

PVC profiles with the insertion of new insulation elaborated from recycled material

Call: INNO-ESPAMAROC ENERGY: Agreement between CDTI (ES) and IRESEN (INSTITUT DE RECHERCHE EN ENERGIE SOLAIRE ET ENERGIES NOUVELLES) (MAR)

CDTI website: <https://www.cdti.es/index.asp?MP=8&MS=155&MN=2&TR=C&IDR=2234>

Deadline: March 25th, 2021

1. Summary:

The building sector is considered as one of the world's largest consumers of final energy, with up to 40% of the world's final energy consumption. This energy demand is growing every day and is consumed in the form of heating, cooling.

In buildings, windows are considered as a weak bridge allowing heat loss up to 30%, several studies have focused on improving the window glazing. Today interest is turning towards frames as an important component to optimize building insulation and reduce energy consumption.

PVC profiles have emerged as a material capable of replacing aluminum and wood in the market. Obtained by extrusion process, thanks to their low thermal conductivity and low cost, PVC profiles present a good compromise.

The project aims to establish a bridge between Morocco and Spain in a new approach by developing PVC profiles with the insertion of insulating materials based on polymers or blends of recycled polymers. These recycled insulations will be positioned inside the inner tubes of the profiles allowing the reduction of heat loss and energy gain, contributing to the energy efficiency.

Going further, the marketing of PVC profiles filled with insulation will not only save costs and energy but also, thanks to the recyclability of PVC, 70% of the frames are recycled at the end of their life cycle. This property has the advantage of reducing manufacturing costs by substituting virgin materials with recycled ones.

On the other hand, the insulating materials used will be based on recycled polymers, which will reduce the waste rate and therefore contributing to a more sustainable production process

and to minimize the impact on the environment (greenhouse gas emissions, increase in waste rates...).

The project involves multiple investigations. Firstly, we will use a qualitative approach by developing a recycling technique to purify the recycled polymer as much as possible, and separate it especially from the other polymers with which it was mixed (when it was poorly sorted), and then characterize it in order to determine its thermal, mechanical and thermomechanical properties. In a second step, we will build on the results obtained to develop a suitable inserted insulation blend formulation that can be applied to PVC profiles. Finally, the last step is the verification of their conformity and certification against international standards and requirements and if it is possible, carry out a validation test of the energy efficiency of the prototype in a real environment.

Objectives

The project aims to propose a new generation of PVC profiles with the insertion of recycled polymer-based insulation. This will achieve a multiple objective: to reduce the rate of plastic waste and minimize greenhouse gas emissions, final energy consumption and product cost, and to improve thermal comfort within the building.

- **Specific objectives**

- Minimizing the cost in terms of raw materials and energy
- Improving thermal comfort by minimizing heat loss. Energy efficiency.
- Characterize waste into recycled polymers to recover them and transform them into new insulation materials.
- Establish an experimental design to determine with a minimum of testing and maximum accuracy the correct formulation of the recycled polymer blend forming the added insulation.
- Study and compare the mechanical and thermal properties of the developed formulations.
- To evaluate the cost of the developed formulations.
- To control and test the PVC profiles (according to the standards in force).
- To analyse the thermal conductivity of the profiles
- Numerical simulation of thermal efficiency.

2. Consortium:

Moroccan consortium:

- Moroccan Company: MEKSA <https://meksa.ma/>
- Centre technique de plasturgie et de caoutchouc (CTPC) <http://ctpc.ma/>

Spanish Consortium:

- Spanish Company
- Leitat Technological Center - <https://www.leitat.org> (to be subcontracted by the Spanish Company)

3. Role of Spanish Company:

The company would develop a recycling strategy using a polymeric waste stream (styrenic, polyolefinic or PVC). The company should provide a separated polymeric residue. The company should also have ability for extrusion processes with the incorporation of blowing agents. The company should also develop/use a profile for correct adaptation of the foamed profile to the window profiles.

- Leitat: First, will thoroughly characterize the polymer properties. Then, will study and select different blowing agents for its incorporation in the provided polymer waste. Thereafter, will study the incorporation effect of the additive in the materials' properties (physical, thermal, and acoustic) as well as the cell formation (through SEM).

4. Role of Moroccan Company

The Moroccan company will manufacture PVC window profiles and develop a technique for inserting the developed insulation inside the empty cavities of the profiles without affecting the properties of the two products (profiles and insulator).

- CTPC: firstly the center will characterize the raw material with which the profiles will be elaborated (PVC), then it will test the properties of the produced profile (not inserted) according to the standards and regulations, carrying out mechanical, thermal... tests, After insertion the CTPC will perform thermal tests on the developed profile.

5. Description of work:

Modification of the cellular structure of a polymeric waste stream, preferably coming from construction, for use as foams for insulation material in window profiles.

The Spanish company will provide a polymeric waste (polyolefin, styrenic, or PVC). Together with Leitat, they will characterize the polymer and select different blowing agents for its incorporation in the previous polymer.

The Moroccan company together with the CTPC will study the effect of the blowing agent incorporation on the cellular structure of the material, together as physical, thermal and acoustic properties. Thus, the adequate material for scaling up will be formulated.

Finally, the Moroccan company will scale up the technology and develop the required profiles requested for windows isolation.

WP1: Requirements definition, state of the art, and design considerations.

- Task 1.1: Requirements definition and design considerations.
- Task 1.2: State of the art.

WP2: Sorting of waste for recycled raw materials obtention.

- Task 2.1: Identification of potential recycled raw materials in waste streams.
- Task 2.2: Sorting of the recycled raw materials.

WP3: Profile Production.

- Task 3.1: Characterization of the raw material and the profile formula (Addition of additives ...)
- Task 3.2: Testing and certification of profiles according to standards and regulations

WP4: Foam production.

- Task 4.1: Additive performance screening.
- Task 4.2: Content-effect exploration and formulation development.
- Task 4.3: Scale up of the technology.

WP5: Validation

- Task 5.1: Technical validation of the developed window frame.
 - (Thermal, acoustic? Physical, mechanical)
- Task 5.2: LCA and LCCA?

6. Budget for the Action

The budget for the Spanish entity will be defined once the description of work is adjusted and agreed with the Spanish company. The Spanish budget will not be less

than 175.000 (as set by CDTI in the call bases), and will cover personnel costs, materials, overheads, and the cost of subcontracting Leitat.

7. Contact details:

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