Example name: Hybrid thermal insulating PV facade element (HYTIPVE)

Template completed by:
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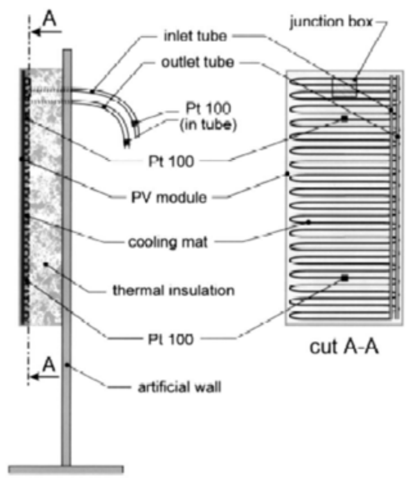


For installations

BISTS *Location: Rio de Janeiro, Brazil 22S, 43W*
Climate Type: *Aw*
Building Use: *mixed*

Level of BISTS integration
Rush level 3 / Reijenga level 4

O New Build
O Refurbishment
~~O~~ Other: R&D

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: ……………………..

BISTS characteristics:
The HYTIPVE was one of 4 PV/T prototypes developed and tested under the 'steady-state solar simulator at Laboratorio Fotovoltaico at Universidade Federal do Rio de Janeiro. The HYTIPVE is designed to be a vertically mounted PV/T unit that combines power and heat generation with improved building envelope insulation.

Stage of Development:		**Responsible:**
O̶	Idea/Patent	Laboratorio Fotovoltaico at Universidade Federal do Rio de Janeiro, Brazil
O̶	Prototype	Laboratorio Fotovoltaico at Universidade Federal do Rio de Janeiro, Brazil
O	Demonstration	…………………………………..
O	Integral building element	…………………………………..
O	Commercially available	…………………………………..

BISTS description and context

The HYTIPVE is a thermal insulating PV facade with an integrated cooling system that consists of a SOLON PV module mounted on a propylene mat (complete with cooling loop and small pump) and a 12.5 cm layer of mineral wool. The thermal insulation was attached directly to the back of the PV/T panel in order to achieve a thermal insulation of k=50.32 W/Km^2, in accordance with WSV 95 (Heat Preserving Regulation for Building Materials by the German Government, 1995). The heated water can also be used for thermal applications (directly or combined with solar thermal systems). The prototype module was 1205 mm long and 545 mm wide.

The prototype was evaluated using a steady-state solar simulator, according to the spectral specifications of a 'Class B' simulator, and used tungsten–halogen lamps of the type 'Powerstar HQI-T 2000W/D/ I'. Irradiance was maintained at a constant 700 W/m^2 on the prototype unit façade.

System viability

The HYTIPVE offers a cooling effect of about 20°C compared to conventional PV curtain facades, and is in the same range as that found for active ventilated structures (max. 18°C). Based on the measured performance of the Hybrid thermal insulating PV facade elements (HYTIPVE), the integral water cooling/heating system allowed an electrical yield that was 9% higher than that found for conventional PV-facades.

Modelling and simulation tools developed/used

A simple in house model was developed to calculate the heat fluxes compare the values with actual measurements.

Energy flux	HYTIPVE flow rate $47.7 \cdot 10^{-6}$ m^{3}s^{-1}
ρ_{opt} G (in W m^{-2})	92.0
P_{PV}/A (in W m^{-2})	54.1
q_k (in W m^{-2})	4.2
q_{rf} (in W m^{-2})	81.4
q_{rb} (in W m^{-2})	0
q_{cf} (in W m^{-2})	35.9
q_{cb} (in W m^{-2})	0
q_w (in W m^{-2})	379.2
Sum of energy fluxes	646.8
Relative difference from 700 Wm^{-2}	−7.6%

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 -

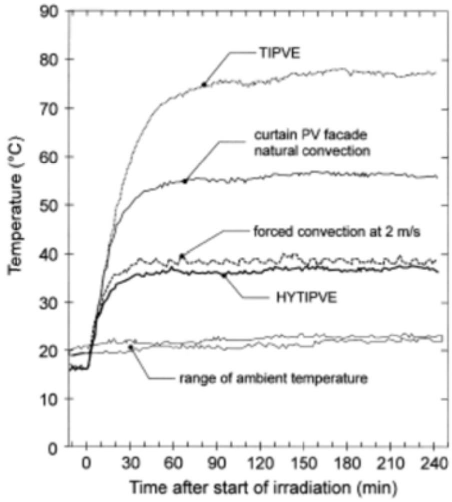
For separate collectors:
performance rating coefficients -

Other:

The graph and tables below detail the temperature based performance and PV performance for the HYTIPVE prototype. 'Table 5' shows the measured stationary temperatures at different flow speeds while using an inlet water temperature of between 13.6–15.9°C.

Table 5. Temperatures of a hybrid thermal insulating PV-facade element (HYTIPVE)

Flow rate in 10^{-6} m^3 s^{-1}	37	43	47.7
T_{cell} in °C	37.6	39.7	36.8
T_a in °C	22.2	24.0	23.1
ΔT_{cell} in K, related to flow rate of $47.7 \cdot 10^{-6}$ m^3 s^{-1} (ref. to T_a=20 °C)	2.2	1.9	0
T_{inlet} in °C	13.6	15.8	12.6
T_{outlet} in °C	15.4	17.1	13.9



Parameter	Values of Solon alpha PV module
Power at MPP under STC P_{mpp}	68 W
Open circuit voltage V_{oc}	21.2 V
Short circuit current I_{sc}	4.42 A
Temperature coefficients TC_V, TC_C, TC_P	−77 mV/K; 1.5 mA/K; −0.35 W/K
Maximum Power Point V_{mpp}, I_{mpp}	17.3 V, 3.93 A

Additional information:

Sources and references:

Combined Photovoltaic and Solar Thermal Systems for Facade Integration And Building Insulation. Stefan Krauter, Rodrigo Guido Arau´ Jo, Sandra Schroer, Rolf Hanitsch, Mohammed J. Salhi, Clemens Triebel and Reiner Lemoine. Solar Energy Vol. 67, Nos. 4–6, pp. 239–248, 1999

INSTRUCTIONS

Please fill in as much information as possible.

Tick where appropriate.

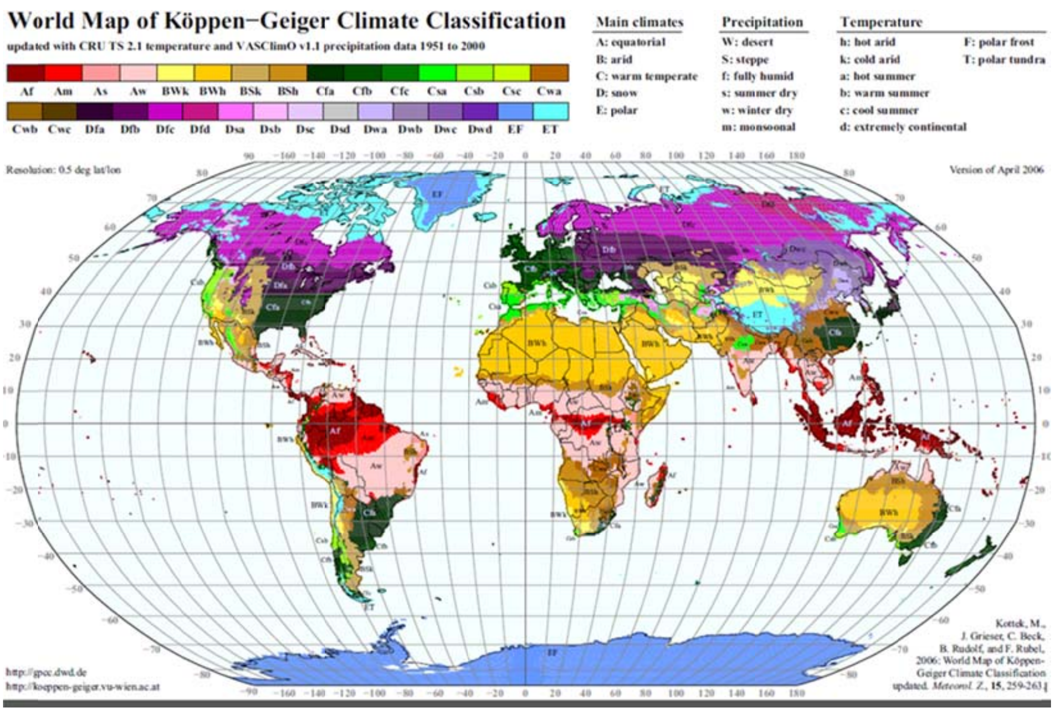
Text in red is suggested guidance. Insert information in provided space, removing red text as appropriate

If possible, use metric values.

If necessary, supply additional information on separate sheets

Reference listing

Köppen climate classification



(Kottek, M., J. Grieser, C. Beck, B. Rudolf, and F. Rubel, 2006: World Map of Köppen-Geiger Climate Classification updated. 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’