Example name: Case Study 3 – Integration on the facade - balcony

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For installations

BISTS Location: Porto (41,157° N, 8,631° W)

Climate Type: CSB

Building Use: Residential

Level of BISTS integration

Reijenga: Adding to the architectural image

- O New Build
- ● Refurbishment
- O Other: ……………………

Type of BISTS:

Active

Function(s):
- ● 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: ………………………


Fig. 14: Use of vacuum tubes as balcony rails – example (source: Basnet, 2012)


Fig. 14: Use of flat panels as balcony rails – example (source: Basnet, 2012)


Fig. 15: Use of evacuated collectors as balcony rails (source: Basnet, 2012)

Building element:

- ● Facade
- O Roof
- O Other: ……………………..

BISTS characteristics:

The apartment complex (still in design phase) is designed as an energy effective, passive house with PV modules on the roof for necessary energy to run the electrical equipment and solar thermal collectors for hot water located on the facade.
The options for the integration of STC analysed were vacuum tubes, flat plate and evacuated collectors.
Vacuum tube solar thermal collectors will be integrated as an architectural element used as balcony balustrades in the south facade. The 90 cm high solar module balustrades that look like normal handrails are a stack of nine long glass tubes. Inside each of these glass tubes, a finger-thick pipe with a metal absorber transports water. The collector as a whole is oriented vertically, but each absorber is turned to an optimum angle towards the sun, to collect the maximum energy in the fall and spring. If the solar collectors were pitched, too much energy would be produced in the summer and too little in the other seasons. Beside the energy advantage and balcony fencing, the solar collectors create aesthetic value by throwing a changing pattern of light and shadow on the floors of the rooms.
Other possibility is the integration of flat pane solar thermal collectors on the balconies, with 90º or 75º tilt, placed on the south facade.

Stage of Development: **Responsible:** N/A

O	Idea/Patent	…………………………………..
O	Prototype	…………………………………..
O	Demonstration	…………………………………..
●	Integral building element	…………………………………..
O	Commercially available	…………………………………..

BISTS description and context

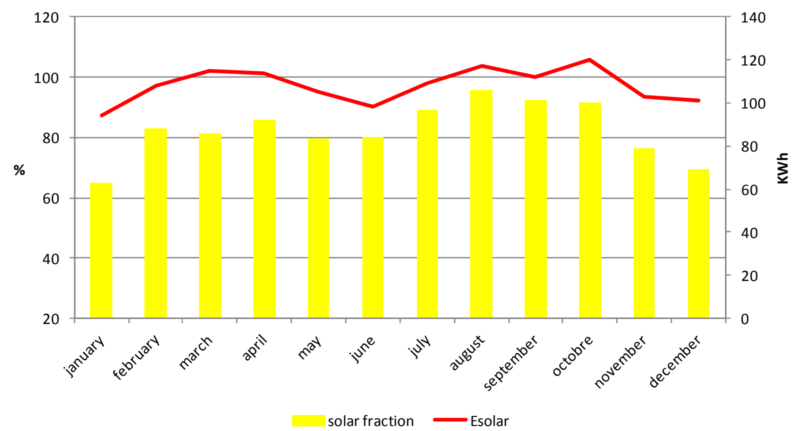
The STC will be integrated in a multifamily building located in Porto. The principle was to integrate solar collector not only on the roof, as usually done in Portugal, but to integrate them on elements as sun screening or on balcony surfaces as the balconies usually are oriented toward south and west. Besides the use of STC as cladding multifunctional elements in the facade, they can equally be used as balcony railings. The tubular vacuum collectors as balcony railings, which makes the conventional railing unnecessary; have a good degree of transparency giving interesting shadings on the floors. Most important is that these tubes make solar energy visible.
Other example is the integration of flat pane solar thermal collectors on the balconies, with 90º or 75º tilt, placed on the south facade.

System viability

The STC systems used in balcony railings are better than to photovoltaic systems in terms of installation cost, annual savings, maintenance and return. Normally the return, in terms of carbon emissions, of a solar thermal energy system is 2 years.

Modelling and simulation tools developed/used

The presented results are based in estimations and modelling developed in the SolTerm software.

BISTS Performance data	
Based on: ● Estimation O Detailed simulation ● Measurement/testing O Long-term monitoring **Performance parameters** For integrated systems: key performance indicators - Solar savings fraction: 82,0% Esolar:1294 KWh Leaning radiation: 1004 KWh/m^2 horizontal radiation: 1449 KWh/m^2	 **Fig.16: Estimation of the STC performance during the whole year**

Additional information:

collectors as balcony railings	
Shape and size	Collector modules with nine evacuated tubes. Each was dimensioned as standard balcony railing
Positioning	the modules are positioned at regular intervals in the facade
Colour	Standard reflecting blue colour is in harmony with the colour of the background glazing
Material and surface texture	The horizontal lines created by the solar tubes characterise the horizontal lines of the timber cladding
Flexibility in integration	Good aesthetics integration was achieved using this approach, since the evacuated tubes are similar to conventional balcony railings.

Solar flat-plate collector	
Shape and size	The height of the module is derived from the floor to floor height.
Positioning	The modules are placed in a checker board style in asymmetrical pattern in the facade
Colour	Blue colour of the modules is in harmony with the reflecting blue colour of the windows.
Material and surface texture	The horizontal lines seen on the absorber of the collector break the verticality of the facade
Flexibility in integration	The flexibility in integration is more prevalent with the used similar sized modules.

Sources and references:

Arjun Basnet (2012). Architectural Integration of Photovoltaic and Solar Thermal Collector Systems into buildings. Master's Thesis in Sustainable Architecture. NTNU. Trondheim, Norway.