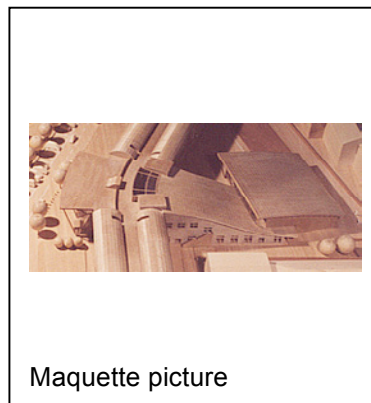
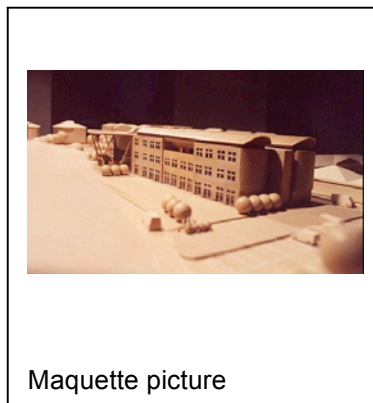
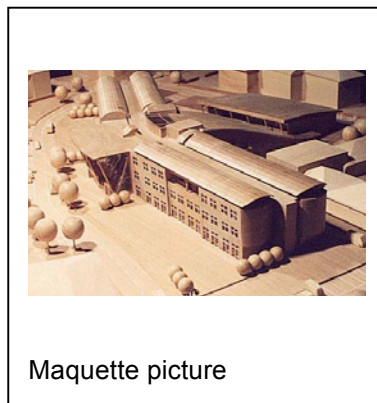


## Evaluation ENERBUILD-Tool – Building in planning phase

### Mezzolombardo School



#### 1 Basic information about the building

Name of the building	Mezzolombardo School
Address of the building	Via Perlasca, 38017 Mezzolombardo (Tn), Italy
Owner/investor	Autonomous Province of Trento – Servizio Edilizia Pubblica
Year of construction	2003
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 m <sup>2</sup> (net)	4012 m <sup>2</sup>
Additional private uses	-
Effective area for private use in m <sup>2</sup> (net)	-
Total effective area in m <sup>2</sup>	4012 m <sup>2</sup>
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+solar
Date of the building evaluation	In progress

## 2 Execution of the building evaluation with the ENERBUILD tool

Responsible Organisation: University of Trento – Department of Civil and Environmental Engineering - Italy

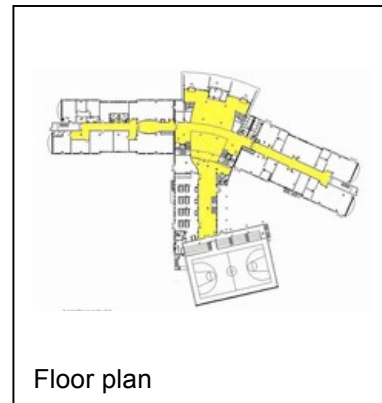
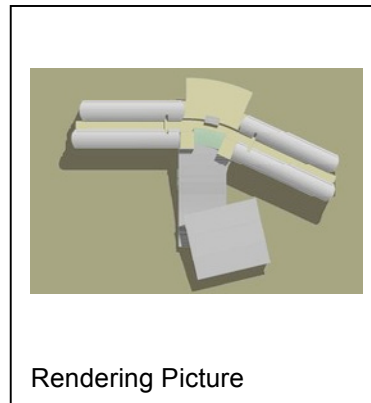
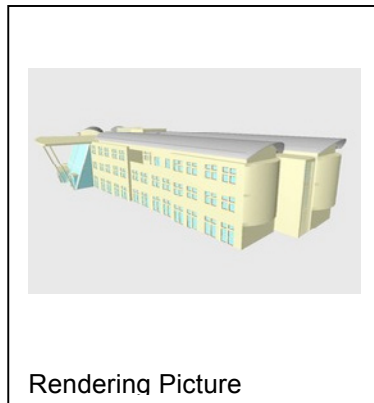
Contact person: Prof. Antonio Frattari

Telephone: +390461282668

Email: antonio.frattari@unitn.it

## 3 Results

Nr.		Title	Must criteria (M)	max. points	evaluated points
<b>A</b>		<b>Quality of location and facilities</b>		max. 100	92
A	1	Access to public transport network		50	50
A	2	Ecological quality of site		50	42
<b>B</b>		<b>Process and planning quality</b>		max. 200	195
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	25
<b>C</b>		<b>Energy &amp; Utilities (Passive house)</b>		max. 350	235
C	1	Specific heating demand (PHPP)	M	100	40
C	2	Specific cooling demand (PHPP)	M	100	55
C	3	Primary energy demand (PHPP)	M	125	93
C	4	CO <sub>2</sub> -emissions (PHPP)		50	47
<b>D</b>		<b>Health and Comfort</b>		max. 250	30
D	1	Thermal comfort in summer		150	0
D	2	Ventilation - non energetic aspects		50	0
D	3	Daylight optimized (+ lightening optimized)		50	30
<b>E</b>		<b>Building materials and construction</b>		max. 200	55
E	1	OI <sub>3</sub> <sub>TGH-ic</sub> ecological index of the thermal building envelope (respectively OI <sub>3</sub> of the total mass of the building)		200	55
<b>Sum</b>				<b>max. 1000</b>	<b>607</b>



## 4 Conclusions from the building evaluation with the ENERBUILD-Tool

### a) Generally

The building received a score of 608 points: it is not very high because of building's large size which requires the use of large-scale plants, and because of a large window on the main front. So, in this case evaluation process was quite difficult and probably not really reliable. The use of PHPP, a software though for passive buildings, was quite difficult to be adopted for this kind of construction giving not well controlled output.

Moreover, The great majority of points are lost in part D "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 15.6 % of time. 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.
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.

### b) About the planning process

The building was designed to get Leed certification, as well as all public buildings in Trentino.

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 new school will house 4300 students and it will consist of:

- 25 classrooms and 7 workshops;
- physics laboratories;
- 2 science and chemical laboratories;
- 3 drawing classrooms;
- 4 computer labs and a mechanical laboratory;
- 1 library (about 100 mq);
- a lecture hall (approximately 80/100 seats);
- 2 / 3 splitable rooms;
- secretarial and Office Chair;
- a teacher room;
- hall, bar, vending;
- gym with basketball court (approximately 80/100 seats);
- refectory for 80/100 seats.

The building was also designed to obtain Leed certification. In particular, its specific construction techniques are:

- great attention to stormwater design (quality and quantity control) and to site development (in particular, to maximization of open spaces);
- optimization of building's energy performances;
- use of renewable energies such as solar;
- high internal environmental comfort provided by a forced-air ventilation with heat recovery;
- use of regional materials.

### d) About the evaluation process

In this case, the evaluation process was not easy at all, because of the large building size and complexity of its functions. In fact, the institute hosts – in addition to regular classrooms – workshops, kitchens, a refectory and a gym. Therefore, it was quite difficult to compile PHPP layers (probably, this software was designed for small buildings), being impossible to define the same values of air exchange and of internal temperatures for all spaces (as required by PHPP). So, the gym's volume has not been considered: without this simplification the calculation of Specific heating demand and of Specific cooling demand by PHPP (C1, C2 criterion) could'nt be reliable.

The other problematic aspect of the research is 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 / (m<sup>2</sup> 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 CO<sub>2</sub>-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 h<sub>θ</sub> (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 (+ lightning 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-Ic 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 not 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**

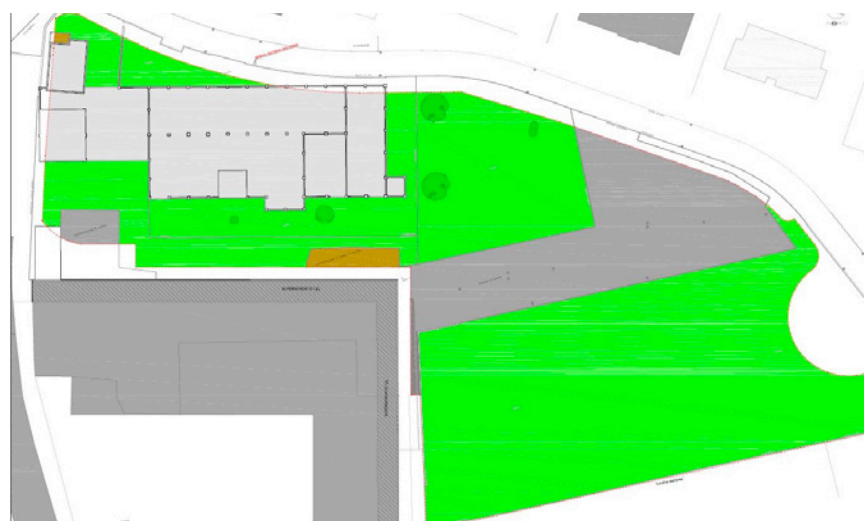


Close to the school there are two bus stop and a train stop. Transport’s frequency is lower than half an hour during time of entry and exit and so it was awarded the maximum score for A1 criterion.

Criteria	Max points	Obtained points
A1 Criterion	50	50

**A2 Ecological quality of site**

Before this construction, a percentage equal to 35% of the site was occupied by a building now demolished – which matches to area a1, area with no ecological value –, while remaining area was occupied by prairie – area a2, with low ecological value – .



Pre-develop situation



Index of ecological value of site is equal to the  $I_E$  weighted sum of the two areas, according to the formula:

$$I_E = \frac{s1x1+s2x2+s3x3+s4x5+s5x7+s6x10}{s1+s2+s3+s4+s5+s6} = 1,65$$

So, the points for A2 credit assessment are calculated using the formula:

$$\text{Points} = -1,25I_E + 6,25$$

Criteria	Max points	Obtained points
A2 Criterion	50	42

## 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). It has been partly allowed the use of ecological materials as regional materials – having been tried the Leed MR Credit C5 – .

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	2	2
Access to public transport	2	2
Landscape impact - soil quality	2	2
Energy efficiency	2	2
Ecological use of materials	2	1
<b>Sum</b>	<b>25</b>	<b>25</b>

### 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. In particular, objectives of this project are:

- great attention to stormwater design (quality and quantity control) (Leed SS Credit 6 tried) and to site development (in particular, to maximization of open spaces) (Leed SS Credit 5.2 get);
- optimization of building's energy performances (Leed EA Credit 1 tried) ;
- use of renewable energies such as solar (Leed EA Credit 2 get);
- high internal environmental comfort provided by a forced-air ventilation with heat recovery (Leed credits EA Pr3, EA C4, IQ C7 tried);
- use of regional materials (Leed MR Credit 5 tempted).

So, ENERBUILD criterion may be fulfilled in accordance with the goals contained in the two reports and in checklist required by Leed certification 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: the building is constructed with good materials and so its LCC are lower than those of reference model (OIB6) and the ENERBUILD criterion is fulfilled.

Criteria	Max points	Obtained points
B3 Criterion	40	40

### B4 Product management-Use of low-emission products

The Leed credits get for this building project are related to use of regional 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	20	0
90% of works	15	0
70% of works	10	0
Were all products of all craftworks declared?		
100%	30	30
90%	20	-
70%	10	-
Does an ecological building supervision exist? Did the supervisor do regularly inspections on the building site?		
- Total construction process	20	-
- Partially construction process	10	10
<b>Sum</b>	<b>60</b>	<b>50</b>

### B5 Planning support for energetic optimization

It is not a residential building and so 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

User manual exists for the building, since it has been get Leed credit EA C3 “Commissioning advanced”.

Criteria	Max points	Obtained points
B6 Criterion	25	5

## C Energy & Utilities (Passive house)

### C1 Specific heating demand (PHPP)

Specific space heat demand: 25 kWh/m<sup>2</sup>a

Criteria	Max points	Obtained points
C1 Criterion	100	40

### C2 Specific cooling demand (PHPP)

Specific cooling demand: 5 kWh/m<sup>2</sup>a

Criteria	Max points	Obtained points
C2 Criterion	100	55

### C3 Primary energy demand (PHPP)

Specific primary energy demand: 131 kWh/m<sup>2</sup>a

Criteria	Max points	Obtained points
C3 Criterion	125	93

### C4 CO<sub>2</sub>-emissions (PHPP)

CO<sub>2</sub>-emissions: 31,9 kg/m<sup>2</sup>a

Criteria	Max points	Obtained points
C4 Criterion	50	47

## D Health and Comfort

### D1 Thermal comfort in summer

PHPP software has calculated the value h<sub>0</sub> (overshoot the maximum allowable temperature in the summer) equal to 15.6%, superior than 5% required by ENERBUILD certification system. 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 certification systems 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:

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

Daylight factor result D= 3,66%

Criteria	Max points	Obtained points
D3 Criterion	50	30

## E Building materials and construction

### E1 OI3TGH-Ic ecological index of the thermal building envelope

When value  $OI3_{TGH-WG-BGF Ref}$  takes values between 38 and 295, the points for the credit E1 assessment are calculated using the following formula:

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

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

In this case:  $OI3_{TGH,BGF} = 197$

Criteria	Max points	Obtained points
E1 Criterion	200	55