MF-Retrofit aims to address the numerous requirements of external façade panel retrofitting by developing a multifunctional, lightweight, durable, cost effective and high performance panel. Its layered structure enables the separate but also synergistic function providing thermal & acoustic insulation, excellent physical properties, resistance to fire and self-cleaning properties, supported by a fast, easy and economic installation.

**Objectives**

- To optimize the incorporation of nanomaterials into building envelope components (PCMs, polymers, fire protection systems and self cleaning coatings).
- To orientate building envelope materials towards exploitation of industrial byproducts (fly ash and rice husk ash) as well as renewable sources (biopolylols).
- To integrate multiple technologies into a single multifunctional façade panel system.

**Impact**

- Massive reduction in CO₂ emissions during production and operation of façade panels.
- The significant reduction of overall panel thickness and weight.
- To make retrofitting considerably easier, faster and more accessible.

**Anchoring Layer**

Development of polyurethane is accomplished using diacids and polyalcohols from renewable sources: terephthalic acid (glucose, biomass), adipic acid (sugar and red beets) and succinic acid (rhubarb, tomato). Ethanol, 1,3-propanediol and glycerin will be received from glucose and fatty acids. The integration of PCMs is also being conducted.

**Main Insulation Layer**

Clay Aerogel: Na-MMT as clay source, reinforced with PVA, cellulose fibers and casein.

Silica Aerogel: Rice husk ash as raw material, with TEOS, TMCS as siliating agents and reinforced with sepiolite, and porcine gelatin.

PCMs are being mechanically incorporated.

**Intumescent Layer & Surface Coating**

Development of intumescent layer: Intumescent coating using new materials technology to enhance thermal conductivity and fire resistance.

Development of the surface coating: A clear coating containing photocatalytic agents, compatible with most color formulations.

Development of photocatalytic agents: doping of TiO₂ nanostructured powder with metallic and non-metallic elements, modulating the material absorption. Commercial photocatalytic TiO₂ powders used as reference.

**External Layer**

Fiber Reinforced Polymers: fabricated with the hand lay-up process, reinforced by glass and carbon fibers, as well as inorganic nanoparticles dispersions, mainly for fire resistance enhancement.

**Phase Change Materials**

Commercial PCMs were reinforced with CNTs and graphene oxide. The incorporation of PCMs is investigated in the anchoring and main insulation layers through the development of associated models.

**LCA and modelling**

The specifications and experiments will be aligned with simulation and modelling tools to maximize efficiency.

**Development of thermal models**: Heat-air-moisture, CFD/Fluent, Thermal & Mechanical, Theoretical calculation of U-value. LCA/LCCA analysis performed regarding materials and processes employed. Numerical models are being developed to define and optimize PCM positioning in the panel, as well as modifying the thickness of individual panel components depending on thermo physical properties.