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Original Paper

The Research Laboratory of the Mediterranean University

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Abstract

The laboratory, called LAB RENEW MEL created to test new technologies for producing energy from renewable sources thanks to the decisions of the management committees of three projects funded under the National Operational Program for Research and Competitiveness 2007-2013:

RENEW Project (2014-2016) Coordinator prof. Claudio De Capua (Note 5)

MEL Project (2014-2016 Coordinator prof. Pasquale Fabio Filianoti (Note 6)

GELMINCAL Project (2011-2014) Coordinator prof. Francesco Della Corte (Note 7)

All three projects together have a budget of nearly thirty million Euros. These are substantial resources that can allow the Mediterranean to take on a role of excellence in research on renewables. The establishment of a research center aims to achieve this goal, involves three departments of the University of Reggio Calabria, two of Engineering area, the Department of Civil Engineering, Energy, Environment and Materials (DICEAM) and the Department of Information Engineering, Infrastructure and Sustainable Energy (DIIES) and one of Architecture area, the Department of Architecture and Territory (dArTe).

The author of this article is also the designer together with professor Alessandro Villari and professor Angelo Di Chio, who have followed, from the initial stages, all aspects related to the relationship between the objectives of the research and those related to the implementation of the Laboratory.

Keywords

laboratory, energy efficiency, sustainability, disassembility, reversibility

1. Introduction

The research units, in the original aims, consistent and in line with the technical and scientific debate on the issues of sustainable development and energy conservation, has promoted the realization of the Laboratory with a project oriented to promote sustainable and environmentally friendly solutions that are well confronted with those strictly related to the complexity of the specific destination of use and of the equipment contained and focusing in four main basic elements:

- Primary generation systems, such as photovoltaic panels, solar thermal panels, storage facilities.
- Generation of secondary systems, such as equipment for the production of electricity from fuel cells.
- Presence of advanced systems for electrical measurements able to analyze in detail the performance of appliances and a characterization of highly advanced accumulator system.
- Presence of volumetric and architectural forms experimentation entrusted to the elements added and modified until total elimination. These essential components is responsible for the verification of energy-architecture interactions. Ambitious but innovative because it requires the building to "be" the subject of experimentation not simply "include" experimentation.

2. Method

To date under completion, LAB RENEW MEL insists on a residual area of the city, terminal place but also head of the urban waterfront and although the main objective was to design a "Laboratory building", it also raises to regenerate a place of the city that, although in a central position, is degraded and almost abandoned **(Figure 1)**.

Figure 1. The Site

The idea that supports the project is suggested by the elongated shape of the area and by the proximity to railways and long trains stop at the depot. It is a building-train, one floor, divided into sections fitted together with different arrangement planimetric. It hosts the laboratory functions under a single roof, shaped like an origami that follows the profile of the mountain on the horizon over the Strait. This building, with structure and envelope made entirely of wood, thought to be removable and therefore with the possibility of being repositioned to another place and whose design choices derive from the assumption of principles of sustainable development:

- Need to limit the consumption of materials and energy resources;
- Need to create a building with a high level of energy efficiency and with a strong propensity to integration systems;
- Need to explore new forms of thermal energy self-sufficiency also towards exceptional events natural disasters where the energy supply should be interrupted;
- Evolution of the realization processes towards advanced systems able to give concrete answers to the need to reduce consumption and impacts.

Design decisions resulted, in large part, of the pre-design knowledge, focusing the condition of the place with its natural features and man-made ones, its history, its tracks.

The localization of Lab MEL RENEW in seafront, clearly recalls the role foundational public work in a strategic place of the city. This evidence is even stronger when you consider the intervention as part of the "University system" of Reggio Calabria, to which, from the beginning, was attributed the large and difficult task of contributing to the development and redevelopment of urban order.

The above is confirmed by the various constituents of this site: the Messina Strait, the coastline, the Waterfront, the railway station and the system of the binary, the torrent Calopinace, the Mediterranean University Laboratory NOAEL and the project South Linear Park. In fact, after a careful reading of this ensemble we understand the extraordinary potential of the urban site, for reciprocity and the interrelationships of forms that characterize the settlement pattern and the morphology and the natural environment. A place where the dialectic between artifice and nature **(Figure 2)** is appreciable and the strong relationship with the Strait highlights belonging of area to a wider scope and more ambitious programs (Waterfront).

Figure 2. The Project

The landscape is really extraordinary, the city of Messina, the north coast of Reggio Calabria, the sea of the strait are a single scenario every day in different colors and depth of perspective, a good to be protected above all to value, unlike that which is the present condition. The landscape value elements present in it are concerned specifically with environmental and natural features rather than architectural. These are the elements that the project wants to emphasize through the architectural choices and materials.

The impact of the project is minimal thanks to the reversibility of construction choices, but we believe that it can even further enhance the place through architectural and materials solutions that tend to show the scene as a picture framed by the wooden doors of the Laboratory through optimization of pathways and the use of the road gradient to avoid impacts and visual barriers.

In terms of construction and technology, the building manifests from the first moment the project all the hallmarks of careful construction equipment at any time of its construction process: from the transport of building components to the adopted construction method and to the constituent materials. Starting from the mechanism associated with minimum impact on the ground that hosts it making use of a lightweight prefabricated founding system so oriented as to its construction to its "deconstruction". The project, with structure and closures entirely of wood **(Figure 3)**, is thought to be dismantled emphasizing its nature as perfectly reversible intervention with zero impact. With the possibility to be relocated to another place again by reactivating the constructive action as well as its experimental feature and informative.

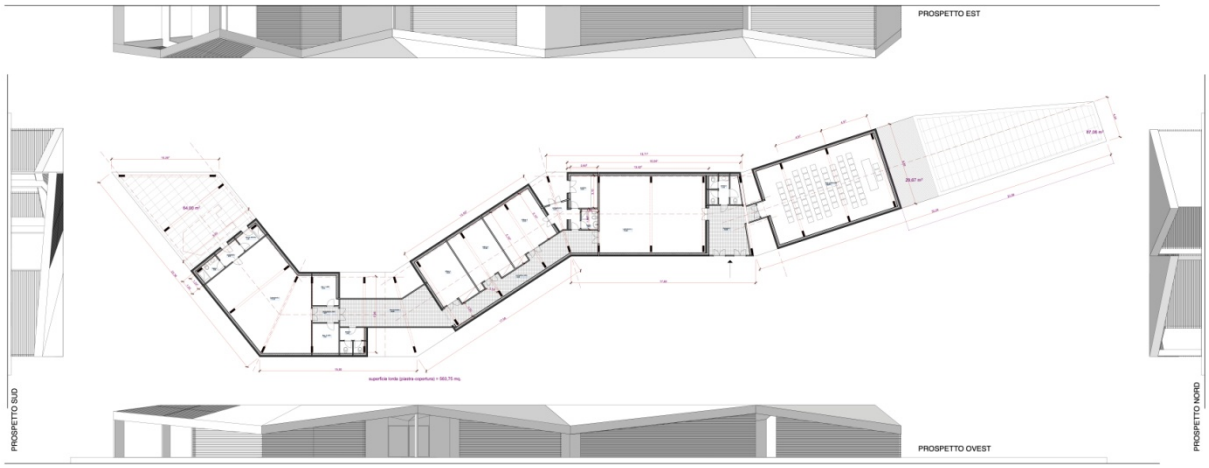

Figure 3. The Internal Distribution of the Ground Floor

The building envelope, the architectural organism extreme edge, for centuries measure and compare with their own architectural materials and building technologies that build it.

LAB RENEW_MEL aims at an innovative exploration: that of the integration between the form of architecture and new technical elements in conscious and in particular energy consumption for the production of energy from renewable sources.

Until now elements devoid of characteristics adequate for integration in the constructive system, dimensionally not insignificant to be considered system, not unwieldy to make them inadmissible. Awaiting to be reviewed in the possibility of obtaining hospitality within the architecture. Where the morphological and stylistic history not yet have its own historicizing, the site of the project assumes the typical role of research and experimental exploration which typical way of designing.

These aspects are all internal to the philosophy of the whole project. Desire extreme to the maximum "integrate learning" here considered for a project as ambitious as scientifically rigorous. The construction involves structuring aspects of Technology and Materials. new frontiers integration of photovoltaics in architecture will be explored. Bases of study for new application trials will be set, from the micro wind turbines due to "domestic" omnidirectional in the airflow in the wind tunnel amplification conditions.

The Strait of Messina has, for its peculiar topography and microclimate geographical conditions, the favorable conditions for the harnessing of wind as well as in all places the same features (intra-island channel, Aeolian Islands, Strait of Bonifacio, Elba, Tremiti Islands, etc.) in which the air flow is already, in addition to frequent, also in natural conditions and acceleration of clear prevailing direction.

The scientific place of the experimentation is the evaluation of new volumetric forms and surface to "venture" effect in which is the same building to provide increased accelerative further. The turbine systems, as is known, haven't the limits imposed by the wind towers that, on the contrary, have both startup inertial difficulties that higher operating speed limits. This is one of the tasks that will be assigned to the building-laboratory with installations both stable and interchangeable. The "heads" of

the building have the best potential for these possible future experimental solutions: the construction of additional curved walls which house the turbines flow amplification.

In the first construction phase this aspect does not have the economic resources needed to start it. the assessment was postponed to a later date possible but desirable.

In the contract, the features of the building have been described through a performance logic, preferring a classification into "technological units" (Campioli & Lavagna, 2013), in which the processes involved in an interrelated manner and with criteria of integration and complementarity with respect to:

- Bearing structures (foundations, elevation, containment);
- Horizontal internal closures (floors, completions);
- External closures (opaque vertical, fixtures, horizontal floor, roofs).

3. Result

The constructive model allows the building a high level of flexibility and adaptability of use, able to optimize energy consumption in relation to environmental conditions health required (D'Olimpo, 2017). The building's spontaneous behavior can be integrated by the use of appropriate solar gains and other local climatic factors (climate-sensitive building).

These capacities are according to some fundamental points and the identified materials and the underlying assembly process, offer themselves the best declaration of these possibilities:

- The reduction in energy demand by improving the efficiency of housing;
- The exploitation of the natural elements to obtain the indoor comfort conditions;
- System integration and design.

The prefabricated technology aim at serial and is careful to issues concerning indoor comfort and the reduction of impacts thus the most significant requirements related to the project are: Adaptability, Flexibility, Reversibility, Integrating Plant Engineering, Energy Efficiency.

As for the technical choices (Askeland, 2017), we chose to adopt dry construction systems with S/R technology (structure/Coating) **(Figure 4)** representing the most advanced example of rationalization of construction processes accessible through high degree of industrialization. These are characterized, for the high degree of flexibility of the technical solutions, for the use of materials and thus also performance (thermal one, acoustic one, fire prevention measures, etc.). The subset of the bearing elevation structure is made of a wooden frame in the form of preassembled portals in number and unique shape for each portal for a structural pitch of about 5 meters.

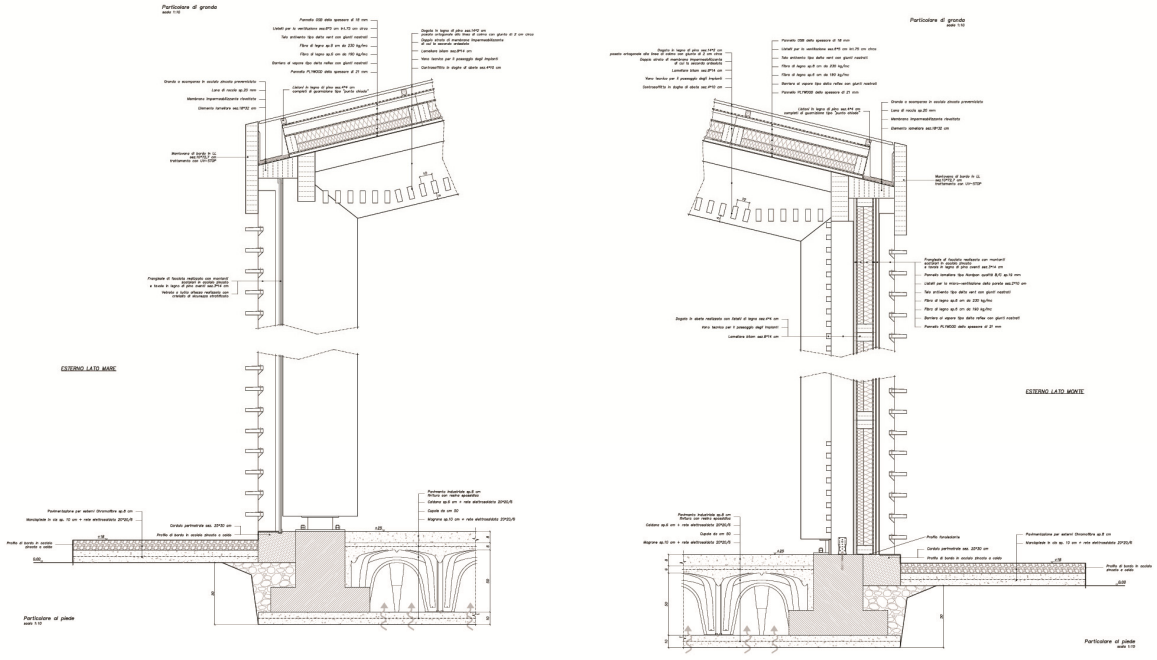

Figure 4. The Dry Construction Systems

All vertical walls and horizontal floors are constructed of materials and components chosen appropriately to specific functions: assemblyability both in work and out of work, easy to transport with ordinary means, disassembly forecasts, easily of hosting also reversible system networks. In the interspaces and in interconnection spaces, the system networks can be easily inspected, integrated or replaced throughout with removable proceedings.

The requirement of easy of inspection, substitution and integration is not directed so much to the merely operational and maintenance possibilities as to the real possibility of offering the adoption of alternative solutions of new functional models and technical elements resulting from experimentation that, as "machine" flexible, the building will offer in time and place. The latter character is the real goal of the challenge of thought put in place by LAB_RENEW_MEL project.

The foundation beams **(Figure 5)** are cast on site in reinforced concrete whose bearing surface has been oversized in order to ensure its reuse possible in different conditions in the event of displacement of the entire laboratory. The intimate structural connection relationship will be integrated by an interposed system of seismic isolators, also dry assembled, acts to permit verification of the behavior of the building under dynamic stress of horizontal thrusts. Although not part of this project could be the subject of specific studies in synergy with future research projects on earthquake. We do not forget the particular territory and the territory where the Mediterranean University has been operating for almost fifty years.

Figure 5. The Foundation Beams

The bearing structure of elevation **(Figure 6)** is obtained through the construction, transport and assembly of "portals" laminated wood **(Figure 7)** as well as for the beam-pillar connection, the constraint at the base is also provided for interlocking but may also contain the hypothesis of its hinged constraint for the particular connection to the supporting system on the ground. In accordance with the general objectives of complete removability of the building with minimal alterations of the host sediment. Key building block of the entire system itself becomes functional technical element on which all subsequent technical systems and completion will lean: cover, vertical closures, higher systems, interior partitions.

Figure 6. The Bearing Structure of Elevation

Figure 7. The Bearing Structure of Elevation

The technology roof package is consistent with the architectural image toward achieving a morphological conception unitary monolithic material: wood as raw material constructive, structural and surface.

4. Discussion

Functional layers extrados and intrados will be located in the outer fringe of the dimensional reference of the supporting beams reclining geometrically to the shape of variously inclined planes where the lower surface repeats and doubles the formal definition and extrados geometry.

The technical-constructive solution provides, from bottom to top, a first layer formed by serial axes in vertical section placed in a rhythmic way between full and empty such as to allow a partial view of the construction of the entire wall thickness including the dedicated systems lighting.

The systems will be located among the wooden beams of the longitudinal distribution. The set of common technological layers will be placed above the system compartment **(Figure 8)**: supporting element, vapor barrier, insulation, sealing layer, covering layer also made of wood waterproofed in tank.

Figure 8. The Technical-Constructive Solution

Considered the difference in elevation between the floor and the road surface, really, the building will be characterized by two longitudinal elevations but also of a “third” one, far from being virtual, consisting either of the plan coverage: the one visible from the road crossing to the creek Calopinace. The technological solution is apparently constructive, bringing on itself all the importance of the architectural definition.

The definition of the stratification of vertical closures and follows concludes the theoretical and formal options of the entire body of the building. The wood will be the determinant character **(Figure 9)**. The outer surface is provided by a brise-soleil system **(Figure 10)** with horizontal axes placed on a rhythmic frequency rather tight. Their interspace, depending on the width of the wooden lamina will

constitute element of automatic shading in the summer season in higher bow angle reference solar and partial shading in the winter season.

Figure 9. The Roof

Figure 10. The Brise-Soleil System

The definition is used to monitoring of seasonal natural energy contributions. In addition appropriate parts of the walls, opportunities for the position and orientation, will host translucent linear photovoltaic panels. Portions will be subject to testing and measuring of electrical production. The internal surface **(Figure 11)** of the technical package will consist of a high-efficiency window frame against the containment energy: thermal cut, triple low-emissivity glass, monitoring of the permeability

to air and natural ventilation system. Between the two systems will be built a system of opaque closures aimed at both the anti-intrusion security that the regulation and modulation of the passage of the sun's natural radiation.

Figure 11. The Internal Surface

5. Final Consideration

The aim of the designers was to ask themselves what is the complex system of principles that animate sustainable architecture today (De Capua, 2002; De Capua, 2019). If those exclusively aimed at greater attention and protection of the health of users and the environment or also concerns social and economic issues at a time when it is proposed as a cultural, social, ecological and economic change necessary for the protection of future generations. Thomas Friedman says that globalization and technology have flattened the world. In fact, in my opinion, globalisation has, in very rare cases, made it possible to bridge the gap between industrialised and emerging countries, and not always by opening up extraordinary opportunities for all. But this "flattening", which forces us to run faster and faster to stay in the race, has perhaps made our planet too small and too accelerated to allow each of us and society as a whole to adapt to it in a stable way.

Today, the new needs that contemporary living demands of architecture and cities means that the project becomes an interpreter of the places and needs of the inhabitants through appropriate technological solutions. Whether in urban suburbs, in smaller towns, in the slats of social housing or in disused industrial areas, action is required that guarantees direct and indirect benefits, that interprets the desires of the communities involved and that responds to the new environmental paradigms.

In coherence with what we have said, the design decisions have largely come from the pre-design cognitive phase, in which the state of the places, with its distinctive natural and anthropic characteristics, its history, its layouts, its conditions and the behaviors that these induce in the performance dimensions of the buildings and intermediate spaces, according to their dispositive and material configurations, have been detected, influencing the way in which the living space is used.

The effort has been to understand how this complexity has really promoted solutions aimed at achieving a high energy-environmental quality in transformation interventions or has been a simple academic operation.

In fact, a project culture has been promoted that is able to correctly combine economic development issues with strategic environmental budgets for the conservation of natural resources and systems over time.

A new way of designing, integrating the environmental theme in all choices, to stop paying the price of having built, for too long, in the most complete indifference of conditions to the context, without attention to the waste of energy or using materials but at the same time denying the nature.

Figure 12. The Volcano Etna in the Background of the Laboratory

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Notes

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Note 5. PON 2007/2012—"RENEW Project"—Production of energy from renewable sources and energy recovery "financed by the European Community". The primary goal of RENEW is the competitive strengthening of the region for the development and transfer of scientific and technological knowledge on the use and integration in electricity grids of advanced power generation. This is achieved through the study and certification of existing products and/or the development of innovative solutions in wind, hydroelectric, solar and biomass.

Note 6. Marine Energy Lab. MEL (2014-2016). Also MEL, like RENEW is a Public Private aggregation formed by the University of Reggio Calabria, from the Polytechnic of Bari and businesses GE AVIO S.r.l., and ZEN Yacht; aimed at creating a laboratory that can become a center of excellence in the areas of research and training on the issue of border energy generation on the marine environment. The objective is to provide research, development, prototyping and industrialization of systems located:

- Above sea level: offshore wind power plants on floating infrastructure.
- Below sea level: energy conversion systems of tidal currents on floating infrastructure;
- Sea level: installations in oscillating water column for converting wave energy (the help system, in an innovative way, the damping of the waves and the coastal protection).

Note 7. Gelmincal “Magnetic Levitation Wind Power Generator in Calabria” was presented by Mediterranean University of Reggio Calabria in conjunction with the Inter-University Consortium for Research Me.S.E. It has the dual purpose of setting up in Calabria an interdisciplinary group for the study of new technologies for energy generation from renewable sources, the construction of a prototype wind generator of new design and the purchase of diagnostic equipment to increase the proponent group in diagnostics dedicated primarily to the Project.