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Rethinking user based innovation: Assessing public and professional perceptions of energy efficient building facades in Greece, Italy and Spain

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ABSTRACT

This paper investigates the public and professional attitudes towards an innovative energy efficient façade refurbishment system, in Mediterranean countries, including Greece, Italy and Spain. Two types of multiple choice questionnaires were developed and addressed to two different target groups: building professionals and users. The survey questionnaire was created so as to elicit information on the interviewee's background and explore attitudes and perceptions towards the proposed system. Results signify that both potential users and professionals are generally positive towards the system's energy performance; however, the increased cost of acquisition, maintenance issues and the replacement of natural ventilation by mechanical means consist significant constraints that induce hesitations for the users. Professionals are willing to apply a ventilated façade in a future project but the lack of the corresponding knowledge may be an important obstacle to face.

1. Introduction

An important part of the existing European building stock, built before 1960, is of insufficient insulation levels and equipped with inefficient systems due to low energy efficiency requirements during the construction period. Consequently, this high energy consuming part of the building stock constitutes one of the most important sources of energy saving and CO_2 reduction potential. Within this context, the Energy Performance Buildings Directive obliged all members of the EU to adopt a number of measures orientated towards innovations and practices in order to respond to the growing energy demand of the building sector and imposed minimum energy performance requirements for new and existing buildings under major renovation, both for the residential and the tertiary sector. However, according to the Energy Efficiency Communication of July 2014, the EU is expected to achieve 18% of energy savings, rather than the initial target of 20%, due to the low speed of legislation implementation. Aiming at a more energy efficient future, the new Energy Roadmap defines milestones for 2050 and sets actions to be carried out in order to reduce greenhouse gas emissions by 80–95% when compared to 1990 levels. In this context, additional work and post-2020 strategies have to be developed, in order to respond in the long-term requirements for 2050 [1]. Among others, 'decarbonisation scenarios' include high energy efficiency levels in new and existing buildings, aiming at the nearly zero energy building standards. Yet, the achievement of high levels of energy efficiency requires: (a) investments by households and companies and thus, further economic incentives and new financial programs that would mobilize investment capitals; (b) innovative informational campaigns and engagement of citizens during the decision making process, in order to assure the acceptance of new technologies and take into account the local environment [2]. Given that citizens' support is generally recognized as a main element towards the large scale implementation and the successful market introduction of new technologies, the present study aims to investigate social acceptance issues, associated with an under development new façade refurbishment solution, named E2VENT system, standing for Energy Efficient Ventilated Façade. The proposed external refurbishment solution embeds different technologies such as a heat recovery unit and a latent heat thermal energy storage unit, so as to ensure its high efficiency; a brief technical description of the system is provided in the next section.

Up to the present time, numerous scientific studies have investigated public attitudes towards energy efficient systems; yet, they mainly focus on the implementation of Renewable Energy Sources (RES) technologies [3–12] rather than on systems that involve interventions on the building envelope, also combining heat recovery and thermal storage systems. This study aims thus to fill this knowledge gap in the existing literature and to provide a valuable contribution in the research field of façade energy efficient technologies' introduction in the market. Since E2VENT system is a new retrofit solution, potential social barriers may arise, mainly due to low levels of awareness or

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experience, when selecting such an advanced system as a building retrofit measure. However, as Hanger underlines, public perceptions towards technological innovations are shaped by a variety of factors associated, from one hand, with citizens' information, public involvement and levels of trust in developers during the project development process and on the other hand, with the anticipated project results, including risks and benefits [9]. Promoting energy efficient technologies while integrating social sciences is thus of crucial importance in order to better understand the dynamics between energy issues, potential risks and public perception [13]. Given that social acceptance considerations are rarely included in research projects developing novel systems for buildings' energy upgrade, this paper aims to provide further insight on the extent that different parameters may affect potentials users and professionals support towards an energy efficient facade retrofit solution such as the E2VENT system. The importance of various drivers including the level of economic, environmental and energy impacts are explored through a survey questionnaire, a detailed description of which is provided in chapter 3.

The paper is organized in the following way: First, a brief description of the main characteristics of the novel technology is given. At the next step, a literature review of previous studies explaining and assessing the main parameters that shape public attitudes is provided. In the third part, the implemented methodology of assessing public and professionals perceptions in three Mediterranean countries is described. Finally, the obtained results are discussed and analyzed and the main conclusions are presented.

1.1. E2VENT project description

The technology is being developed within the context of the research project E2VENT, funded by the H2020 program (GA 637261) and run by 13 educational and industrial organizations across Europe (http://www.e2vent.eu). The project started on January 2015, has a duration of 42 months and involves the product development, pilot studies as well as market preparation. It is an external refurbishment solution with external cladding and air cavity, which comprises of the following components (Fig. 1):

- A smart modular heat recovery unit (SMHRU) that allows the air renewal while limiting the associated thermal losses. The heat exchanger is specifically designed for the E2VENT system. It will be aluminium-made, in order to be lighter and with good thermal conductivity. The unit is designed to preheat inlet ventilation air in winter and precool it in summer. Apart from the normal winter and summer modes, it allows heat storage and free cooling modes. The unit is modular, allowing operation in series or parallel, depending on heating/cooling requirements (Fig. 1.b).
- A latent heat thermal energy storage unit (LHTES), based on phase change materials, acting as a daily thermal storage for both cooling and heating to allow the electricity peak shaving (Fig. 1.c).
- A smart management system so as to control the components on a real time basis targeting optimal performances. A series of sensors will ensure that the E2VENT system will recognize the predicted weather and communicate with existing systems.
- A ventilated façade system, which consists of (a) the bearing structure, made of aluminium and is designed especially for this application, both from a mechanical and a thermal point of view, (b) the thermal insulation, positioned on the outer surface of the building and (c) the external aluminium cladding (Fig. 1.d). Special attention is given to the production of an efficient anchoring system that limits thermal bridges and allows for an easy and durable installation [14]. Load bearing elements made of aluminium, support the ventilated façade. Vertical T-shaped beams bear the outer cladding; each one is supported by an L-shaped bracket, which is anchored on the wall. All bearing elements have been selected in order to comply with the structural requirements and have the necessary bearing capacity for the selected loadings and combination of loadings. Thermal insulation is positioned between the anchors, covering all exterior opaque elements.

The minimum thickness of the system is 20 cm and a detailed description of the components along with a quantification of its energy performance is provided in [15]. Regarding material finishes, the external aluminium cladding could be painted in different colours, depending on the architectural decision. It has to be emphasized that in this study, when it comes to the aesthetics of the system, only the material and not the colour was taken into consideration; further aesthetics issues in terms of the external finishes and the corresponding renderings will be addressed on future studies. The main target market of the retrofitting system is the one associated to the energy refurbishment of multi-storey residential buildings, mainly built before 1960–1970, characterized by their weak insulation efficiency and bad indoor air quality due to the lack of air renewal system. According to the results of European Union Table Project [16], within the existing European building stock, a large share close to 34% of the suburban multi-storey residential building stock is built during this period, before the implementation of any national thermal insulation regulations. Thus, a great potential of energy conservation arises through the respective energy renovation methods. In this context, E2VENT technology could considerably ameliorate the building's energy performance as preliminary studies have indicated that its implementation can result in a significant reduction of 40% on primary energy needs

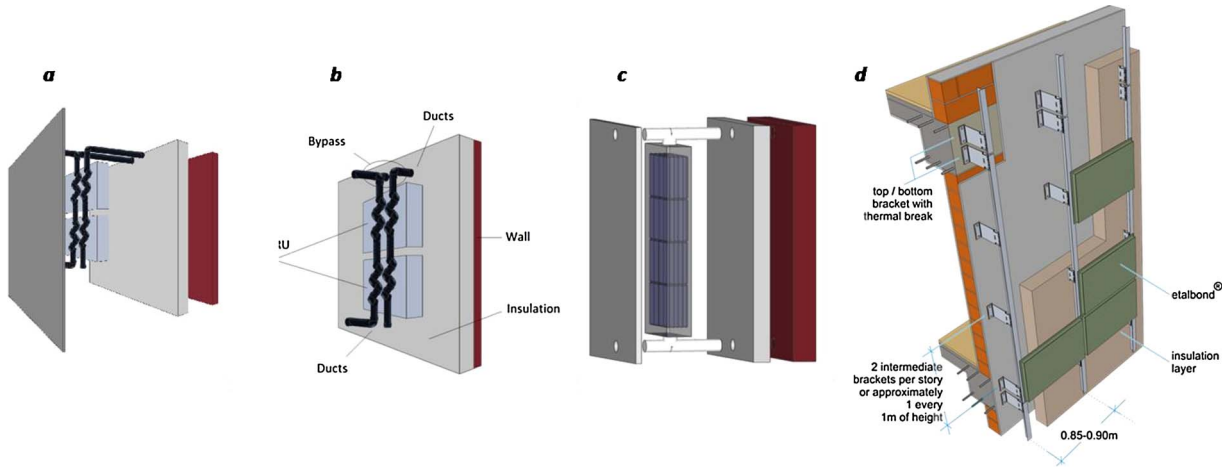

Fig. 1. E2VENT concept presentation. (a): E2VENT module, (b): SMHRU, (c): LHTES, (d): Ventilated façade system.