Chapter 2
Is the Passive House Right for Us? (Follow the Money)

Davide seemed excited by my proposal, so we agreed to meet the following week to discuss it. Once back at the desk in my studio, I organised my thoughts about my skills:

- I have already constructed buildings with good energy efficiency;
- I have adopted construction solutions for protecting the thermal bridges;
- I have used the design solutions of bioclimatic architecture;
- I have studied the general criteria of passive buildings in the preparation of my lessons at the University (where I teach Architectural Final Construction Design for energy efficiency);
- I have read quite a few books on the topic, finding mostly theoretical concepts and practical applications that are partial and not all-encompassing.

Even if I did not feel as if the task was totally beyond my capacity, I've never actually built a Passive House, though it's always been my wish to do so. An excellent opportunity fell into my lap, but I was lacking what anthropologists call "*field experience*".

The anthropologist Bronislaw Malinowski writes about field experience:

> It would be easy to quote works of high repute, and with a scientific hall-mark on them, in which wholesale generalisations are laid down before us, and we are not informed at all by what actual experiences the writers have reached their conclusion. No special chapter or paragraph is devoted to describing to us the conditions under which observations were made and information collected. I consider that only such ethnographic sources are of unquestionable scientific value, in which we can clearly draw the line between, on the one hand, the results of direct observation and of native statements and interpretations, and on the other, the inferences of the author, based on his common sense and psychological insight. (Malinowski 1922, p. 11)

There were many things that I still did not know and many questions still ran through my mind without finding an answer. I took a deep breath and thought "this will be my field experience". I know I can do it: all I need to do is avoid the traps hidden in the thick of the jungle and dodge any poisoned arrows.

I stopped daydreaming and began to concentrate on the main objective of every architect: satisfying the client.

S. Piraccini and K. Fabbri, *Building a Passive House*, Green Energy and Technology,
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How much time is saved and therefore how much money, if a building is built in brick? *Is there any way of knowing*? One can only make rough estimates. Should the work be done with a truck-mounted crane or with a tower crane? Should all the curing times be calculated? How long does it take for the client to make his or her choices, because the mason has to fit the wiring and tubes in the wall while that isn't necessary with wood? And if it rains? And even more difficult: how much have you saved in terms of bank interest through reducing the time by one month and how much more have you spent building a wooden slab rather than a concrete and masonry flooring system? How much more is spent building a Passive House compared to a building with energy performance standards regulated by law? One would have to make an economic analysis of the specifications, minus all the costs of the extra thickness of insulating, obtain estimates from several companies in order to arrive at the correct price, divide some all-encompassing items to subtract the elements relevant to the protection of the thermal bridges, etc.

Transforming the specifications in a detailed economic analysis of the intervention is equivalent to writing an encyclopedia: the focus of this book is the Passive House, the technology, the construction site and so forth.

This is a "logbook" of the professional activity, the approach is operational and aimed at optimising the times and choices for the construction of a Passive House. In regards to the economic aspects, I reasoned that the construction times of technologies in wood are usually lower than those in concrete and masonry, so I enquired with the undertakings which gave me estimates and construction schedules, confirming my hypothesis.

In this chapter, I discuss all the preliminary evaluations that I have made before beginning the planning for the construction of a Passive House capable of achieving Davide's objective: increasing the number of real estate units, framing the building intervention in renovation in order to obtain tax incentives, finding the right technology to build a passive building that would keep the thickness of the walls to a minimum in order to gain useable and commercial surface area.

Davide's objective was primarily increasing the income received from the old building in Via Ariosto. In the current state, the building is composed of two apartments and two shops, all of them on the rental market.

The new project must therefore meet such a requirement by creating apartments with nearly zero energy consumption and high standards in terms of comfort, all of it ensuring the economic sustainability of intervention so that, figures in hand, would make it worth the effort. *But what is the relationship between zero energy consumption and the increase in income from rent?* The tenants of the old building in Via Ariosto complained about energy costs that were simply too high. Davide was forced to reduce the rent to avoid a mass migration of his tenants towards newer and more energy-efficient apartments. Apartments with near zero energy consumption and high comfort levels would have justified higher rents for Davide and meant high appeal on the market, given that, at least as far as Italy is concerned, it would be the first building of its kind.

To increase the income, the new project must be based on the following strategies:

1. increasing the number of real estate units compared to the existing property: with more apartments, there is an increase in the income from rents;
2. obtaining the tax incentive provided by Italian law for the interventions of building renovation and retrofitting;
3. individuating a construction technology capable of reducing the thickness of the external walls, so as to increase the usable area;
4. reducing construction time, thus limiting the interest on loans requested from banks and accelerating the generation of income from the property;
5. building a Passive House standard building so as to place on the market buildings with near zero energy costs and high levels of indoor comfort;
6. seeking to combine sustainable economics and environmental sustainability.

2.1 Increasing the Number of Real Estate Units

The building in Via Ariosto has to be demolished to allow for the reconstruction of a new building composed of 8 apartments, the maximum permitted by the regulations of the Municipality of Cesena (FC—Italy).

The new building should produce greater income, and the increase of the real estate units plays in our favour: at the same location and with the same construction quality, the sum of the rents of two small apartments measuring 50 m^2 is greater than the rent of one apartment with an area of 100 m^2. To determine the most convenient size for new apartments and to make an estimate of adequate rents, we have availed of consultants in the real estate market, data banks made available by the Revenue Agency and real estate agents located in the territory. This method allowed us to verify the rental cost of newly built apartments of the same type that are located in the vicinity.

The rental market was showing a robust demand for real estate of small/medium dimensions (studio apartments, two-room and three-room apartments) compatible with the maximum number of eight apartments that local laws allowed us to build.

The preliminary project thus provides apartments that are different from one other, with medium/small dimensions that respond to market demands. The types, studio apartments and two-room and three-room apartments, on the one hand, guarantee diversification of the commercial offer, and on the other hand, they aim at social sustainability by ensuring access to many categories: singles, students, couples without children, families with children and so forth.

In order to evaluate whether this would be the right strategy, we need to make a rough economic evaluation, comparing the assumed rents of the new project with those received from the old building.

The overall income received by the monthly rents of the old building amounted to € 2560, divided as shown in Table 2.1.

The rents were rather low, the reason being that the property had not aged well and, especially, it was due to the high energy costs that on many occasions the tenants were deprived of the money needed to pay the rent.

Table 2.1 Monthly rents prior to the intervention

Description	Surface area (m2)	Rental income (€)
Apartment 1 (four rooms, one bathroom)	100	600
Apartment 2 (four rooms, one bathroom)	112	700
Shop 1	110	760
Shop 2	110	500

Table 2.2 Monthly rents after the intervention

Description	Surface area (m^2)	Rental income (€)
Apartment 1 (onr room, one bathroom)	33.60	520
Apartment 2 (one room, one bathroom)	35.10	520
Apartment 3 (one room, one bathroom)	33.10	530
Apartment 4 (three rooms, one bathroom)	68.70	730
Apartment 5 (one room, one bathroom)	35.00	500
Apartment 6 (three rooms, two bathrooms)	66.80	770
Apartment 7 (three rooms, two bathrooms)	77.60	740
Apartment 8 (two rooms, one bathroom)	53.60	680

The expected income from monthly rents of the new building, considering eight apartments designed through a preliminary project, can amount to € 4990, divided as shown in Table 2.2.

The new building can put in the pockets of the Zoffoli family (Davide and his brothers) an additional € 2430 each month. The new building, just with the increase of the real estate units, brings about an increase of about 95% compared to the income received from the old building.

2.2 Tax Incentives

To reduce construction costs, we decided to take advantage of the tax incentives for the renovation of buildings and energy retrofitting. Starting in 2007 with Law 296/2006 and DM 19/02/2007, Italy has introduced the deduction of 55% (since 2015, it has been increased to 65%) of the amounts for expenditure on "Energy Retrofitting" which are added to the incentives introduced for the first time in 2006 for the "Building Retrofitting" interventions (deduction of 50% of the expenses per real estate unit).

The law has been amended several times over the years and probably will be once again at the time of this book's publication. It is a law with broad margins of interpretation and its application is susceptible to many variables. In this paragraph, we illustrate its application limited to the case in question.

Currently, tax incentives are translated into a deduction, distributed over the course of 10 years, from the taxes on the IRPEF (tax on the income of individuals) or IRES (tax on the income of companies) tax base of a quota of the building cost, i.e. the cost necessary for the construction work and design.

Incentives for "Building Retrofitting" involve a deduction amounting to 50% of the cost of construction up to a maximum of € 96,000 of the amount of the works, deduction which can reach 65% in case the intervention concerning the primary residence provides for a structural improvement. The ceiling can be incremented by multiplying it by the number of real estate units present at the time of the construction intervention.

Additionally, the law allows an extra bonus in the deduction of a maximum of € 10,000 for furnishing, a bonus that once again can be multiplied by the number of real estate units.

It is possible to access the incentive when the building work is defined as building retrofitting or extraordinary maintenance.

The incentives for "Energy Retrofitting", when the entire building is involved, are able to bring about a deduction amounting to 65% of the construction cost with a ceiling of € 153,846. It is possible to obtain the incentive when the construction intervention ensures a reduction of the energy performance index lower than the minimum limit of law (*about 20% lower*). Those able to take advantage of the tax incentives are the owners of the property, the cohabiting family members, tenants including commodatary ones. In this case, the beneficiaries of the tax deductions are Davide, his two brothers and their father. At the time of the building intervention, Davide was resident in the building in Via Ariosto therefore, being his main residence, he was entitled to a quota of the incentives for retrofitting amounting to 65%, while for his father and two brothers, residents in other buildings, the quota was reduced to 50%.

Using this information, it is possible to calculate the total value of the incentives on the tax deduction that one is entitled to receive with the construction of the new building (Table 2.3).

In total, the intervention is able to benefit from a quota of tax deductions amounting to € 306,440, corresponding to € 537,846 of the construction costs,

Table 2.3 Tax deductions on the "Building Retrofitting" calculated on the four real estate units

Deduction	Description		Deduction amount (€)
Building Retrofitting	Main home (no. 1)	€ 96,000 × 65% × 1	=€ 62,400
	Real estate units for rent (no. 3)	€ 96,000 × 50% × 3	=€ 144,000
	Furnishing bonus for all real estate units (no. 4)	€ 10,000 × 4	=€ 40,000
Energy Retrofitting	Entire building	€ 153,836 × 65%	=€ 100,000 (maximum amount)

more than half of what has been estimated for the intervention. The tax deduction, divided into ten years, amounts to an annual allowance of € 30,644 to split in relation to payments made by the various beneficiaries of the Zoffoli family.

The Zoffoli family (Davide, his brothers and their father), every year, for 10 years, would have obtained a refund from the State amounting to about € 7661 each.

To ensure the economic sustainability of the intervention, tax incentives play an important role, therefore in order to qualify for them, it is necessary to frame the intervention in terms of retrofitting, even if the only way to obtain the desired number of real estate units is to completely demolish the old building and build a new one from scratch.

We are accustomed to thinking that the retrofitting measures relate to a set of works that maintain the original structure of the building and not its complete demolition. Demolishing a building and rebuilding it are an operation that comes closer to the definition of new construction.

For this purpose, recent updates of urban planning regulations come to our aid. They introduce demolition into the definition of building retrofitting as long as there is faithful reconstruction with an equal volume of the building that was demolished.

In order to fall within this definition, the project must maintain the same volume of the demolished building without the possibility of any volumetric increase: *this is a difficult condition to meet when one intends upon doubling the number of real estate units.* To reach the goal, the maximum optimisation of the usable surface area is required, to the detriment of the thickness of the external walls.

2.3 Individuating the Construction Technology

In parallel with the economic evaluations of this phase, I had to individuate the most effective technological solutions for the construction of this building. The goal was to build, in a reasonably short time, an energy-efficient building; therefore, the characteristics of the walls, of the insulation and the construction technology itself, had to closely follow the economic evaluations, also because these choices are, in fact, economic choices in the construction and management phases.

To ensure an energy-efficient envelope, it is necessary to use copious layers of thermal insulation, which normally increases the thickness of the external walls. Satisfying this requirement, which takes on greater significance in the construction of a Passive House, is not at all easy when you have little usable surface area at your disposal.

In our case, the reduction in the useable surface area could compromise the number or the size of the apartments, with the consequent decrease of the income from rents.

Therefore, it is necessary to use construction technologies that, at equal thickness, ensure excellent energy efficiency in terms of *transmittance,* the ability to reduce heat transfer through the wall and *thermal lag*, the ability to delay the heat wave that flows from the outside towards the inside of the wall (see Chap. 6).

In a climatic context such as that of the Mediterranean, determined by cold winters and warm summers, both conditions are important: transmittance in winter conditions and thermal lag in summer conditions. Basing myself on the examination of some case studies recorded in the Passive House database (http://www.passivhausprojekte.de/) and on research in the literature of the sector, I deemed it appropriate to orient myself towards construction technologies capable of guaranteeing a thickness of the external walls of approximately 40 cm with transmittance values of U $\pm$ 0.13 W/m^{2}K and a thermal lag of $\varphi \pm$ 16 h.

The dry layered systems can achieve high performance in terms of transmittance, due to a large number of gaps where insulating panels can be placed, but normally it does not excel in terms of thermal lag, since it is constituted of "*light*" materials that have a reduced mass.

Construction technologies in concrete and masonry are defined as "*heavy*" in relation to the substantial thickness and high mass that is characteristic of the materials employed (bricks, hollow blocks, reinforced concrete, etc.). These systems are deficient in terms of transmittance, a problem that is solved with the subsequent application of ample layers of insulation, which considerably increases the overall thickness of the walls.

The construction system in concrete and masonry is widely used in Italy: known by the local craftsmen, it is normally the most economical construction system, given the strong competition among construction companies. However, to ensure suitable thermal transmittance for a Passive House built in concrete and masonry, the perimeter walls would have to be approximately 50 cm thick.

In this case, the use of such a system would have resulted in greater thickness of the external walls, and therefore a sharp decrease in the usable surface area, parameter used for the calculation of the rents. Furthermore, the project must maintain the same volume of the old building: an envelope of elevated thickness reduces the habitable volume and can affect the number of real estate units planned for the new building.

Reinforced concrete is an excellent thermal conductor (thermal conductivity λ = 2.3 W/mK), and steel is even more effective (λ = 60 W/mK), therefore, the use of both materials requires particular care and attention in the design of thermal bridges through the use of considerable layers of insulation. The protection of a thermal bridge generated by a structure in reinforced concrete, especially in correspondence to the projecting elements (cornices, balconies, etc.), may entail high costs in the use of high-performance insulation and surface coatings so that the insulating material is hidden from view, and in some cases also in the use of structural joints with thermal break that can significantly increase costs.

Unlike the previous materials, wood has low thermal conductivity if one considers that fir, the main wooden species used in construction, *and therefore, the least expensive* amounts on average to 0.126 W/mK.

In reference to wood, the book "Il progetto dell'involucro in legno" states that:

> (…) it is the most widely used wood in the construction sector. Its good mechanical characteristics in terms of resistance make it particularly versatile, especially as regards the production of structural elements and recomposed wood products such as plywood and structural panels. (Boeri et al. 2012, p. 31)

The thermal conductivity characteristics in terms of the material favours the choice of wood as the primary building material, especially for facilitating the design of the thermal bridges, reducing both the design time and the insulation necessary for their protection.

The dry layered systems in wood can be divided into two families:

- frame systems;
- load-bearing walls systems.

Which one is the best for our case?

The frame systems are innovations of traditional technologies that were developed in climatic contexts characterised by an abundance of the material and a consequent establishment of this building culture. They are composed of a more or less dense structural framework with vertical and horizontal frames, generally with a rectangular, square or double T section, anchored with metal connections.

Although they are systems that are fairly widespread on the construction market, I encountered difficulties in obtaining solutions capable of satisfying the prerequisite requirements in terms of the necessary thickness and thermal lag.

2.4 The Choice of the CLT System

After having discarded the technologies in cement and masonry and the frame system, we have no other choice but to orient ourselves towards the load-bearing walls system. However, once again, they too are divided into two further types: a system of overlapping logs and a system of cross-layered solid wood panels.

The first, characteristic of the traditional architecture of the mountainous regions of Northern Europe, consists of a succession of stacked logs that constitute the load-bearing walls of the building. Today, the main construction systems of stacked logs use standardised elements with a rectangular section, with rough logs no longer being used. Despite this innovation, the technology presents major structural limits in the construction of multi-storey buildings, characteristic that, to a certain extent, also is true of the frame systems.

All that remains is the system in cross-laminated solid wood panels or cross-laminated timber (CLT), better known in Italy as X-LAM. These panels are composed of crossed layers of wooden slats in fir. It is a technology that has been developed mainly in Austria and Germany in the mid-1990s, spreading to Italy over the last ten years.

Compared to the previously examined construction systems in wood, CLT is particularly suitable for the construction of multi-storey buildings: through the use of metal anchors, the panels can be used both in the production of floor slabs and for load-bearing walls. Moreover, the panels are provided with a considerable mass that, unlike the frame systems, favours the performance in terms of thermal lag, while the mechanical characteristics of the material allow high structural performance and at the same time maintain reduced thickness.

Given its technical characteristics and the starting requirements, CLT is the most suitable construction technology in our case.

2.5 Reducing Construction Time

The main advantage of the dry layered systems is the execution time of the works.

But why is it so important for my client to reduce construction times as much as possible?

The Zoffoli family, in order to proceed with the realisation of the new building, has taken out a loan from a credit institution that covers 80% of the amount of the construction costs. Once construction has ended, the income generated by rent of the eight apartments will be such as to almost entirely cover the monthly loan payment. However, *during the entire period of construction, the building will not generate any income at all, only costs.* The monthly instalment of the loan payment will have to come from the pockets of Zoffoli family.

In this context, reducing construction time is an important requirement for hastening the income generation of the property, therefore limiting my client's exposure to debt.

Specifically, the loan requested by the Zoffoli family from the credit institutions involved an average monthly instalment before repayment (interest) amounting to € 900 that, starting from the 18th month, amounted to € 5600 (interest + capital).

For the entire duration of the construction, Davide and his brothers would have to provide for the payment of the monthly instalment of the loan exclusively from their salaries. Once the construction was terminated, they could receive an extra monthly income of about € 4990 from the collection of the rents of the eight apartments.

The construction system in CLT, like all dry layered construction systems, ensures shorter construction times compared to conventional technologies.

In my experience as a designer, timber construction, at least as regards the area of Italy where I live, is still an exception. Suffice it to say that at the time of the drafting of the project (2013) in the province of Forlì-Cesena (North-central Italy) only one construction company had built buildings with this technology. The same applies to the building material: the CLT was not produced in Italy but processed and imported from Austria. This situation reflects the national panorama to some extent, even if, currently (2016), it is showing some sign of improvement.

The presence of a limited number of manufacturers and construction companies with experience in buildings in CLT reduces the competition. This phenomenon produces an escalation in the cost of the technologies that are not very widespread, especially in relation to the competitive costs of technologies in concrete and masonry that are widely used in Italy.

In the province of Forlì-Cesena, the construction costs for a multi-storey building in concrete and masonry, of good quality, contracted to a single, well-structured building company are approximately € 1300–1400/m^2, value that rises to € 1450–1550/m^2 for a building in wood. Construction in wood costs on average 11.5% more than that in concrete and mansonry.

Taking the example of a commercial area (defined by the Standard UNI 10750) of about 490 m^2, close to what is hypothesised for the new building, construction in concrete and masonry costs about € 1400 × 500 m^2 = € 700,000, while the construction of a building in CLT costs about € 1550 × 490 m^2 = € 759,500.

From this rough evaluation, we can see that construction in CLT has an extra cost amounting to € 59,500.

Is the speed of construction enough to justify the extra cost?

Wooden construction is faster: it is not necessary to respect the curing times of the concrete, it does not use water, it increases the level of prefabrication and many operations are performed in the production plant.

Ok, but how "fast" is it? By way of example, the construction of the new building in wood in via Ariosto, composed of four levels of floors and walls in CLT was assembled *in just 10 days with the use of a truck crane*.

The same structure built in concrete and masonry requires approximately two months for the construction of just one floor: 28 days of curing of the concrete for the casting of the pillars, 28 days for the casting of the beams of the slab, plus the time required for infilling the entire framed structure with bricks and hollow clay blocks, time that varies in relation to the number of workers employed in the operations.

In the structures in concrete and masonry the plumbing and wiring installations are normally inserted in the masonry curtain walls. This operation involves the running of the installation in the masonry, the placement of the wiring and pipes and the subsequent smoothing in plaster: all operations that are not necessary in the stratified structures.

Wooden structures are usually completed with metal frames infilled by panels of fibre-plaster or fibre-cement, systems that have spaces where it is possible to place the systems, creating the outlet holes in correspondence with all the system devices (switches, light fixtures, sanitary fixtures, etc.).

The constructions in wood, compared to those in cement and masonry, have a greater level of prefabrication. By way of example, the walls in CLT are brought into the construction site complete with holes for windows and doors. This involves longer planning times and accurate, detailed final construction designs, a process that simplifies the execution phase and reduces time, because the decision-making process is shifted to the planning phase.

The constructions in concrete and masonry have a more hand-crafted process, many decisions or changes may be made in the course of the work using a hammer and chisel, without significantly affecting costs. On the other hand, to intervene in the course of the work on the cut of the structures in CLT is not at all easy and it entails high costs, therefore it is necessary to begin the final construction phase with very clear ideas and a complete awareness of the final construction project.

Design times extend even more in the planning of a Passive House because it is necessary to have an accurate design of all thermal bridges, of the airtightness and the correct exposure to the sun. This additional level of detail, although once again lengthening the design time, elevates the degree of awareness of the project, further speeding up the decision-making processes during the final construction design phase.

Extending the design times—*in my case, they have doubled*—did not cause particular problems for the Zoffoli family, because it can continue to collect the rents of the old building in Via Ariosto while waiting for the commencement of the construction.

The process of construction of a building is subject to many variables that depend on the organisation of the construction company, the number of workforce available, the effectiveness of suppliers, any indecision regarding the design choices, regulatory interpretations, bad weather and so forth.

It is therefore difficult to make a precise estimate of the difference in the time schedule of the construction site when comparing a building in wood to one in concrete and masonry. In the evaluation of the times, the parameter of experience once again comes into play. Comparing the times required for the construction of other buildings that I have designed and built I have analysed the processes capable of *reducing working time*.

In summary,

- the assembly of a multi-storey structure in CLT is measured in days while a multi-storey structure in concrete and masonry is measured in months;
- the structure in CLT is constituted of load-bearing wall sections and does not require infill walls, differently from the framed structures in concrete and masonry;
- the integration of the installations system in the vertical walls of the buildings in wood occurs in the gaps present in its functional layers (mainly in coverings or walls in fibre- or drywall), while for buildings in concrete and masonry, it is normally necessary to create the conduit and tubing route in the masonry with a hammer and chisel, lay the installations and then plaster with cement;
- the constructions in wood require a more detailed design that involves longer planning time, but in compensation, simplify the decision-making process in the course of the work;
- the multiplication of all previous points in a multi-storey structure.

Taking into account these evaluations and after discussion with the operators of the sector, the estimated time for construction of the entire building using a CLT structure was 12–13 months, an amount of time that, in the final balance, is half of what would be necessary for the construction of the building in concrete and masonry.

Halving the time translates into approximately 12 months of rent, amounting to € 59,880 (€ 4990 × 12), a *figure just slightly greater than € 59,500, which is the extra cost of construction of the structure in CLT!*

This economic evaluation, with all the approximations necessary, shows that on the one hand it is possible to cover the extra cost of construction (€ 59,500), on the other, it is possible to finish the construction within the time frame for the amortisation of the loan (18 months) to then take advantage of the income of rents (€ 4,990) as partial coverage of entire loan instalment (€ 5,600).

Moreover, let us not forget that, according to the Passive House database, we were about to realise the *first* certified Passive House multi-residence in wood in the entire Mediterranean area, we had already begun a commercial promotion in this sense, it was necessary to make haste: *how embarrassing it would be if we were to arrive second.*

2.6 The Advantages of a Certified Passive House Building

Having identified the energy-efficient construction technology capable of reducing the construction times, it is necessary to evaluate if reaching the highest levels of efficiency by constructing a building with near zero energy consumption according to the international Passive House protocol is economically advantageous for my client. The advantages of a Passive House can be summarised in the following points:

- energy costs close to zero, especially in relation to air conditioning in summer and heating in winter;
- raising the levels of indoor comfort, which translates into better quality of the air and relative humidity, and constant internal surface temperatures;
- increasing the life cycle of the building, due to the higher quality of construction that provides the air seal and the protection of the thermal bridges;
- it is a sustainable building in environmental terms: the building does not use renewable fuels, does not release pollutants into the atmosphere, takes advantage of the passive energy resources (sun, the heat of the human body and of household appliances), uses renewable energy sources.

These characteristics can only obtain a greater appeal on the market.

The Passive House database records, at the time of writing of this book, in the main countries of the Mediterranean area: 171 certified buildings in France, 24 in Italy, 19 in Spain, 2 in Greece. Their numbers increase in areas of a temperate climate such as Germany, with 441 certified buildings.

There are many more Passive Houses without certification, i.e. designed according to the same protocol but without having requested verification of the work performed by the Passive House Institute or other IPHA (International Passive House Association) affiliated institutes. The certification is voluntary, and it configures as a review by a third entity of the design and construction process by the designer, to guarantee that all aspects of the Passive House standard have been complied with. It is therefore a quality seal that does not have any effect whatsoever on the efficiency of the building. This procedure has a cost that, in many cases, the client prefers to economise on, especially when he or she has no need to approach the real estate market to rent or sell the property.

They are buildings that are not yet widespread and are inserted as a novelty with respect to the real estate market of reference.

In a commercial transaction such as that of the Zoffoli family, obtaining the certification means demonstrating that it tells the truth, that the work of the designer has been reviewed and it is free of errors and that the building functions as a Passive House. A plaque issued by the Passive House Institute is affixed on the building, certifying that it is indeed a Passive House, irrefutable data available to any potential tenant.

In a context such as the current one, where issues such as renovation and retrofitting of the existing property, energy efficiency, environmental sustainability and indoor comfort, begin to take hold with the mass culture, from cultural debates to conversation in the neighbourhood, a certified Passive House building can be identified as a virtuous example of this cultural movement, that sees its own objectives concretely made manifest.

Building a certified Passive House building in North-central Italy, in Emilia-Romagna, in Cesena, in Via Ariosto, as in many other places on the planet, cannot fail to promote the market response since it would be, with high probability, the only building with this level of characteristics in terms of energy efficiency, environmental sustainability and indoor comfort.

In my experience, this evaluation has obtained positive feedback; all eight apartments were rented out with long-term contracts before the construction was concluded.

The building began to produce income as soon as the work was finished, allowing the Zoffoli family to obtain a speedy return on their investment and the sustainability of their loan instalment. We have no way of knowing for certain, but if we had built a building with characteristics in the norm, it is doubtful that the results would have been the same.

However, the technological features relating to the use of additional layers of insulation, the protection of thermal bridges, the use of high-performance window and door frames, etc. entails, *in the construction of a Passive House, an extra cost amounting to approximately 3%: given that it has been hypothesised in the stage of preliminary design and was verified in the final balance at the end of the construction.*

2.7 Economic Sustainability and Environmental Sustainability

Could the advantages in terms of efficiency and comfort justify such an extra cost, considering that our apartments are intended for the rental market? We have seen that the cost of construction of the new building with structure in CLT amounts to approximately € 1,550/m^2, while the extra costs for building a Passive House entail an increase of the cost of construction amounting to about 5%, that is, € 1,628/m^2. The extra cost quota therefore amounts to € 78/m^2 (1,628 − 1,550 = € 78/m^2) that, multiplied by the 490 m^2 of useable commercial surface of the new building amounts to an overall figure of € 38,220.

The energy-saving advantages of a Passive House can rapidly cover this extra cost, also acting on the rent.

To continue the reasoning, it is important to bear in mind that normally a tenant must pay monthly, beyond the cost of rent, also the cost of the bills for climate control in the winter and in the summer, for domestic hot water, for the annual maintenance of the boiler that in Italy is required by law, in addition to other expenditure of lesser entity such as television fees, taxes on waste, ADSL, household appliances.

We have evaluated an average of the rents of the new building net of energy costs through a market survey that has analysed the rents of new buildings of the same dimensions present in our area of reference, a value which we shall call (*A*).

This value is added to the average value, obtained with the same principle, of the energy costs for heating and air conditioning, the maintenance of the boiler and the production of domestic hot water of buildings built with traditional technologies and present on the market, the value which we shall call (*B*). The sum of the two values (*A*) + (*B*) has produced an all-encompassing rent which we shall call “all inclusive” of the energy costs (*A*) + (*B*) = (*C*).

For greater clarity, we will take a two-room apartment as an example: it is composed of two bedrooms and a bathroom, the average monthly rent (*A*) amounts to approximately € 573, the monthly energy expenses (*B*) are approximately € 135, and therefore, the “all-inclusive” monthly rental (*C*) will amount to € 708.

This evaluation was carried out considering a building built with traditional technologies and an energy consumption that is within the norm. Monetising the energy consumption is a very complicated procedure because it varies, in addition to the parameters relating to the structure of the building, also in relation to the energy cost, therefore the values used are precautionary.

In a two-room apartment of this type, the lessee will be able to keep the amount of the quota (*A*) of € 573, since the quota (*B*) € 135, will be used in its entirety to pay energy costs.

But what happens if we use the value (C), as previously calculated, to define the rent inclusive of expenses for a two-room Passive House?

A Passive House has energy costs close to zero and, if well designed, does not need a boiler but only a mechanically controlled ventilation system, where maintenance translates into the washing of the filters, an operation that can be executed directly by the tenant.

In this case, the entire quota (*C*) of € 708 will remain in the pockets of the lessee, except for that minimum quota of energy costs slightly above zero. Defining such a low quota with precision is not easy, since it depends on many small variables; therefore, a wide margin of caution was used in the planning phase.

As of today (February 2017), the building was built, thus the share of expenditure can be easily determined: the monthly consumption of approximately € 60 for the domestic hot water and € 90 for climate control of the rooms. An overall total of € 150 that, divided for each apartment, omitting the differences of size, amounts to € 18.75 monthly.

In the case of a two-room Passive House apartment, the lessee will obtain about € 689.25 (€ 708.00 − € 18.75 = € 689.25), earnings that are approximately 20% higher (associated with an extra cost of only +5%) compared to € 573 of a traditional solution.

This strategy involves extra earnings from the rent that, having the data of the built building, we can now estimate with greater precision as being € 116.25 (=€ 135.00 − € 18.75), value which, multiplied by eight apartments, produces extra earnings of € 930 monthly and € 11,160 annually.

By using only the extra earnings derived from the "all-inclusive" formula, the extra cost for the construction of a Passive House, approximately € 38.220, can be amortised in just over 3 years' time.

Lastly, what are the advantages in the building of a Passive House?

For tenants: overall expenditure congruous with that of the market, comparable to the sum of the rent with the energy expenditure, and furthermore:

- the guarantee of the highest levels of indoor comfort:
  - comfortable indoor temperatures in every season;
  - air at the right level of relative humidity;
  - almost constant internal surface temperatures;
  - healthier air and reduction of CO_2;
  - a healthier environment without the formation of moulds or condensates and with reduced formation of dust.
- and for my client:
  - greater income from rent through the "all-inclusive" formula;
  - longer lease contracts because the tenants are satisfied, reducing the costs of administration and registration of the contracts;
  - increase of the life cycle of the property and reduction of regular maintenance interventions. The airtightness and protection of thermal bridges inhibits the formation of moulds and condensation: agents of deterioration of the structures.

- and for the environment:
  - an energy demand by the building that is nearly zero, reducing the pollution derived from the extraction of methane gas or by the production of electricity;
  - the building does not use renewable fuels; therefore, it does not produce and does not emit CO_2, particulate matter and other polluting substances into the atmosphere;
  - the spreading of a culture of sustainable building that combines profit with respect for the environment and of the people who live there, preserving the quality of the air and energy resources for future generations.

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