Evaluation ENERBUILD-Tool – Building in planning phase

Romarzollo School

1 Basic information about the building

Name of the building	Romarzollo School
Address of the building	Via Carducci, 38062 Romarzollo di Arco (Tn), Italy
Owner/investor	Municipality of Arco
Year of construction	20010-2011
Building type	Massive construction
Building method	Concrete walls with external insulation
Number of buildings	1
Number of levels above earth	3
Number of levels underground	1
Kind of the public use	School
Effective area for public use in m² (net)	1780.1 m^2
Additional private uses	-
Effective area for private use in m ² (net)	-
Total effective area in m²	1780.1 m^2
Source of energy for heating	Natural gas
Heating system	Central-heating boiler powered by natural gas
Water heating system	Central-heating boiler powered by natural gas
Date of the building evaluation	In progress

2 Execution of the building evaluation with the ENERBUILD tool

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3 Results

Nr.		Title	Must criteria (M)	max. points	evaluated points
A		Quality of location and facilities		max. 100	88
A	1	Access to public transport network		50	50
A	2	Ecological quality of site		50	38
B		Process and planning quality		max. 200	170
B	1	Decision making and determination of goals		25	25
B	2	Formulation of verifiable objectives for energetic and ecological measures	M	20	20
B	3	Standardized calculation of the economic efficiency	M	40	40
B	4	Product-management - Use of low-emission products		60	50
B	5	Planning support for energetic optimization		60	35
B	6	Information for users		25	0
C		Energy & Utilities (Passive house)		max. 350	303
C	1	Specific heating demand (PHPP)	M	100	100
C	2	Specific cooling demand (PHPP)	M	100	28
C	3	Primary energy demand (PHPP)	M	125	125
C	4	CO2-emissions (PHPP)		50	50
D		Health and Comfort		max. 250	0
D	1	Thermal comfort in summer		150	0
D	2	Ventilation - non energetic aspects		50	0
D	3	Daylight optimized (+ lightening optimized)		50	0
E		Building materials and construction		max. 200	0
E	1	$OI3_{TGH-lc}$ ecological index of the thermal building envelope (respectively OI3 of the total mass of the building)		200	0
Sum				max. 1000	561

Site plan

Classroom

Gym

4 Conclusions from the building evaluation with the ENERBUILD-Tool

a) Generally

The building scored 561 points: the score is not high although its level of environmental sustainability is quite good. In particular, the project doesn't get any score in section "Health and Comfort". In particular:

1. For what concerns the criterion "optimized Daylight", LEED do not consider acoustic criteria, so no calculus is available at the moment on this issue.
2. Regarding "Thermal comfort in summer", even if T upper limit has been raised to 27°C (in order to consider higher summer temperature in Italian situation), the upper allowed temperature is overshoot for the 36.4 % of time. This is probably due to the fact that schools are not used from middle June to middle September, so not enough attention has been put to summer overheating. Besides, in Mediterranean countries it is quite difficult that upper temperature is overshoot less than 5% of time in summer, so this limit should be raised. In school, only effectively period of use should be considered.
3. Considering "Daylight optimized", Leed certification considers only regularly occupied spaces, and it requires daylight factor up to a maximum percentage of 2% in 75% of these spaces, while according to ENERBUILD certification this factor has to be as possible equal to 5%, and superior to 2%, calculated on entire area, that is effectively a too severe request.
   Besides, no points are obtained in section E "Building materials and construction" being the OI3 index too high due to the wide use of concrete in the construction.

b) About the planning process

The building was designed to obtain a Leed NC 2.2 Gold certification, corresponding to a score of 44-57 points.

For what concerns the planning process, it has been done using LEED as reference and not ENERBUILD tool, that has been applied in a second moment and so it can be considered more an evaluation tool than a planning tool. However, the following considerations about ENERBUILD-Tool can be done:

1. Point A1 is clear and easy to be faced.
2. Point A2 is well defined and the proposed index is easy to be used.
3. Points B1 and B2 are very detailed and well done. All the most important aspects of planning phase are taken into consideration. Each point has a proper reference with LEED tool (see even following detailed considerations).
4. Point B3 has been quite difficult to be done. LCC is a procedure more and more important in the planning phase (together with LCA) and it is important that in ENERBUILD it has a good relevance, but the ISO Standard and the Austrian standard has been difficult to be applied. For this reason, a simplified method has been followed considering the classical value analysis theory.

5. Point B4 is very important concerning human health in indoor spaces. ENERBUILD is quite complete even if the definition of the percentage of structures with ecological declaration is not clear. It could be easier to have reference to European standards and not to local ones. Even a list of most common building components could be useful.
6. Point B5 is of course an important issue and it has clear reference, point by point, with LEED protocol. It is sufficiently clear and not difficult to be faced.
7. Point B6 is clear and very important. Unfortunately, not all the energy and environmental tools consider this aspect.
8. Point C1 to C4. This is the most problematic section of the tool. In fact, we agree that, in order to have comparable results, the same energy calculation tool should be used. However, PHPP is a good tool only if a passive building has been designed, and the pilot building considered is not a passive one. Moreover, cooling demand is often overestimated and low points are given. It is our opinion that other software should be used, even national ones, taking into account that all the partners should agree on some “fixed points” so that final results of the energy calculation could be compared. For example, it is important to consider international standards. But the choice of the energy calculation tool should be free.
9. Point D1: refer to previous comment.
10. Point D2: in this case, it should be better to leave the partner free to consider national legislation and not fixed values. Also the acoustic index used should refer to international standards. In the case of the pilot building considered, calculation were not made so it is quite impossible to calculate the correct indexes.
11. Point D3: the point is simple and using the EN standard it is easy to calculate. Anyway, the 5% of DF required seems to be too high. In our opinion, following LEED specifications, a daylight factor up to a maximum percentage of 2% in 75% of frequently used spaces should be sufficient.

Point E1: the procedure for calculating the OI3 index is quite simple and it is an important aspects of building construction.

c) About the building itself

The Municipality of Arco has planned the construction of a new elementary school in the locality Romarzollo to satisfy the educational needs of neighboring villages. The area is included in the instrumentation planning purposes "on public services" and it is a quiet area flanked by a sport center and well connected by roads and public services.
The new school will house 300 students and will consist of 14 classrooms and laboratories, a gymnasium, a canteen with related services, storage spaces and outdoor spaces.
The new building fits in an environmental context and landscape of valuable features, which have influenced the project architectural formal-choices. Especially on its north side landscape is strongly marked by characteristic "terracing" form of cultivated land that mark the hills.
The design of the new school try to integrate with existing landscape. The building is designed by parties and volumes buried and above ground, the flat roofs of buried shares become walking plans which integrate in the landscape. The visible part of the building has a very regular shape with the purpose to become a strong element of recognition.
Choices have been made also with the intent to offer users the best conditions of comfort (lighting environments, strong contact with the external environment, space and regular and clearly recognizable routes) by exploiting the favorable climatic conditions in the area and to develop a strategy aimed at reaching a low energy consumption. All windows are equipped with systems to control solar radiation.

In particular, its specific construction techniques are:

- integration in the context of the building of settlements;
- photovoltaic system;
- reducing water consumption by using rainwater for toilet and for irrigation;
- use of materials with recycled content, rapidly renewable and regional;
- automatic checks for a reduction in power consumption;
- automatic checks for a reduction in power consumption;
- management control of lighting systems
- indoor air quality monitoring;
- attention to acoustic performance;
- use of green roof to guarantee a good insulation;

- facilitation of mobility alternative: parking for vehicles with low emission of toxic gases and buses, bicycle parking areas, attention to public transportation system.

d) About the evaluation process

In the case of small buildings like this, evaluation process is not too difficult.
As opposed to what was done for the Mezzolombardo school, the volume of the gym has been considered, because of its small size and because it has very low impacts on the overall energy consumption.
The most problematic aspects of the research has been those related to the collection of all necessary documents and information – that sometimes must be too detailed –. For this reason, we chose to perform ENERBUILD evaluation process using data provided by Leed certification protocol. So, we had to verify where these two systems overlap and which Leed credits correspond (even partly) to ENERBUILD criteria and which have been tried for the considered building. However, if there is no correspondence (as in the case of credit D2, and, partly, credit B1) or a Leed credit has not been tried, we considered the correspondent ENERBUILD criterion not satisfied. Section C and criteria B3 and E1 – which have no Leed equivalent – are instead calculated separately, according to the instructions of the manual.
Here follows the comparison between ENERBUILD criteria and Leed credits tried for this building.

A Quality of location and facilities

A1 Access to public transport network

Leed evaluation process requires easy access to public transportation through SS Credit 4.1 "Alternative Transportation: Public Transportation Access". To get this criterion, Leed and ENERBUILD evaluations use very similar approaches, both requiring to place the project near an existing public bus or train stop. However, compared to Leed certification, ENERBUILD evaluation process also requires a transport minimum hourly frequency.

A2 Ecological quality of site

There is no direct correspondence between LEED credits and ENERBUILD A2 criterion. However, it is possible to calculate area's ecological index by Leed certification, and in particular through SS Credit 1 "Site Selection" and through SS Credit 2 "Density & Community Connectivity".

B Process and planning quality

B1 Decision making and determination of goals – B2 Formulation of verifiable objectives for energetic and ecological measures

Decision making is defined by Leed evaluation process through an initial diagram and through two reports ("Basis Of Design", BOD, and "Owner's Project Requirements", OPR, defined by EA Prerequisite 1, "Fundamental Commissioning of the Building") that contain the objectives to be pursued. Checklist is also a Leed tool which allows to evaluate the project team's choices and to get B1 and B2 ENERBUILD Criteria.

In particular, for credit B1 assessment important criteria are SSPr1, SSPr2, SSC2, SSC4, SSC5 into the SS Section "Sustainable Sites", criteria EAPr2, EAC1 into the EA Section "Energy and Atmosphere", criteria MR C4, MRC 5, MRC6 into the MR Section "Materials and resources" and IEQ Criterion 4 into the EQ Section "Indoor Environmental Quality".

B2 credit is met by two Leed reports – BOD and OPR – defined respectively by the owner and by the design team. These tools are a necessary prerequisite for Leed certification and so B2 criterion is always get.

B3 Standardized calculation of the economic efficiency

Standardized calculation of the economic efficiency (LCC) is not considered by Leed certification and so it was calculated separately.

B4 Product management – Use of low-emission products

Product management is defined into the MR Section "Materials and Resources" and into the EQ Section" Indoor Environmental Quality" through different criteria. In particular, Leed evaluation process requires to use materials with recycled content, rapidly renewable and regional as defined, respectively, by MR Criterion 4, C5 and C6.

However, Leed evaluation process requires full documentation of all materials used but it requires Low-Emitting Materials only for building's interior and in particular, for adhesives and sealants, paints, and coating, carpet systems composite wood, agrifiber products (and according to the manual "Leed for School", furniture) as required by Credits 4.1, C4.2, C4.3, C4.4 into the EQ Section.

Therefore, although the correlation between Leed evaluation and credit B4 is not direct, it is possible to compare these two protocols and ENERBUILD criterion B4 is get if all Leed criteria have been tried.

B5 Planning support for energetic optimization

B5 criterion requires to satisfy the following conditions (each associated with 5 points):

- design by specifying destination, size, frequency and intensity of use of the rooms, and their internal temperatures. This criterion is quite similar to Leed Credit EA1, because building energy simulation requires the same information;
- design of air flow room according to hygiene requirements, as required into the EQ Section, "Indoor Environmental Quality", and in particular by EQPr1 (that requires to establish minimum indoor air quality);
- identification of internal heat sources, condition necessary to develop building energy simulation and so condition already required by Leed Credit EA1;
- calculation of thermal bridges by means of a default value of 0.03 W / (m2 K) and detailed verification of thermal bridges. There is no correspondence to Leed certification system;
- description of energy parameters in the contract, as required by Leed EA Pr1;
- verification of energy aspects of the tenders with the requirements of the contract, condition satisfied because it gets EA Prerequisite 1;
- visits to the site to support local management about energy issues, required also by Credit EA C5;
- provide to conduct the Blower Door test, that is an option required by Leed certification just in case of residential buildings, through EQ Prerequisite 2 (Option 3);
- measure of ventilation system, as required by Leed evaluation with EA Credit 1;
- hydraulic balancing of the heating, as required by Leed EA Credit 1;
- update of the calculations of energy requirements at the end of the construction and conduct a blower door test as final control. This criterion get Leed EA Credit 1;
- verification of energy requirements at the end of the work, as required by Leed EA Credit 5 “Measuring and verification”.

B6 Information for users

Leed evaluation process requires to develop an use and operating manual just if you want to get the EA Credit 3 "Enhanced Commissioning". So, its development – very rare – depends on project team’s choice, on building’s complexity and on its destination.

C Energy & Utilities (Passive house)

C1 Specific heating demand (PHPP) – C2 Specific cooling demand (PHPP) – C3 Primary energy demand (PHPP) – C4 C_O2-emissions (PHPP)

Section C on the energy requirements (C1, C2, C3) can not be compared directly with EA Leed section "Energy and Atmosphere". In fact, ENERBUILD certification system requires an analysis developed by using Phpp software, whereas Leed evaluation process just requires (EA C1) to observe the minimum prescriptive measures. Also, if you want to obtain the maximum score, Leed requires to develop a

dynamic simulation (EA C1, Option 2) that involves comparison of the building with a basic model defined by prescriptive measures (ASHRAE 90.1.2007 norm, Appendix G).

D Health and Comfort

D1 Thermal comfort in summer

Although into the EQ Leed section credits EQ C7.2 and EQ C7.1 define all the requirements for summer thermal comfort, it is necessary to use Phpp software to calculate value hθ (percentage overshoot the maximum allowable temperature in summer) required by ENERBUILD certification system. Therefore, D1 ENERBUILD criterion doesn't find a match with Leed certification.

D2 Ventilation – non energetic aspects

Leed evaluation process defines the requirements for sound insulation just when the building is a school. Again, however, there is no correspondence to ENERBUILD evaluation process: Leed certification requires to achieve in classrooms a background noise up to a maximum level of 45 dBA, equivalent to standards required by ANSI S12.60/2002 (EQ Pr3); instead, ENERBUILD requires not only a background up to a maximum level of 30 dBA, but also that sound pressure level (not exceeding 20 dB) is evaluated with the weighting curve "C". In particular, this second aspect is not considered by Leed evaluation process and so these two evaluation processes are not comparable.

D3 Daylight optimized (+ lightening optimized)

D3 criterion is similar to Leed EQ Credit 8.1 "Daylight and views". However, Leed certification considers only regularly occupied spaces, and it requires daylight factor up to a maximum percentage of 2% in 75% of these spaces, while according to ENERBUILD certification this factor has to be as possible equal to 5%, and superior to 2%, calculated on entire area.

E Building materials and construction

E1 OI3TGH-lc ecological index of the thermal building envelope

Although Leed evaluation process rewards the use of ecological materials (MR C4, MR C5 and MR C6), Leed doesn't require the calculation of ecological index of thermal building envelope. So, ENERBUILD E1 criterion doesn't find a match with Leed certification system.

5 Suggestions for improvement of the ENERBUILD-Tool

- Mandatory criteria shouldn't have score;
- Criterion B3: life cycle cost analysis is a mandatory criterion, but in practice LCC are rarely calculated. moreover, prescriptions and assumptions for profitability calculation are not clear and ISO 15686-5 is not sufficient;
- Section C: some PHPP layers require information too detailed and very difficult to collect for already designed and built constructions, especially if nor passive buildings;
- Criterion D3: only regularly occupied spaces and not entire area should be considered in order to calculate the average daylight factor.

5 Annex A: Detailed evaluation of criteria

A Quality of location and facilities

A1 Access to public transport network

The building is located near a bus stop and so it is served by a good public transportation. Being also verified hourly frequency during the opening hours of the school, A1 criterion score is equal to 50 points.

Criteria	Max points	Obtained points
A1 Criterion	50	50

A2 Ecological quality of site

Before the construction, the area was occupied by prairie – area a2, with low ecological value – and its index of ecological value is equal to 2. So, the points for A2 credit assessment is equal to:

Criteria	Max points	Obtained points
A2 Criterion	50	38

B Process and planning quality

B1 Decision making and determination of goals

Decision-making documentation coincides with the checklist developed in pre-design phase.
In this case, variants were evaluated by all ENERBUILD accounts, except the term relating to variant 0 which was not evaluated (Leed certification do not requires it) and it has been allowed the use of ecological materials such as materials with recycled content, rapidly renewable and regional – having been tried, respectively, the Leed MR Credits C4, C5 and C6 – .

Criteria	Max points	Obtained points
Exists a documentation of the decision making process?	10	10
Have been variants considered and evaluated?	5	5
Has been 0-variant considered?	5	0
Does a documentation of the evaluation scheme of the variants exist?	4	4

Does it contain: Urbanism Access to public transport Landscape impact - soil quality Energy efficiency Ecological use of materials	 2 2 2 2 2	 2 2 2 2 2
Sum	**25**	**25**

B2 Formulation of verifiable objectives for energetic and ecological measures

Reports BOD and OPR (EA Prerequisite 1) define the characteristics of the project, including energetic and environmental measures. So, ENERBUILD criterion may be fulfilled in accordance with the goals contained in the two reports and in checklist required by Leed evaluation system.

Criteria	Max points	Obtained points
B2 Criterion	20	20

B3 Standardized calculation of the economic efficiency

The life cycle costs and the economic efficiency were not calculated in planning and Leed certification phases. However, since the criterion ENERBUILD is mandatory, the analysis has also been carried out: building's life cycle costs are not lower than those of reference model (OIB6) and the ENERBUILD criterion is not fulfilled.

Criteria	Max points	Obtained points
B3 Criterion	40	0

B4 Product management-Use of low-emission products

The Leed credits tried for this building project are related to use of recycled, regional and rapidly renewable materials. 100% of the structure is declared but documentation of construction process is partial.

Criteria	Max points	Obtained points
Exists a documentation of the ecological optimization of the materials during the planning phases	10	10
The tender for all craftworks have been declared ecologically? Criteria like in baubook. 100% of works 90% of works 70% of works	 20 15 10	 0 0 0
Were all products of all craftworks declared? 100% 90% 70%	 30 20 10	 30 - -
Does un ecological building supervision exist? Did the supervisor do regularly inspections on the building site? - Total construction process - Partially construction process	 20 10	 - 10
Sum	**60**	**50**

B5 Planning support for energetic optimization

It is not a residential building and Blower Door test was not developed (Leed evaluation process doesn't require it in this case). EA Credit 5 was not tried.

ENERBUILD	Points	Leed credits	Obtained points
Design by specifying type, size, frequency and intensity of use of the rooms, and their internal temperatures	5	EAC1	5
Design of air flow to room according to hygiene requirements	5	EQPr1	5
Identification of internal heat source	5	EAC1	5
Calculation of thermal bridges by means of a default value of 0.03 W / (m2 K) and detailed verification of thermal bridges	5	-	-
Description of energy parameters in the contract	5	EAPr1	5
Verify of energy aspects of the tenders with the requirements of the contract	5	EAPr1	5
Visits to the site to support local management about energy issues	5	EAC5	0
Provide to conduct a Blower-Door Test	5	EQPr2	0
Measure of ventilation system	5	EAC1	5
Hydraulic balancing of the heating	5	EAC1	5
Update of the calculations of energy requirements at the end of the work and conduct a blower door test to control	5	-	-
Verification of energy requirements at the end of the work	5	EAC5	0

Criteria	Max points	Obtained points
B5 Criterion	60	35

B6 Information for users
A user manual does not exist for this building, since it has not been tried Leed credit EA c3 “Commissioning advanced”.

Criteria	Max points	Obtained points
B6 Criterion	25	0

C Energy & Utilities (Passive house)

C1 Specific heating demand (PHPP)
Specific space heat demand: 12,4 kWh/m²a

Criteria	Max points	Obtained points
C1 Criterion	100	100

C2 Specific cooling demand (PHPP)
Specific cooling demand: 8 kWh/m²a

Criteria	Max points	Obtained points
C2 Criterion	100	55

C3 Primary energy demand (PHPP)
Specific primary energy demand: 93 kWh/m²a

Criteria	Max points	Obtained points
C3 Criterion	125	125

C4 Co2-emissions (PHPP)
Co2-emissions: 22,7 kg/m²a

Criteria	Max points	Obtained points
C4 Criterion	50	50

D Health and Comfort

D1 Thermal comfort in summer

PHPP software has calculated the value hθ (overshoot the maximum allowable temperature in the summer) equal to 36.4% superior than 5% required by ENERBUILD evaluation process. Therefore, D1 criterion score is zero T upper limit set to 27°C).

Criteria	Max points	Obtained points
D1 Criterion	150	0

D2 Ventilation – non energetic aspects

In this case, the two evaluation processes are not comparable and so, missing necessary data, D2 criterion score is zero.

Criteria	Max points	Obtained points
D2 Criterion	50	0

D3 Daylight optimized (+ lightening optimized)

The daylight factor was calculated with following formula from UNI EN 15193, 2008 for each room:

$$\overline{D} = \frac{A_g \cdot \theta \cdot \tau_{D65}}{A \cdot (1 - R^2)}$$

Daylight factor: D= 1,61%

Criteria	Max points	Obtained points
D3 Criterion	50	0

E Building materials and construction

E1 OI3TGH-lc ecological index of the thermal building envelope

When value $_{OI3TGH\ WG\text{-}BGF\ Ref}$ takes values between 38 and 295, the points for E1 credit assessment are calculated using the formula:

$$Points = 2 \times (0{,}0007 \times OI3_{TGH-BGF}{}^2 - 0{,}623 \times OI3_{TGH-BGF} + 123)$$

If $OI3_{TGH\ WG\text{-}BGF\ Ref} \leq 38$, are awarded 200 points, while if $OI3_{TGH\ WG\text{-}BGF\ Ref} \geq 295$, are instead assigned 0 points

In this case:

$OI3_{TGH,BGF} = 2328$

Criteria	Max points	Obtained points
E1 Criterion	200	0