Supplying historic buildings with energy, without impinging on their historic and cultural values

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Abstract

The Venetian Villas are an historic body of 3782 buildings in Veneto and Friuli from the XVI century to the XVIII century. UNESCO has certified 24 villas of Andrea Palladio as World Heritage Sites. The Regional Institute for the protection of these sites has launched a competition to find innovative technological solutions that contribute to the energy needs of the villas without interfering with the architectural and landscape quality of the same. The paper illustrates the technological solution that won the competition.

The possibility of powering the historical Venetian Villas with renewable energy sources is explored. The realization of submerged PV plants integrated with existing water basin is suggested as the best solution. Energy yield is adequate and landscape quality is conserved. Technical details and architectural layouts are discussed.

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1. Introduction

In Italy, and more generally in Europe, there is the problem of how to introduce technological innovations that provide energy contributions from renewable sources, within areas of cultural interest and landscape protection \cite{1}, \cite{2}.

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The case of the Venetian Villas (built by the Venetian nobility mainly between the XVI and XVIII centuries) is a good example; they constitute a vast heritage (3782 villas have been catalogued between Veneto and Friuli) partly public, but mostly private and predominantly characterized by high conservation and management costs. [3], [4]

First of all, it is important to create conditions of use appropriate to present times, in particular for internal environmental comfort and to bear in mind that their usability today (in a completely different context from the original) is a guarantee for their conservation. But the main difficulty lies in introducing a high fruition quality without damaging the historical consistency of architectural and artistic artefacts. The problem originated more than a century ago, when technological developments emerging at the turn of the XIX century offered the opportunity to introduce substantial improvements to the comfort of buildings through sanitation, electrical appliances, heating and transport, that is, bathrooms, lighting, radiators and elevators. Although these improvements were easily introduced to new buildings, they caused a trauma in those pre-existing, and in particular in all the historic buildings of cultural value.

It is well known that these events affected both Venetian Villas and, in general, the whole historic heritage. Things are further complicated where this heritage has been reused as public venues, such as museums or cultural centers, where measures of accessibility, safety, escape routes etc. have generated further problems.

The last potentially looming trauma concerns the introduction of renewable energy plants to supply electricity or heating to historic buildings. These are generally energy-intensive plants, because of their intrinsic characteristics and the fact that it is almost impossible to limit energy consumption, since the dispersing surfaces cannot be modified. Therefore energy procurement becomes strategic in the reduction of management budgets.

Several studies have been carried out in Europe [5], [6] and in the USA [7] about PV integration in historic buildings but the Venetian Villas require a very specific approach; for these reasons we propose a new original idea: SP2 (Submerged Photovoltaic Solar Panels)

In Italy, interventions on the historical heritage are under the control of the Ministry of Cultural Heritage and Tourism, which has published, among other things, "Guidelines for improving energy efficiency in cultural heritage" [8]. These guidelines are aimed at preserving the architecture from any tampering that would alter their characteristics and value. In the review of technological innovations covered in this paper, the technologies for protecting buildings, such as films on windows glasses and heat pumps, are few and somewhat inconclusive. The submerged PV technique is unknown since it is an unprecedented breakthrough.

This solution is based on the following items:

1. Water strongly absorbs the infrared part of solar radiation but slightly affects the visible part which is the important component used by commercial PV modules
2. Large water basins are available in many parks of Villas
3. Submerged modules are not visible so that the landscape is not modified
4. Solar energy harvesting is adequate for the Villa energetic needs if equipped by a suitable energy storage systems and modern heating and lighting facilities.
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