



## Villa Castelli

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Roof Integrated Photovoltaic System

### Solar

#### *What is the solution?*

The BIPV roof was designed with several working table among architect, manufacturer, and heritage Authority. The panels, in fact, were already in production and were used almost exclusively for sailing boats and small flexible products. The roof is made of anthracite gray BIPV panels, directly glued on the aluminum roof with a specific structural double-sided tape with a similar thermal expansion coefficient of the roof. This technology was developed with a cooperation with the Italian National Research Center (CNR). It is based on an innovative lamination process of monocrystalline cells with special and selected technopolymers as encapsulants.

#### *Why does the solution work in terms of compatibility with conservation and technical aspects?*

Electrical energy is produced with a PV-system, integrated in the roofing. The captive surface is 10 kWp, as a balance between the optimization of production and the aesthetical visual impact. During the design phase, managed directly by the Solbian company, a solar diagram was used to simulate the daily and annual trend of shading, allowing the estimation of the average monthly losses. The choice to install a 10 kWp system is based on the estimation of some possible future consumption and on the need to maximize the electricity production.

#### *Description of the context:*

The building is located in Bellano, on Lake Como (Lecco, Italy). The area is listed from a natural point of view. The building itself is not listed.

*Pros and cons of the solution:*

The architectural integration project considered the visual impact of colors and shapes in the PV integration on the roof. The heritage office in charge of the project has evaluated as fundamental criteria: (i) the aesthetic characteristics of the panels (color and surface finish); (ii) their geometric arrangement in relation to the shape of the roof surface and the orientation of the building (shape of the plant, modularity); (iii) the adherence and coplanarity to the roofing; (iv) the non-reflective surfaces; (v) the perceptibility from around, with particular reference to the road, lake and circus-standing landscape level. Before the heritage authorities approved the PV system, several prototypes were developed for a roof-integrated and preferably invisible installation. The selected prototype was developed in a technical working table was created with Solbian and Prefa, with walkable, thin, efficient panels perfectly camouflaged within the roof. The system was integrated in the roof, following its symmetry made by different pitches with a varied orientation. Then, it considered the important shading produced by some secular plants of the historic garden over large areas of the same. The heritage authorities opted for the double-curved aluminum sheet covering of the roof - which is quite common for buildings of this age in a similar way - with integrated mono-crystalline PV modules, folded plates with integrated photovoltaic cells, of about 11 kWp.

*Type of data available (level of information, simulation):*

The system of Villa Castelli consists of inverters, a monitoring system, a measuring system for production and consumption, and a series of radio sockets for the direct management of the loads. The monitoring system receives continuously the photovoltaic production data, the input data, and the data of the energy grid. In addition, through the available meteorological data, it determines a production forecast and rationalizes automatically the loads.

*Additional information about the solution:*

Three prototypes were developed. First, colored cells panels have been chosen to privilege the aesthetic impact of traditional materials and landscape. The roof has also to solve the problems caused by the presence of a large Deodara Cedar above the house that causes several maintenance problems due to its

continuous fall of needles. Three prototypes have been developed. Initially, a roof in Valmalenco Stone (serpentine) has been chosen. This material is frequently used on historic buildings throughout the Como Lake. Two prototypes were produced. The first was created on a transparent support by combining two glass panel and interposing the classic polycrystalline PV cells. The integration was based on the transparency of the support. The second prototype was based on chromatic integration. A special panel has been created using gray-green cells from Germany with a size perfectly adapted to the Valmalenco stones. In collaboration with Brandoni, an Italian manufacturer of panels, a 1:1 prototype has been created to verify the installation problems. The result was aesthetically pleasing, but impractical for the not walkability of the panels and the complex maintenance. In a second step, a technical working table was created with Solbian and Prefa and a third prototype has been defined. For publications: see the general publication list of the case study "Villa Castelli"

*Are there any related publications or pictures of the solution?*



The roof before the intervention  
(@Valentina Carì)



The BIPV roof (@Valentina Carì)



Study of the visual impact with Heritage Authorities (@Valentina Carì)



Study of the visual impact with Heritage Authorities (@Valentina Carì)

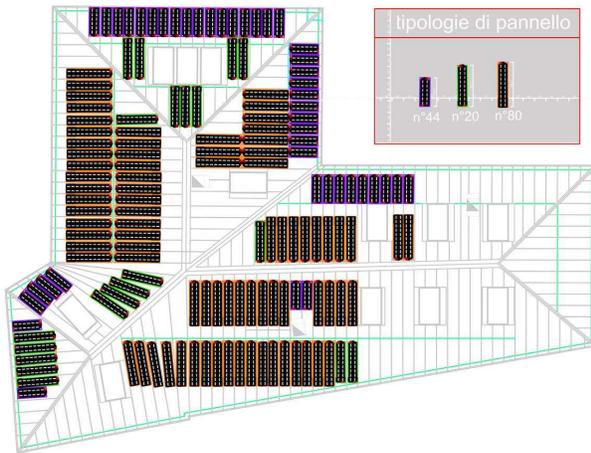


Study of the visual impact with Heritage Authorities (@Valentina Carì)



Detail of the roof (@Valentina Carì)

Oz



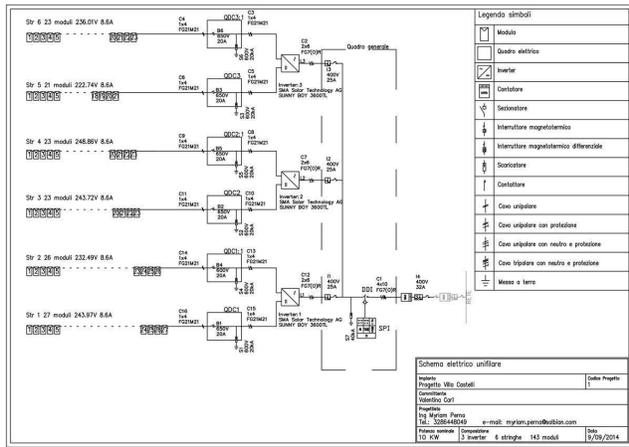
BIPV roof (@Myriam Perna)



Detail of the roof (@Valentina Carì)



Detail of the roof (@Valentina Carì)



Electrical scheme (@Myriam Perna)



BIPV roof construction (@Valentina Carì)



BIPV roof construction (@Valentina Carì)