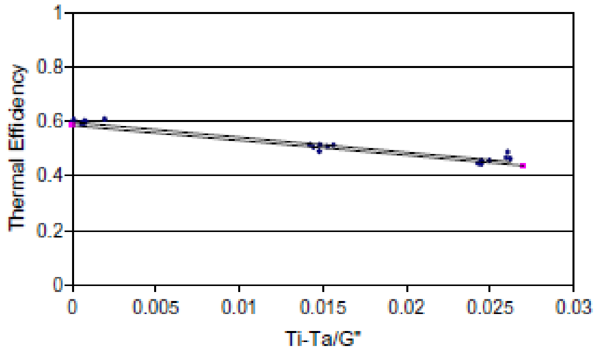

Fig. 5. Experimental and theoretical thermal efficiency of a glazed BIPVT collector.

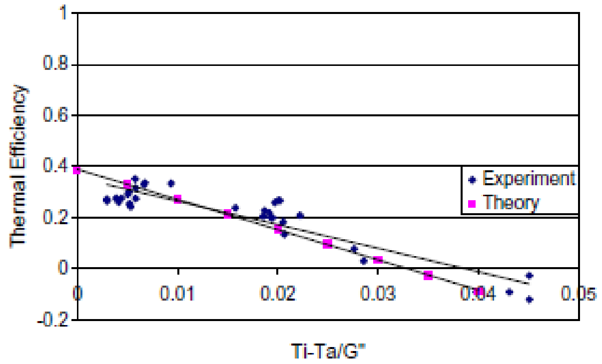

Fig. 6. Experimental and theoretical thermal efficiency of an unglazed BIPVT collector.

Additional information:

Sources and references:

T.N. Anderson, M. Duke, G.L. Morrison, J.K. Carson. Performance of a building integrated photovoltaic/thermal (BIPVT) solar collector. Solar Energy 83 (2009) 445–455