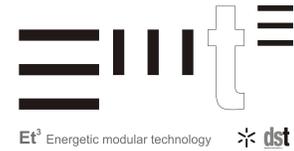


Brief description – Abstract

Projects short characterization. Advantages of this solution compared to the actual state of the art.



Et³ Energetic modular technology – *keeps, renews & reuses energy*. Prototypes and simulation of architectural utilizations.

The present technology establishes an innovative timber-glass composite constructive system in which the combination of these materials simultaneously assumes energetic, structural, functional and aesthetic character. This particular feature places the product of this investigation in the combined sphere of Engineering and Architecture, in the specific field of ground-breaking technologies in construction, both in new buildings and in the rehabilitation of existing ones.

The system materialises through a multipurpose modular panel, able to be applied horizontally – as slab – or vertically – as sustaining wall. It integrates passive solar systems and bioclimatic functions, which results in energetic efficiency, thus constituting a clear innovation in terms of prefabricated structural elements. Besides prefabrication, this product assumes as strategic principles modularity, habitational evolutionability, industrial production and transportability. Such principles fit in the pursuit of productive optimization and implementation strategy.

While assume the role of architectonic and structural skin, border line between interior and exterior spaces, this system reinforces its importance in the energetic performance of the construction and the comfort of the inhabitable space, mainly in terms of thermal transfers, air circulation and natural lighting levels – aspects which, taking advantage of the solar energy, decisively contribute to the rationalisation of energetic consumption and effectiveness in its management. The central strategy is based on principles intended to be economically solid, culturally evolved, socially fair and ecologically responsible.

Main objective and the basic problem solved by the innovative solution.

The resolution of the question on the basis of the developments achieved with this project lies on sustainability criteria, and is, in a first stage, an answer to the latest challenges and global energetic conditions. Within this context, and based on the cooperation between the fields of research – University of Minho – and industry – dst, s.a. –, a sequence of products and innovative constructive technologies was developed, whose main purpose is also to strengthen the competitiveness of the involved sectors. Timber is a renewable material. However, it does not ensure sufficient thermal inertia in order to be utilised in bioclimatic passive solar systems. The **Et³ Energetic modular technology** goes beyond this concern by including energy accumulating stone elements inside the timber panels. Besides providing stiffness to the timber substructure, glass allows solar radiation to shine on its surface and prevents the subsequent dissipation of the gathered energy, thus complementing the system. The recourse to renewable energies can also be enhanced by applying solar glass, making possible the introduction of additional active solar systems – unprecedented feature in structural elements. Besides the properties of the utilized materials – renewable and recyclable –, the constructive system is based on the presumption of reusing, via the solutions of evolutivity and connection / disconnection developed

at the level of architectural detail. Hence, as a way of optimizing the production process and deeming the product replicable, modularity and prefabrication criteria were adopted according to the strategic scope of the developed solutions. Besides being economically central, these criteria make way to filling a market gap as far as energetic, sustainable and bioclimatic prefabricated structural products are concerned.

The Et³ lies on a scientific base of three years of undisclosed applied research, whose core was the timber-glass structural bonding. This technology – we named **tglassbond**, *timber-glass structural bonding system* – comprises an extraordinary potential of constructive and energetic development, yet internationally unexplored. Summing up, it is possible to state that, with this bonding technology, the mechanical capacity of the composite system is substantially higher than the sum of the individual behaviours of the composing materials, which confirms its structural capacity. With the purpose of achieving the ideal balance between strength and stiffness for each specific situation, an extensive set of experimental tests, which included several trades and adhesive types, was performed.



Detailed description of the present technology and energy efficiency plan.

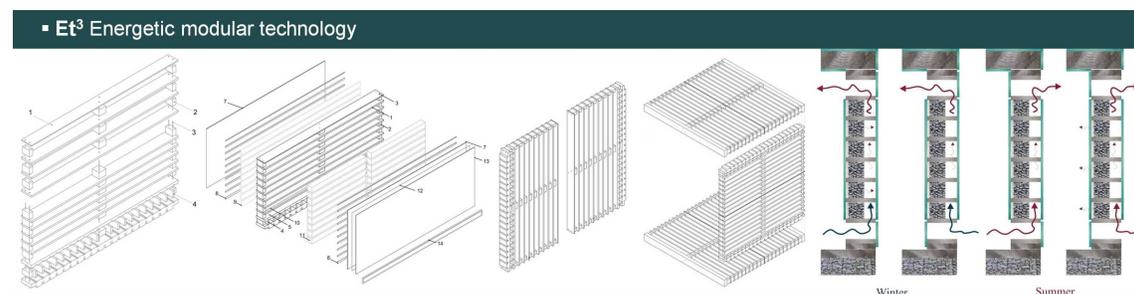
The combination of the potential of natural lighting with the expressive component, making use of the yet unexplored resistance capacity of glass – through the very first structural solar glass –, and integration of strategies of renewable energy, results in a prefabricated product, radically distinct from what is currently available in the construction market.

The Trombe ventilated wall is an important reference in this context. Nevertheless, its concept is usually not compatible with prefabricated constructions, even less when they applied as the entire structural component of the building, and certainly even less with features of lightness and luminosity in the vein of those accomplished by Et³.

Et³ holds a set of characteristics which, when combined, distinguish it in terms of innovation and marketing strategy:

- **Multi-structurality.** Autonomous triaxial element (slab, sustaining wall with vertical or with horizontal boards);
- **Energy.** Thermal, acoustic, lighting efficiency and consequent enhancement of energetic resources;
- **Sustainability.** Integration of passive and active solar systems, bioclimatic principles and natural lighting;
- **Architecture and modulation.** Metrics, modularity, habitability and urbanity;
- **Self-restraint.** Ribs integrated inside the element restraining perpendicular actions;
- **Lighting and shadowing.** Architectural expressiveness and effective solar protection in several orientations;
- **Rehabilitation.** Integration of technical infra-structures in the panel hollows;
- **Prefabrication and applicability.** User-friendly system, control of costs, quality control and transportability;
- **Durability.** Protection of the timber and the adhesive by means of glass skins.

The images depict the simplicity of production and assembly of panels, in different positions. They also illustrate the natural ventilation system at work, adaptable to the several seasons. The panel openings – located at the top and base, inside and outside –, allow the air circulation that ensures the cooling of the wall (in summer) and the heating of the inner space (in winter), thus minimizing the energetic costs and supporting comfort.



Et³. Assembly outline of the timber substructure, panels assembly and integrated natural ventilation system.

Plans concerning the practical implementation of the idea. Market strategy.



▪ **lighthouse** – prefab modular houses & urban solutions



lighthouse – prefab modular houses & urban solutions. *Lightweight & natural lightening*. Et³ architectural applications.

The Et³ technology is at a stage of development in which, simultaneously, steps such as prototypes, replication analysis and production potential, scientific validation, national patent registration, market research and implementation sectors survey, marketing project and business plan have already been fulfilled, and quite encouraging results were achieved.

As a starting point, several laboratorial prototypes were generated, then tested regarding their structural component – as will ahead be illustrated. The industrial production component was also analysed. The guarantee of quality control was proved, as well as the industrial productive profitability and cost decrease, thus leading to high replicability.

As far as the markets are concerned, the purpose is to follow ways that lead to export and implementation in all the European continent – particularly in countries that already have timber use policies (e.g. France, Germany, Switzerland, Austria, Finland) –, but also in Asia, North America and Australia, given the energetic advantages of the product.

The implementation sectors are broader than usual, due to the feature of panels being able to be traded as final product – for a regular use in rehabilitation projects or new construction –, or a sub-product of another product developed based on the Et³ system – the *lighthouse, prefab modular houses & urban solutions*, as show in the pictures above –, and in which commercially investment is intended. The utilization of the concept of multipurpose and structural autonomy of the Et³ panels leads to the conclusion that these comprise a considerable potential of market implementation.

Sustainability consequences of implementing this technology and strategic concepts.

The present innovation comprises three components in the framework of the principles of sustainability: the economic viability of its implementation, based on a promising business plan; the environmental compromise with recourse to solar systems integrated in an innovative method; and the social and cultural support based on the constructive approach to nature and its renewable resources, which leads to the *Forest Based Sector*. Thus, the Et³ system reinterprets, reinvents and recreates new horizons in the application of sustainable solutions. That is the *spirit* of its impact.

Given the important role of the construction sector in the lives of populations, a high social impact regarding this project is expected, mainly in the perception of citizens on eco-efficient and environmental responsibilities. This is a compromise we endorse as fundamental in the development of our R&D activity.

▪ Prefabrication and metrics , transportability, modularity, habitability and urbanity – self-sustainable architectural solutions



Strategy – some principles and assets associated with the implementation of the product of the investigation.