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E2VENT: an Energy Efficient Ventilated Façade Retrofitting System. Presentation of the Embedded LHTES System

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Abstract

Within the existing European building stock, a large share of the suburban multi-storey residential building stock was built in the 60's-70's, when there were only few or no requirements for energy efficiency. These buildings are characterized by very high energy consumption, low air quality due to poor ventilation, and low architectural value.
In this context, the European project E2VENT, that started in January 2015, aims at providing new solution of retrofitting of residential building. The proposal is a modular and adaptable ventilated façade retrofitting system that integrates an energy efficient HVAC system.
This paper first presents the concept of the E2VENT module, its architecture and how it is currently designed aiming at the reduction of the energy consumption and the improvement of not only the indoor air quality but also of the aesthetic of the building. Then the presentation focuses on the LHTES system, presenting its working principle, its thermal model and how it is designed in order to allow a daily thermal storage for both cooling and heating to allow the peak shaving. Three different PCM encapsulations are presented and discussed based on their efficiency calculated with a simple model but also on more practical considerations. Finally, the first prototypes are shown and the experimental protocol to be carried out is detailed.

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Keywords: Building façade retrofitting; PCM; Thermal storage; Air cooling system

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Nomenclature

Nu_D	Nusselt number based on diameter (-)	T_{pcm}	Temperature of the PCM
Re_D	Reynolds number based on diameter (-)	T_{in}	Temperature at the intlet of the system
Pr	Prandt number (-)	T_{out}	Temperature at the outlet of the system
Σ	Dimensionless pitch (-)	T_{ext}	Temperature of the external air
h_{pcm}	Internal enthalpy of the PCM (J)	T_{inf}	Starting temperature for PCM melting
h_{cv}	Convective heat transfer coefficient (W/m².K)	T_{sup}	Starting temperature for PCM crystallization
ρ	Volume mass (kg/m^3)	$\dot{V}$	Volume flow rate (m^3/s)
Cp	Thermal capacity (J/kg.K)	Ql	Thermal losses (W)
ε	Heat exchanger efficiency with NTU definition (-)	α	Liquid fraction (-)

1. E2VENT module

While new buildings can be constructed with high performance levels, it is the older buildings that represent the vast majority of the building stock, which are predominantly of low energy performance and subsequently in need of refurbishment work. Owing to this lack of energy requirements, the average energy consumption of the existing residential building is very high, representing 56.17% of the European residential building energy consumption and different reasons like low quality of the urban design or lack of minimum ventilation conditions allow the generation of different pathologies related to the humidity, deteriorating the indoor air quality and the life quality of the end user. The H2020-funded E2VENT project consists in the development of an adaptable renovation module for multi-storey residential buildings aiming at the reduction of the energy consumption and the improvement of not only the indoor air quality but also of the aesthetic of the building, increasing the value of the asset and providing healthier conditions for the occupants. The E2VENT system will be demonstrated on two buildings in Poland and Spain.

The targeted buildings correspond to suburban multi-storey residential buildings built in the 60's 70's that are characterized by a high energy consumption, bad air quality due to the lack of air renewal motorized system, and with low architectural interest. The E2VENT system is an external thermal building refurbishment solution with external cladding and air cavity that embeds different technologies that will ensure its high efficiency:

- A Smart Modular Heat Recovery Unit (SMHRU) for the air renewal allows the heat recovery from the extracted air using a double flux exchanger. Indoor Air Quality is ensured while limiting the energy losses.
- A Latent Heat Thermal Energy Storage (LHTES) based on phase change materials (PCM) will provide a heat storage system for heating and cooling peak shaving.
- A smart management system that controls the devices on a real time basis targeting optimal performances. It will embed new sensors, communicate with existing systems and recover predicted weather.
- An efficient anchoring system that limits thermal bridges and allows an easy and durable installation.

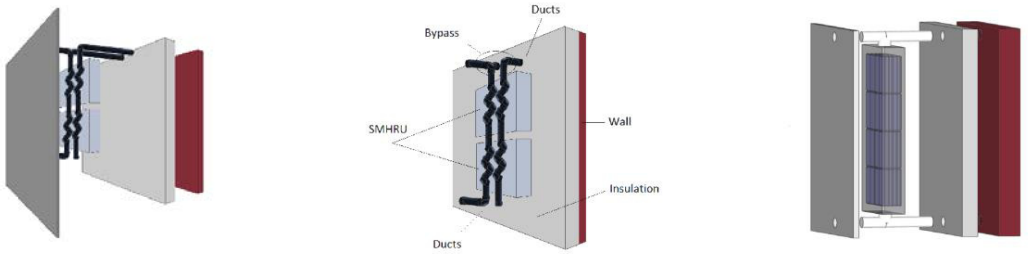

Fig. 1. E2VENT concept presentation. Left: E2VENT module. Center: SMHRU, right: LHTES

The Smart Modular Heat Recovery Unit (SMHRU) will provide the air renewal with an air flow that is determined by regulations. Thus the LHTES is not designed for the air renewal but only to store the external potential energy in order to use it for heating or cooling. Therefore it can be seen as a complementary system with