Certifying a sustainable reconstruction of vernacular architecture in Peneda-Gerês National Park

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ABSTRACT: In this paper we apply an environmental certification method to the rehabilitation of buildings in environmental sensitive areas, namely in the only National Park located in Portugal. A case study will be presented as a means of verifying the method. The certification of green buildings is one of many ways of reducing the environmental impact of buildings. In several countries there is already one or more of these methods available. In Portugal a method called LiderA has just been made public. Our aim is to apply this method and test it as a tool for architects to environmentally assess the reconstruction of the vernacular architecture located in the National Park of Peneda Gerês (PNPG), and ultimately to certify those retrofitted buildings. The house in Serra da Peneda, will be turned into an ecology field station whose certification evaluation will help us establish the feasibility and adequacy of some requirements

1 INTRODUCTION

Portugal is a country with many protected natural areas and tourism. Almost 20% of the country area is under protection and nature tourism is growing at a rate of 7% per year. These protected areas are very attractive for both national and international tourists, which can have a strong impact on its conservation. A national strategy based on sustainable tourism is required in order to preserve these areas. Since tourism depends on the construction industry, the environmental assessment of construction in these areas could prevent significant impacts. Like in other countries, the building certification has been a way of encouraging the construction industry to become more environmental friendly and several systems are now widely accepted in the UK (BREEAM), USA (LEED), Canada (GB Tool) and Japan (CASBEE).

2 THE EXISTING CERTIFICATION METHODS IN PORTUGAL

The energy certification of buildings is recently available in Portugal thru the approval of the Decree of Law 78/2006 on April 4th 2007. Furthermore the environmental and voluntary certification of buildings will be possible during 2007 thru the LiderA method developed in IST (Manuel Pinheiro, 2006). This method consists of an adaptation of several methods developed in other countries and by different teams to the Portuguese construction and environmental scenario.

The present paper uses this method to verify the possible certification of a restored house in Minho. Although there are some new buildings under certification in Portugal, this one is a particular case that consists of not only retrofitting a building but also doing it in a protected natural area.

3 THE PENEDA GERES PARK AND ITS CERTIFICATION BY EUROPARC

The Peneda-Geres natural park is the only national park in Portugal and has around 9000 inhabitants and five counties. The park is visited by thousands of people each year and the protection of species and landscape, as well as the environmental education, are priorities for its authorities. The Park aims to provide a special tourism, eventually certified in all its aspects: certified landscape, environmental education and certified buildings:

- The landscape is presently certified by the international Europarc Federation (European charter for sustainable tourism in protected areas) together with its adjacent Galician park partner, the Baixa de Limia -Serra do Xurés Natural Park. This mark is valid for 5 years and it aims to promote tourism in areas that are both nature and landscape friendly, meet the visitors and the local population and contribute to the economic development of the region.
- The education is to be provided in 5 new thematic buildings to be built in each Park county border. So far the Park built two of those buildings called Portas like in S. João do Campo and Lamas de Mouro, and three more Portas are being designed (Paradela, Lindoso e Mezio) .
- The certified lodging can be the next step thru the retrofitting of more than 50 granite houses, fifteen of them for renting (shelters, rustic houses), since it is not required by the Europarc seal. These buildings can contribute for an environmental education as well.

4 CERTIFYING BUILDINGS IN A PROTECTED NATURAL AREA

The Park of Gerês is a mountainous area with several clusters of old and small granite houses. In the past shepherds used to move their cattle from the upper lands to the lowlands during the snowy Winters and built houses in those places called Inverneiras (winter villages). During the Summer the cattle would move up in order to find better grasslands in the so called Brandas (summer villages). Most winter villages are now abandoned, and some houses are in ruins or for sale. Retrofitting can be a solution since most tourists look for historic lodging and for nature proximity. In the summer campgrounds suit groups of children but during other seasons, schools tend to rent houses that still cannot comply with thermal requirements especially during wintertime. The houses made of granite work fine in the summer due to the thermal inertia.

Retrofitting more houses could prevent new construction and could contribute for restoring the transhumance villages that consist of a unique historic patrimony that will soon disappear. A reconstruction based on little environmental impact could help preserve the local nature and certification could be a good marketing tool to attract nature oriented tourists. The certification could either be the energy certification or the broader environmental certification by LiderA.

The application of the LiderA national method to the case study will tell us if the method should be adapted to a more regional and specific case like the retrofitting of vernacular architecture in the Park.

5 THE CASE STUDY

5.1 *The existing house*

The house being presented is a granite house built in the 30`s which is detached although it is part of a cluster of 3 more houses located in an Inverneira called Podre. It is facing the east side of Castro valley and the lot spreads over 1000m2 down the slope. Its location provides a privileged view over the valley and the plateau of Castro Laboreiro. The latitude is 42ºN and the longitude is 8ºW. Its climate is rigorous in the winter, with mild summer temperatures. The precipitation is high and in the summer the forest fires are frequent. The house is close to an oak forest and its west side is shaded most of the day. It used to have 2 stories, the upper floor for housing, and the lower floor for animals. These animals provided a heat source for the living upper space. The construction materials used were blocks of granite from a rock nearby, oak wood harvested from the forest nearby and roof tile still in good condition.

Figure 1. The existing house.

5.2 *The project*

The house will be converted in a field station for ecologists. In order to adapt the space from a housing space to a mix office-living space, the building was raised 1meter. The new roof provides a south orientation for solar collectors and Photovoltaic panels. The new building has a two-storey-high working space with a mezzanine for 6 beds, a small lab, two bathrooms, two bedrooms, a living room and a small kitchen. There is also a shed for the heating equipment. The insulation of the house was critical to avoid damp and increase thermal comfort. The glazing area increased over 75% and the building increased its exposed thermal mass in 17% (27m2). The upper floors have now a floor vs. glazing area ratio of 23% and the lower floor of 10%. The cross ventilation was provided in almost every space. The heating system is based on solar collectors and biomass. The house is now under construction until June 2007.

The construction materials were chosen according to their volume and environmental impact. The majority was recycled, a significant percentage are local materials (produced in the district of Braga), and the certified materials are both national and international.

Figure 2. The project (left) and the on-going construction (right).

5.3 *The LiderA certification*

The LiderA system is a voluntary system for recognition of sustainable buildings. It is based on 6 parameters with different weights: Local and integration (18%); Resources (35%), environmental Loads (15%); Indoor Environment (20%); Durability and Accessibility (5%); Environmental Management and Innovation (9%).

These parameters are divided in sub-parameters and criteria illustrated in Table 1.

Table 1. The LiderA criteria and weights (Pinheiro, 2006)

Parameters	Sub-parameters	Wi	R	criteria	C#
Site and integration	Soil	7	S	Site and valorization	C1
				Occupied area	C2
				Ecological functions of soil	C3
	Natural ecosystems	5	S	Natural areas	C4
				Ecological valorization	C5
	Landscape	1	S	Local integration	C6
	Amenities	1		Local amenities valorization	C7
	Mobility	4		Low impact mobility	C8
				Public transport access	C9
Resources	Energy	18	S	Passive energy performance	C10
				Total electricity consumption	C11
				Renewable resources based energy	C12
				Consumption of other energy sources	C13
				Consumption of other renewable sources	C14
				Equipment efficiency	C15
	Water	10	S	Consumption of potable water (indoors)	C16
				Consumption of water in common spaces and outdoors	C17
				Control of consumption and loses	C18
				Use of rainwater	C19
				Management of local water	C20
	Materials	5	S	Material consumption	C21
				local materials	C22
				Recycled and renewable materials	C23
				Environmental certified materials/ low impact materials	C24
Environmental loads	Sewage	3	S	Sewage flow	C25
				Sewage treatment type	C26
				Reused sewage flow	C27
	Atmospheric emissions	5	S	Substances with global warming potential CO2 emissions)	C28
				Particles and/or substances with acid rain potential (other pollutants emissions, SO2 and NOx)	C29
				Ozone layer damaging potential substances	C30
	Waste	5	S	Waste production	C31
				Dangerous waste management	C32
				Waste recycling	C33
	Exterior noise	1	S	Sources of exterior noise pollution	C34
	Thermal pollution	1		Thermal effect (heat island effect)	C35
Indoor environment	Indoor air quality	7	S	natural ventilation	C36
				VOC`s emissions	C37
				micro-contamination	C38
	Thermal comfort	6		Thermal comfort	C39
	Illumination	3	S	Illumination levels	C40
				Daylighting	C41
	Acoustics	3	S	Acoustic insulation / noise levels	C42
	Controllability	1		Controllability	C43
Durability and accessibility	Durability	3		Adaptability	C44
				Durability	C45
	Accessibility	2	S	Accessibility of handicapped people	C46
				Accessibility and interaction with the community	C47
Environmental management and innovation	Environmental management	5		Environmental information	C48
				Environmental management system	C49
	Innovation	4		Innovative solutions, applicability and integration	C50

5.4 *The application of the LiderA certification method*

The LiderA was directly applied to the case study and once the criteria seemed non-adjusted, it was registered.

5.4.1 *Site and Integration*

Both soil, natural ecosystems and landscape criteria were only partially complied because:

- The infiltration rate may be reduced due to the fact that a natural sewage treatment plan is more adequate to this remote place than any other form of treatment.
- It may be difficult to control the construction noise and possible disturbance of animal life due to proximity of the oak forest to the field station. In this case and attending to the law that permits the forest cleaning of an area enclosed in a 50m diameter, the noise should have been monitored beyond the 50meters limit which didn't happen.
- Light pollution will be prevented in the house but can not be avoided in the public space due to an existing light post.

Furthermore both the amenities and mobility criteria don't apply to a natural area like the Peneda Mountain. The proximity to public transports, shops or heath care is scarce and not financially viable. The closest village, Castro Laboreiro is 4 Km away from Podre and the nearest city is 40Km away (Melgaço). People developed their own medicine, grow their own food, raise cattle, and own a car, (sometimes rent a taxi). Amenities and mobility lack in the Park and are part of a major discontentment that may change with a tourism increase. Nevertheless there is a tourist facility which will soon provide bicycles, horses and canoes for tourism. This will be a major surplus for the area.

Figure 3 - East view of the old (left) and new building (right)

5.4.2 *Resources*

5.4.2.1 Energy

The compliance with these criteria was complex and wasn't fully achieved , for example:

- The use of external insulation is not compatible with the typical exposed granite, forcing the designer to a less energy efficient indoor insulation solution.
- Achieving the glazing area for solar gain often requires addition of new walls that allow south oriented windows
- Ventilation requires mechanical systems
- Strategies used:

- The inevitable interior insulation of the stone walls was compensated by the addition of thermal mass in the concrete (water heating) radiant floor. In the field station the glazing area increased 75% and the ratio between window and floor area is over 10%.
- The windows have wood frames, double glazing with exterior laminated glass, and *Bio-clean* glass (self-cleaning glass); and shutters.
- There are operable windows in all opposite walls and doors have thick air chambers in order to provide airtightness.
- Ventilation is possible even in small bedrooms due to openings on the partitions.
- Daylighting is not enough in the bedrooms but all light bulbs are compact fluorescent.
- Solar panels provide hot water for fixtures, space heating and appliances and a photo-voltaic panel will provide at least 5% of the consumed energy.
- A salamander of pellets/wood will provide backup heating in the winter since biomass is quite available in the region.
- Thermal bridges are avoided in most windows.

Figure 4. The north façade showing glazing area increase.

5.4.2.2 Water

Potable water is available in the area from a local spring. Nevertheless its consumption will be measured. The rain water is collected in 2 tanks for irrigation and fire fight.

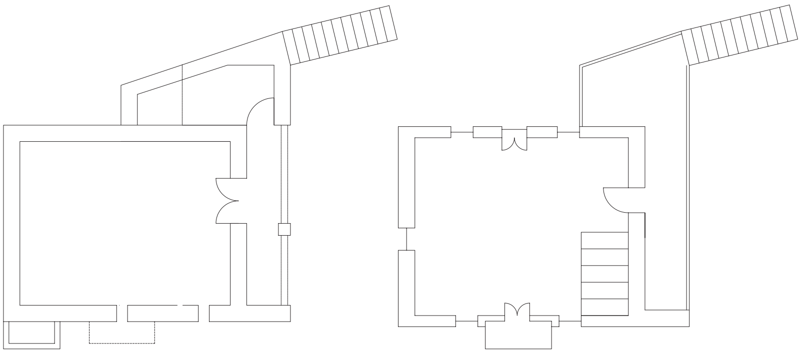

Figure 5. The existing house: ground floor (left) and first floor (right)

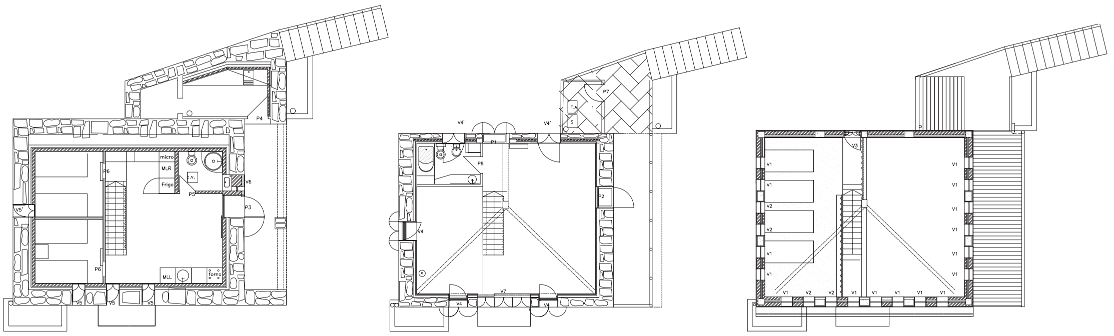

Figure 6. The new floor plans: ground floor (left) , first floor (middle) and mezzanine (right)

5.4.2.3 Materials

The used materials were either reduced, recycled, local or certified:

- The use of materials was minimized whenever possible by using materials that didn't require finishes.
- Most materials are recycled from the demolition site,
- Many came from the region,
- Some (mostly certified) are imported.

5.4.3 *Environmental Loads*

5.4.3.1 Sewage

Sewage was reduced by installing double flux toilets, water reduction tap systems and thermostatic bath taps. A natural sewage treatment plant will be built in the lot. There is no recycled grey water in this facility. Monitoring will be done and some education will be provided to the users.

5.4.3.2 Emissions

The CO2 emissions of the house are not yet calculated but it will depend on the amount of wood (pellets) necessary to backup the solar system installed for heating waters and heating space thru radiant floor. All appliances will be A+ rated (e.g.induction electric cook top, and washing machines that run with solar water). Monitoring will provide accurate figures.

Organic compost will be produced from the forest cleaning waste (50m around the house) mixed with organic trash and ashes from the 2 wood furnaces which will be highly efficient. This compost will be used as garden fertilizer.

Smoking will be forbidden indoors, while outdoors it already is during summer months (from June till September the Park uses this measure for fire prevention).

Materials with no CFC emissions were used in the house.

There will be a manual and a specific place for all harmful substances like lab toxic substances, batteries, lamps and cartridges. Biodegradable cleaning products will be provided to prevent the biological sewage treatment plan from malfunction.

There will be recycling bins for paper, plastic and glass to be taken to the village recycling center.

The noise will be prevented, due to the expanded cork material used both inside the walls and in the roof insulation. Cork flooring will be installed in the mezzanine as well.

Heat island effect will be prevented since the outdoor pavement will be permeable.

5.4.4 *Indoor Environment*

The indoor air quality is assured by windows that provide cross ventilation in all rooms. Hopper windows prevent burglar intrusion and are equipped with mosquito nets. In the smallest bedrooms, trickle vents were used in order to achieve proper air renovation rates. Paints were chosen according to their VOC`s emissions e.g. beeswax, linseed oil and water based paints. Radon was detected in the house therefore, epoxy paint as a soil sealant.

Thermal confort was achieved due to high insulation, water infiltration control, and wind protection from new trees strategic location.

Illumination levels were achieved in all working areas for visual critical tasks.

Daylighting is available in all rooms.

The acoustic insulation is provided from the cork floor and the gypsum and paper panels.

Most windows are operable, with the exception of the upper north windows.

5.4.5 *Durability and Accessibility*

The new interior walls are flexible with the exception of the bathroom walls.

Inside the gypsum wall, the piping is easily accessible and the seams and screws are visible for easier access.

Durability was ensured by using preservatives in the wood. Self-cleaning glass (SGS-Bioclean) was used for the non-accessible windows.

Accessibilty wasn`t complied due to lack of space.

The house won’t be fenced since it is located in a National Park.

5.4.6 *Environmental management and Innovation*

A manual will be provided to the users with some technical info on the house sustainable features and a description of its proper use.

The house will be monitored during a year, and then will be results will be submitted to an energy and environmental audit and certification.

Some innovative features are the use of light panels made of gypsum and recycled paper and the crashed tiles for the bathrooms.

6 CONCLUSIONS

The certification by LiderA helps designers reaching a more environmental solution although the criteria need adaptation when applied to buildings retrofit which are located within a protected area.

Parameters like site and integration, water, materials and accessibility need to be re-assessed.

The field station allowed to perceive that site and integration should have less weight since location is not an option or choice while retrofitting buildings.

Recycling water in the park is not as important as in the south where it is critical.

On the other hand energy self-sufficiency is critical in a building very distant from the grid. A small biological sewage treatment plant is crucial to avoid underwater pollution in a protected area while space use is not as critical. Other advantages of the biological solution include the fact that it doesn`t require electrical energy or technical maintenance.

Recycling materials is more critical in a retrofit especially if it occurs in vernacular architecture on a remote area. Certified materials are still few in the Portuguese market and importing them has a down-side since it increases the material embodied energy. Accessibility is a very big challenge when area constraints are critical like in vernacular architecture. Nevertheless the field station has strong possibilities to be certified and its cost was significantly moderate. The research will soon be completed with more data.

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