

Architectural Integration of Photovoltaic and Solar Thermal Collector Systems into Buildings for new Urban Planning

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ABSTRACT

The existing buildings are responsible for use of large amount of energy for lighting, heating, cooling and use of various energy run equipments mostly powered by electricity grid from fossil energy. Today's intention should be to replace this fossil fuel by solar energy which is free and available in abundance.

At the moment, solar technologies in the form of photovoltaics PVs and solar thermal collectors STC are available in competitive prices. However, their use has not been to the expectation specially in building sector. The main reason for these technologies not being popular in building integration is the lack of good architectural quality rendered not meeting desired design considerations. Innovative approaches have to be explored in terms of design and implementation in order to match the modern technological components to the scale, proportion, material, colour scheme and balance of buildings. So, the objective of this study is to pave possible ways of integrating these technologies into buildings, both on existing and new constructions to add emphasis on the overall architectural expression in addition to producing energy. PVs and solar thermal collectors STC can deliberately be used as architectural design elements in a distinctive way. The development towards passive house, zero energy and zero emission buildings will cause a more frequent use of building integrated solar energy systems as a source of renewable energy. Many solar systems do exist on the market, and with better and better energy performance. It looks like PV integration have brought about some improvements in the architectural quality of building integration, but the solar thermal collectors STC lacks on this part to some extent. While the technical development and energy performance improvements are always in progress, the actual use of these systems in buildings is not increasing as it could and should do.

Integrating these PV and solar thermal collectors STC systems into buildings is not only for clean energy but also to use them as multifunctional elements where they replace the conventional building elements. With this, the economical viability of integration is met and most importantly, they become architectural components. So the possible ways of architectural integration of PV and STC systems have been explored and analysed in this study with special focus made on the aesthetic part of integration. So the urban planners should tack into consideration the concept called nearly Zero Energy Buildings (ZEB). By the end of 2020, all EU member states need to ensure that all newly constructed buildings consume 'nearly zero' energy and that their energy needs are produced locally as much as possible and with renewable sources. Planning for such ZEBs in cities is therefore a difficult

task since urban planners often do not have the technical knowledge to quantify the contribution of solar energy in their urban plans. This study also shows an exploration of geometrical forms of urban blocks and the potential of solar energy to the local production of energy. The following photos are practical examples of PVs and STC application systems for this study.



FIG 1: PV integrated double glazed roof of Café Ambiente, Germany
credit: <http://www.pvdatabase.org/>



FIG 2: PV integration on the curved roof of BP solar Showcase in Birmingham
Credit: <http://www.solartechnologies.co.uk/>



FIG 3: Inclined PV integrated glazed façade of Vocational College in Tirol, Austria
Credit: <http://www.m9-architekten.at/>



Photo: <http://www.sunways.eu/>

FIG 4: Multi-crystalline PV system with bronze and gold coloured silicon solar cells used in the home building,
Credit: <http://www.sunways.eu/>, <http://www.inhabitat.com/>



FIG 5: Integration of STC on the pitched roof of single-family house
Credit: <http://www.iea-shc.org/>



FIG 6: Integrated STC systems on the façade of office building of AKS DOMA Solartedhnik

Credit: <http://www.iea-shc.org/>



FIG 8: PV combined with a thermal system (PVT) façade of Fiat Research Center

Credit: <http://www.solarplaza.com/>

Quality of architectural integration:

Integration of PV and STC is influenced and guided by certain criteria to achieve quality in the process. There exists number of architectural issues that needs to be taken into consideration while integrating these systems into buildings. These issues play very important roles to achieve quality architectural integration. In order to achieve quality in architectural integration; the fundamental aspects of building such as functional, constructive and formal aspects needs to be fulfilled.

Architectural integration quality of PVs and solar collectors STC can hence be defined as the result of their controlled and coherent integration simultaneously under functional, constructive and formal (aesthetic) points of view. Among the functional, constructive and formal issues, it the latter that is to be given more attention as not much has been explored compared to the former two.

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