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COURSE OF SUSTAINABLE ARCHITECTURE
AND DESIGN

Abstract

AL.F.I.E._Reloaded
ALgae Façade Integrated Envelope_Reloaded
Study of a technological system of façade with micro-algae

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In recent decades the discipline of architecture has added new features to the building: the building's skin is made more and more active and dynamic, responding not only to the needs of users, but adapting and working with the natural and urban environment on different aspects: from the automatic control of indoor comfort, reducing the urban heat islands, up to the disposal of CO₂ emissions and clean energy production. With regard to energy waste and environmental emissions, addressed as one of the priorities of European policy in 2020, the buildings are among the main consumers of clean water and pollution in cities. Alarming water consumption figures suggest the need for investigating methods for urban water purification and recycling in the near future. Among the existing systems, a promising technology is the phyto-depuration of the water through the use of photobioreactors with micro-algae to a building scale. In fact the micro-algae can grow rapidly under certain conditions of temperature, solar radiation, carbon dioxide, pH and nutrients. These microorganisms need phosphorus and nitrogen in order to reproduce and grow as main nutrients, these which represent two of the main pollutants of wastewater composition. The growth of these microorganisms on the building is an interesting field of research for the integration of constructed wetland systems in photosynthetic building envelope. After analyzing the main characteristics of domestic waste water and the potential related to the use of micro-algae to treat wastewater and rainwater, the thesis introduces the concept of a technological system of advanced façade: a photobioreactor with micro-algae integrated with the water system of the building. This core technology proposed, called AL.F.I.E._Reloaded, Algae Façade Integrated Envelope_Reloaded, is the evolution of the project AL.F.I.E. presented at the international competition WSB14 of Barcelona. AL.F.I.E._Reloaded is an advanced outer skin layer fully integrated with the water system of the building. It is a photobioreactor that, through the use of micro-algae, purifies and contributes to the recycling of grey water and rainwater. The effectiveness of the system is influenced by the maintenance of the growth parameters of the algae, being careful to the geometry of the system and the characteristics of the culture medium. They were evaluated operating conditions of the photobioreactor designed, assuming the installation of the technology on the façades of the city of Turin, revealing a good performance for the hottest periods of the year, while peak temperatures in winter and summer seem to be harmful for the reproduction of micro-algae, compared to *Scenedesmus Obliquus* used. The technology of façade turns out to be modular, lightweight and self-supporting; does not affect the support casing, it is fast and simple to install and it is easy to inspect in case of malfunction and / or routine maintenance. Among the advantages of integration of the system there are the possibility of significantly reducing the amortization time of investment from the sale of the algal biomass produced for processing plants. Installing AL.F.I.E._Reloaded of several buildings in the neighborhood level would offer the possibility of setting up a distribution service, collection and treatment, thus creating local economies that make it possible to finance the costs of installation and maintenance of the technology. Finally, the dynamic behavior of technology characterize the appearance of the façades in the year, depending on the growth of microorganisms, making the building point of attraction and characteristic of entire neighborhoods.

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