

PARTNER



So.Ri.Ser. S.c.r.l. (Società Consortile di Ricerca e Servizi) is implementing the industrialization phase of the research project **PR.IME3**, co-funded by the Ministry for the Environment, Land and Sea (2009-2013). In response to the demand for innovation in energy and the environment in the Italian context, So.Ri.Ser.'s mission includes: multidisciplinary expertise in sustainable development; energy efficiency implementation; and technological innovation activities.



AE.C.I. S.r.l. (Architettura Edilizia Civile Industriale)
The Company **AE.C.I. S.r.l.** was founded in 1978. The sectors of activity and research in which it operates are: Architectural design and civil and industrial construction (planning, industrial building) Sustainable architecture; Energy Efficiency of Construction Works; Industrial design (design, materials and techniques); Scientific research. The company integrates its design skills with those of **Architettura MICardillo**.



CORMATEX S.r.l.
Cormatex operates internationally in the technical textiles production sector, employing advanced technologies for both quality control and testing of mechanical and electrical components.



INGE.CO. S.r.l. (INGEgneria e Costruzioni)
INGE.CO. s.r.l. has been operating since 1985 as an engineering and consultancy society in the sectors of Civil Engineering, Architecture, Urban Planning, Building and Industrial Technology, Fire Prevention and Computer Science.



Politecnico di Torino – Dipartimento Architettura e Design
The Department of Architecture and Design promotes, coordinates and manages theoretical and applied research, training, technology transfer and services to the territory with reference to the sectors of Architectural Design, Technological and Environmental Design and Urban Projects.

TECHNOLOGICAL SPONSOR



PROJECT MANAGER

ARCH. MARIA IRENE CARDILLO
Via del Casaleto, 200/F Rome, Italy
micardillo@prime3.it
+39 0658233114

SCIENTIFIC COORDINATOR

PROF. ARCH. MARIO GROSSO
mgrosso@prime3.it

ENVIRONMENTAL BENEFITS

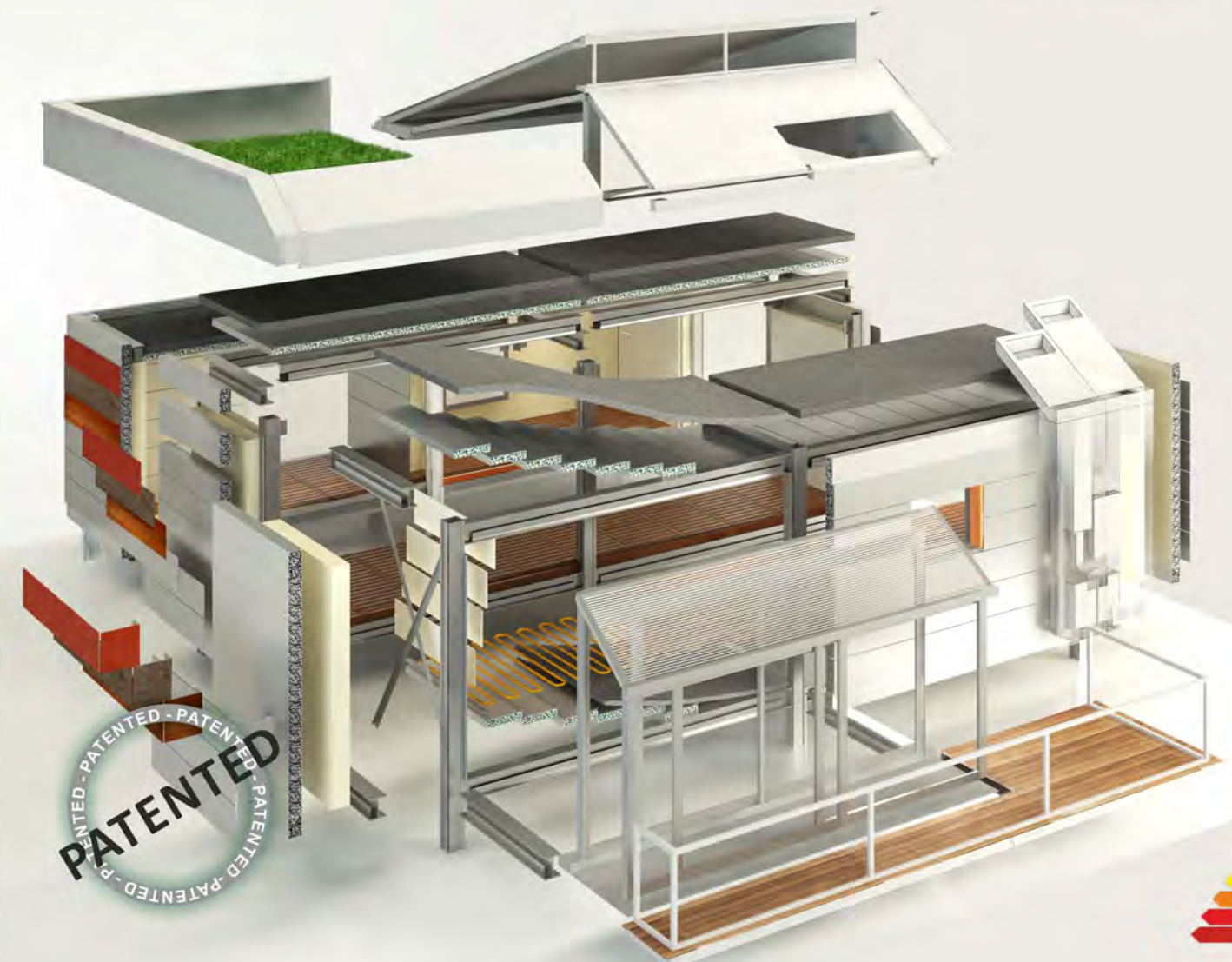
- 70% REDUCTION OF ENERGY DEMAND
- 80% REDUCTION OF CO2 EMISSIONS
- CLASS A+ ON ENERGY EFFICIENCY
- IMPACTS ON PRODUCTION PROCESSES AND MARKET OF BUILDING AND TECHNICAL SYSTEMS

TECHNOLOGIES

- FNAC WALL SYSTEM (HYBRID NATURAL AIR CONDITIONING)
- TECHNOLOGICAL INNOVATION FOR BEARING STRUCTURES USING METALLIC ALLOY
- INSULATION FROM INDUSTRIAL WASTE RECYCLING PROCESSES
- THERMAL RECOVERY OF WASTE WATER

SMART BUILDINGS

- HIGH ENERGY EFFICIENCY/LOW EMISSIONS BUILDING MODULES
- DESIGN FLEXIBILITY
- DRY ASSEMBLY



PR.I.M.E3 (Innovative Procedures for Energy-efficient and Eco-friendly Modular Buildings) is a project related to the industrialisation of modular building units, aggregated both vertically and horizontally. PR.I.M.E3 has completed the prototype phase.

The project aimed at developing and testing a modular building unit, with its individual sub-components, characterised by high energy efficiency and low environmental impact of the elements and materials used, both in the production and use phases as well as by the reduction of costs for transport and assembly. Basic design concepts are: integration between formal aspect and performance characteristics of subsystems, a bioclimatic approach, and optimal orientation.

The PR.I.M.E3 modules are designed for residential, industrial and service building sectors. The single module has a floor area of 50 m² and 70 m²; through the combination of these modules different architectural solutions by types and sizes can be realised.

The project includes different types of aggregation allowing for fulfilling any kind of typological demand from the building market: linear buildings, terrace houses, towers, court buildings...

This aggregation allows for a design flexibility and a pluralism of aesthetical expressions which made the building modules fit to the individual ways of living of the potential users.

The application of PR.I.M.E3 concepts and results at the urban scale could lead to the realisation of **ECO-VILLAGES**, hence, promoting technological excellence in the area of Research and Development, consistently to an urban model characterised by high energy and environmental efficiency. Building modules will be sustainable in all their technological components, representing the ecoefficient modules of Eco Villages with reduced emissions and totally energy self-sufficient. PR.I.M.E3 module, due to its reduced pre-fabrication and assembly time characteristics, is thought to be able to respond also to emergency needs.

ENVIRONMENTAL RESULTS

The environmental benefits of PR.I.M.E3 project's expected results are high: concerning the energy sector, a reduction of 70% of the net energy demand at the same comfort level, and of 80% of CO₂ emissions, are estimated, compared to a current technology benchmark building.

For the whole project, the direct environmental results are: a) a primary energy demand for space heating placing the building module in class A+ (threshold varying with climate zone); b) zero energy requirements for heating of sanitary water; c) use of recycled material for the thermal insulation of the building envelop; d) application of passive and hybrids systems for cooling reducing by half the energy requirements, compared to conventional air conditioning systems; e) thermal recovery of wastewater from showers, sinks and washing machines; f) collection, recovery and reuse of rainwater for compatible uses; g) bearing structure in aluminum with a high percentage of recycled and recyclable material; h) "dry-assembled" construction type, with potential for total disassembly at the end of life, and therefore, reducing the use of raw material for new construction cycles; i) absorption of a portion of CO₂ in the atmosphere through roof garden roofs.

ENVIRONMENTAL INSERTION

The building module has been designed to fit to any environmental context. This aspect, and the relevant analysis of climatic factors, has been essential in the study of subsystems, i.e., in evaluating the potential of: rainwater recovery, thermal insulation, controlled natural ventilation, and cooling. As a matter of fact, those analyses have been referred to three site-samples, representative of the climatic variations of the Italian territory.

TECHNICAL INNOVATION

The PR.I.M.E3 project integrates the sub-components systems in a design process leading to a modular unit characterised by the following performances:

- building elements components are factory pre-assembled;
- sub-modules are easily transportable;
- structural elements and concepts are innovative;
- spaces are functionally flexible;
- building elements are made of innovative recycled and recyclable materials;
- modules realisation costs are low;
- indoor air quality is an essential aspect of system design;
- the construction process is totally industrialised.

The main sustainability value of PR.I.M.E3 module is the integration of the whole environmental performance with the performance of each subsystem, characterized by a high level of technological innovation, e.g.: **the choice of aluminum as a material for the bearing structure**; the synergy between bioclimatic elements such as sun space and buffer space; the concept, design, and testing of a newly developed technical wall component (H-NAC wall: hybrid-Natural Air Conditioning wall), which substitutes HVAC conventional system with passive and hybrid physical mechanisms; an approach based on the life cycle assessment of materials and the reuse of waste materials for integrated building elements.

The great originality and innovation of PR.I.M.E3 building module is precisely the integration of subsystems:

- **Structural Subsystem;**
- **Subsystem of Controlled Natural Ventilation;**
- **Subsystem of Buildings Insulation;**
- **Subsystem of Water Cycle;**
- **Subsystem of Microclimate Control and Monitoring.**

All subsystems are designed and analysed using criteria and procedures characteristic of architectural and structural/construction design. The selection of **an innovative material** such as **aluminum for the realisation of structural components**, has several advantages: lightness, structural efficiency, simplification of the assembly steps, transport efficiency, reduction of the loads transmitted to the foundation.

PR.I.M.E3's design approach responds to many challenges: the building module is not only competitive at the environment and construction level, but also economically, because the adopted solutions, lower considerably construction costs by using a logic of pre-fabrication and seriality.

ECONOMIC AND SOCIAL IMPACTS

The technological transfer of PR.I.M.E3 project's results could have impact at various levels:

Market: the direct applicability of results implies short-term effects in all sectors of construction through a competitive advantage in the containment of construction costs compared to traditional buildings.

Production chain: in the medium term, the tested prototypes will induce the industrial development of innovative prefabricated elements to be used in the building modules for: ventilation and air conditioning (passive air catching/ exhausting elements, windows and vents with motorised openings linked to environmental sensors, passive heat exchange systems, adsorption chambers, etc.); thermal insulation (panels and loose materials from textile and tire production waste recycling process); and structural components (ad-hoc-shaped aluminum profiles).

Operators: there will be a renovation of technicians and operators in the building sector, with the involvement of Professionals Associations to create new training paths for technology, environment and energy efficiency specialists.

Institutions: in the medium term, Local and National Territory Government Institutions will be able to use PR.I.M.E3 knowledge as a tool for a sustainable planning and control of the building development activity aligning codes and regulations to the new-developed indicators.

Society: It is expected an increase in the quality of life for the positive effects on the environment and for more livable and comfort of buildings.

