The challenge of designing and building nZEBs: *a single-family house in Italy*

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CorTau House is a single-family house, realized by renovating a "curmà", a traditional rural building, located in Livorno Ferraris, in the Northern Italian region of Piedmont. The construction of the building, started in March 2014, is still in progress but this nZEB already represents a good example for the replicability and implementation of a high-performing house model at the regional and national levels. The project and realization of the building are described from the project owner/building system designer, S.P. Corgnati, and from the architectural designer, M. Luciano.

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Figure 1. The designed *CorTau House*, south front.

In keeping with the European definition of nZEB [1], the *CorTau House* represents an Italian significant design experience in which the architectural quality in renovating a traditional rural building is combined with the use of high-performing energy solutions. **The nZEB realization challenge is presented here in the form of interview with the designers.**

Keywords: nZEB, energy efficiency, cost control, traditional rural building, building system, architectural quality.

A first question to the project owner: what led you to realize a nearly Zero-Energy Building?

S.P.C.: Mainly the possibility to ensure the energy independence of the building from fossil energy sources: the *CorTau House* (**Figure 1**) is indeed "all electric" and meets the energy demand through self-generation of electricity from a solar PV system. Moreover the project pursues the dual objective of combining the nZEB requirements [2][3] with architectural quality principles and with the renovation of a traditional rural building widely diffuse in Piedmont.

Figure 2. Picture of the pre-existing rural building, south-east side.

Which are the main benefits deriving from this kind of building?

S.P.C.: The main advantages, in keeping with the nZEB philosophy, are surely a considerable reduction of the energy required for conditioning the house and the meeting of energy needs through the use of on-site renewable sources, including the sun and the heat extracted from groundwater.

Which elements have played a decisive role in designing and realizing the building? How influential have been the context, the previous existence of a traditional building and the current energy efficiency legislation?

M.L.: The traditional rural framework has surely influenced the project, whose aim is to preserve and to enhance the distinctive features of the building (**Figure 2**). The roof covering in tiles and the wooden roof structures have been maintained, so as the brick pillars. The design team also had the good fortune to reinterpret an ancient intuitive know-how in a scientific way, according to bioclimatic architectural principles: the existing building indeed, fully opened on the south side, presented a closed façade on the north side (**Figure 3**): the project has been adapted to this simple existing structure, optimally suited to achieve excellent energy performances.

Which architectural, technological and structural solutions have been adopted?

M.L.: Our architecture study is used to work with reinforced concrete septa, which have the dual function of acting as structural elements and including the building systems. Moreover, massive structures are adopted in order to get the most out of the thermal inertia of the building envelope, considering the temperate climate of the context. The result is a building characterized by parallel axes that incorporate the building systems in a north-south direction and by horizontal surfaces enclosing the living space: there is a symbiosis between the building structure/envelope and the technological aspects characterizing the living space. With regard to the building envelope, there is a clear separation between the highly insulated opaque components, characterized by external insulation, and the transparent surfaces, in order to minimize the creation of thermal bridges.

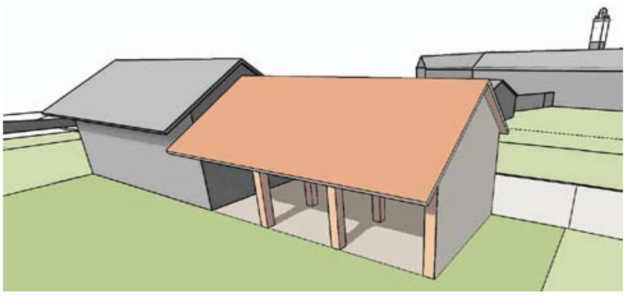

Figure 3. Volumetric representation of the pre-existing rural building, south front.

Apart from building envelope measures, which energy efficiency strategies have been adopted with regard to the building system?

S.P.C.: A controlled mechanical ventilation system with heat recovery and dehumidifier is combined with radiant floors for heating and cooling: a geothermal heat pump provides the production of cold and hot water for the radiant panels and Domestic Hot Water (DHW). All the electricity needs of the building for lighting, cooling and interior equipment are covered from a 7 kWp grid-connected photovoltaic system installed in the roof.

Acoustic solutions have been considered too?

S.P.C.: In the *CorTau House* the soundscape design concerns not only the building itself but also the garden. The main acoustic protection of the house is indeed provided by tree planting and hedges, which have the additional functions of solar control and privacy screening. With refer to the building, reinforced concrete septa placed between living and sleeping areas provide the acoustic insulation of these two macro-areas of the house.

Figure 4. The first concept of the house, south front.

Among the adopted design measures, which ones revealed to be priority for the nZEB realization? On the contrary, which solutions have been ruled out and why?

S.P.C.: The project experience has highlighted the importance of individuating the correct relationship between opaque and transparent surfaces in relation to different room exposures, in order to correctly design external sun screens and to control the solar radiation. The optimization of the building energy performance is based on passive energy solutions: since the first concept, the architectural design and the energy-saving project have been complementary and decisive in the evolution of the project. The project originally involved an articulated system of reinforced concrete septa and slabs: this solution has been ruled out in the final project. The structure has been simplified, giving way to clearer separation between opaque and transparent surfaces, in order to avoid thermal bridges and to control the construction costs due to concrete paving.

A fundamental strategy towards nZEBs is an integrated design methodology: how did the architectural project evolve in order to achieve the goals of energy efficiency and cost optimality?

M.L.: The architectural design work has been carried out in parallel with the building system design from the preliminary phases: the creative role of the architectural designer has been driven by nZEB energy goals, together with the property owner's request of cost control, with reference both to the investment costs and to the future running and maintenance costs. As said before, in a previous stage of the project (**Figure 4**), the house was characterized by an articulated structure with stepped levels, including a basement used as a garage. In order to control the costs, the project has been modified, proposing in the final version a one-storey residential unit with reduced net floor area and volume (**Figure 5** and **Figure 6**). The interior spaces and structures of the house have thus been optimized, ensuring reduced energy losses and, consequently, lower energy needs for heating and cooling in future. Moreover, costs for excavations and costs due to the realization of a second staircase and to the installation of a distribution manifold for the first floor have been avoided.

What about the building estimated energy performance? How have the consumptions been calculated?

S.P.C.: In keeping with the definition of nZEB [1], the energy consumption of the house is nearly zero: the low energy demand is covered through self-generation of electricity from PV system. The energy performance of the building has been calculated in the preliminary phases of the project through calculation software based on the European standards. At a later stage the energy consumptions of the building have been calculated using dynamic energy simulation tools for comparing the estimated final energy demand profiles and the energy production ones.

Which difficulties did you encounter during the nZEB design and construction phases?

M.L.: The building site is a "hostile" place because of the co-presence of different professional figures. In order to achieve the nZEB design goals in terms of architectural quality there is a strong need for collaboration and cooperation between the designers, the director of works and the construction company: only through an agreement between all the parties interesting results become possible. I like to think that the project is a thought, which is made of different nuances. The construction company provides not only for skilled manpower but also for ideas and support; the designers have to integrate and implement the project on the basis of these technical suggestions, though maintaining the basic features of the architectural design.

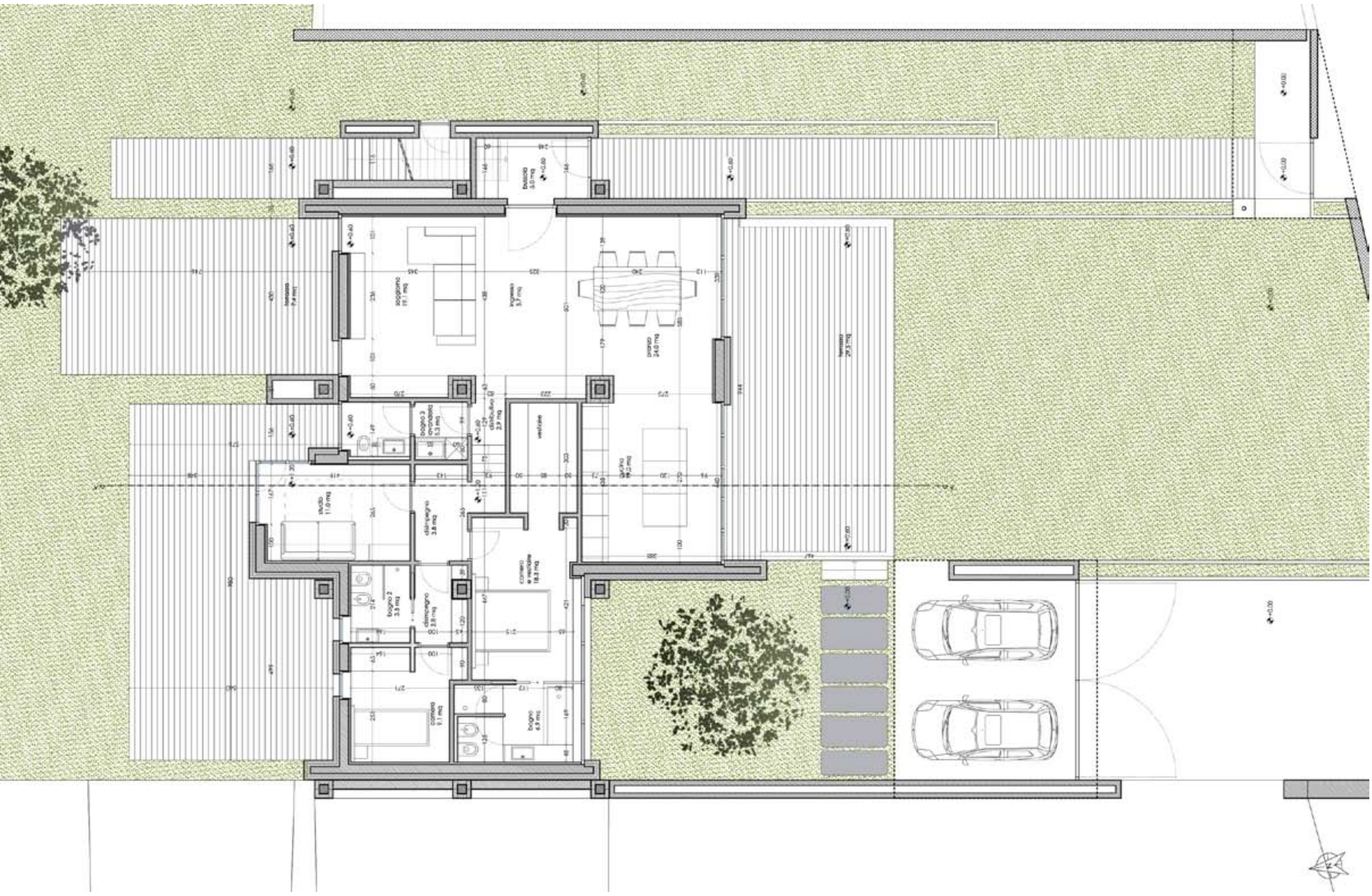

Figure 5. Floor plan of the house.

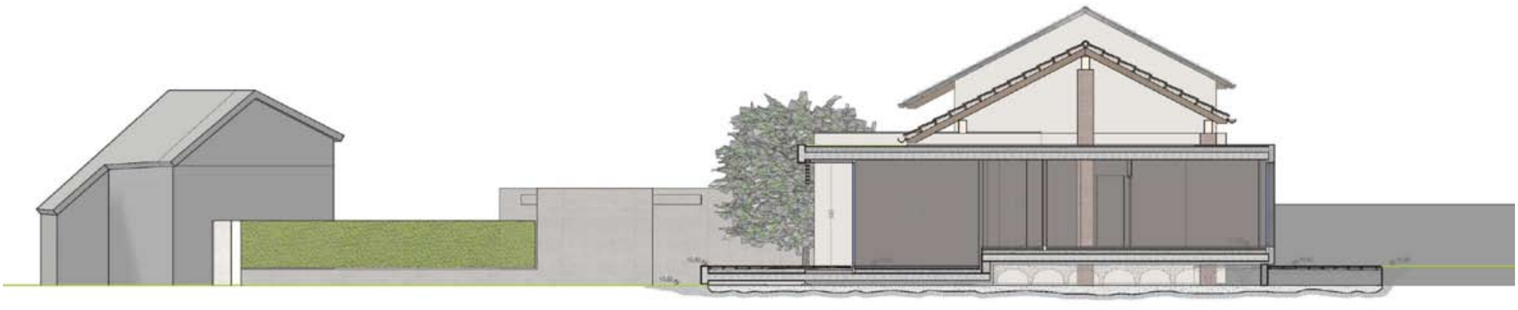

Figure 6. Transversal section.

The quality of the final work is surely prime in order to achieve the prefixed targets; did you encounter any problem in finding materials and trained manpower?

M.L.: No, I didn't encounter relevant problems thanks to a great synergy with a highly qualified construction company. The manpower and the technicians on site revealed to be trained in the construction of high quality buildings: the attention given to building details is a fundamental aspect for the achievement of the result.

How much does the realization of a nZEB cost with respect to a "traditional" building? How long is the estimated payback period of the investment extra-costs?

S.P.C.: The costs are clearly related to the adopted solutions: for example in this case the architectural and structural use of massive concrete structures has affected the construction costs. The investment extra-costs are about 30% higher than the costs to be bared for the realization of traditional buildings, considering standard finishes. This percentage of extra-costs is however more elevated than for other nZEBs because of a decisive boost to experimentation with regard to the building system, which could be simplified. In relation to the investment extra-costs, the payback period has been estimated of less than a decade, a reasonable period considering that the investment is made in a primary residential property.

Are tax deductions or other financial subsidies granted for the realization of a nZEB at the national or regional level? In your opinion are they suitable?

S.P.C.: In Italy energy retrofits are strongly subsidized in terms of tax deductions for interventions of building renovation and energy efficiency. In 2014 and 2015 for refurbishment works on real estate property it is possible to benefit from a tax deduction of 50%, for building renovation, and of 65%, for energy retrofit actions, over ten years, on a maximum spending limit respectively of 96,000 € and 100,000 € per real estate unit. Financial subsidies are nowadays fundamental in order to incentivize energy efficiency actions.

This building can be taken as a model for the future realization of new nZEBs and for their distribution at the national and regional levels. Which design and construction "rules" followed for this case study could be replicated for other ZEBs?

S.P.C.: The "curmà" is a typology of widely diffuse building in the Northern Italian rural areas: the *Cor Tau House* shows a new possible way to interpret its renovation and re-functioning. A replicable "rule" is surely the idea of preserving the existing structure and adding to it a new building organism characterized by innovative energetic and architectural performances.

M.L.: I agree with the above but I would also like to underline that in my opinion there is not a correct or wrong model for designing a building: the building quality is the result of a correct balance between several elements, different for each project. The *Cor Tau House* is an example of nZEB located in a rural Po plain scenario; a good model of nZEB surely fits into the context and is designed on the basis of the specific needs, climatic conditions and traditions of the place in which it is realized.

Is there any other theme you would like to highlight?

S.P.C.: In our climatic conditions the nZEB design challenge can be summarized in two basic concepts: the careful design of the building considering both the winter conditions and the summer ones and the control of humidity – fundamental for a building surrounded by rice fields. The compensation between the building behavior during winter and summer seasons represents the basis of the reasoning intended to emphasize the passive design.

M.L.: I think that this design experience also highlights another issue: this house represents a good project in relation to the urban space, nowadays degraded in Italy. In this sense the *Cor Tau House* can be assumed as a model for sensitive zones, in order to demonstrate that also controlling costs high results in terms of quality of life are achievable. ■

References

[1] Directive 2010/31/EU of the European Parliament and the Council of 19 May 2010 on the energy performance of buildings (recast).

[2] REHVA nZEB technical definition and system boundaries for nearly zero energy buildings, 2013 revision for uniformed national implementation of EPBD recast prepared in cooperation with European standardization organization CEN. REHVA, Federation of European Heating, Ventilation and Air-Conditioning Associations, Report No 4, REHVA 2013.

[3] ECOFYS, Towards nearly zero-energy buildings - Definition of common principles under the EPBD. Final report, February 2013.