Block 5: FEEDSCHOOLS Applications
5.1 ERE App

D.T4.3.1 E-learning course

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BLOCK 5: FEEDSCHOOLS APPLICATIONS
5.1 ERE APP

This block is part of a training package developed to provide local authorities with free tuition that may inspire and help them in adopting new technical and financial solutions to implement 'nearly Zero Energy Building' (nZEB) renovation activities in schools.

Specify block content:

The aim of the webtool is to simplify the energy analysis of school buildings and to implement energy improvement actions to support school decision makers to understand if it is worth implementing improvement actions and to identify which actions bring the greatest savings.

Level: intermediate

The topics dealt with in this block do not require specific knowledge on the building energetics, technical features of the building envelopes and energy systems. Therefore, webtool is likely to be used by users without specific knowledge. However, for a profitable use it is recommended at least to know: what is meant by energy consumption, installed power, emissions benefits, efficiency of a heat generator, and related units of measurement; the most basic energy efficiency measures; how to identify the parameters that influence the calculation of energy savings. Therefore, it is recommended to study of the previous blocks.

Learning Objective:

At the end of this block we will be able to use “Energy Profile Module” to evaluate performance of school building by checking the energy class and “Renovation Options Module” to evaluate the energy savings, carbon footprint and investment cost of some improvement actions and its contribution to total savings.

5.1.1	5.1.2	5.1.3	5.1.4
Method for calculation of specific energy consumption (*link*)	Evaluation of schools’ specific energy consumption (*link*)	Use of web tool: Energy Profile Module (*link*)	Use of web tool: Renovation Options Module (*link*)

5.1.1
Method for calculation of specific energy consumption

5.1.1 Objective

In this unit will you know the method for calculation of specific energy consumption of building schools by comparing them with the reference consumption of a significant sample of building schools: the calculation steps of the method, the mean of the "normalisation" of energy consumption and the normalisation factors will be described, and finally the calculation of the normalised energy indicators (NEI).

METHOD FOR CALCULATION OF SPECIFIC ENERGY CONSUMPTION

NORMALISATION OF THE ENERGY CONSUMPTION

The fuel and electricity consumption of schools should be determined and evaluated by comparing them with the **reference consumption of a significant sample** of schools.

Regarding the consumption of heating fuel, the comparison could be made using the average specific consumption, referring to volume unit and degree days (DD). The specific consumption in schools, however, depends not only on "modifiable" and therefore optimisable factors (efficiency, heat loss through walls, etc.) but also on non-modifiable factors such as the shape of the building (S/V ratio) and the heating time.

From the analysis of a **sample of schools**, used as a reference, it was possible to quantify, with good approximation, the dependence of consumption on the latter two factors.

The values of **S/V ratio** and the **number of daily hours for heating** corresponding to the **average specific consumption of the reference sample** can be identified.

At this point if the school has the same S/V ratio and the same number of daily hours for heating, the comparison with the average specific consumption of the reference sample would be homogeneous and any deviations could be attributed to the modifiable factors.

If, instead, these two factors are different, the comparison would be affected by this difference.

For example, if S/V or the number of heating hours in the school under examination was greater than that corresponding to the average consumption of the sample, there would be a greater energy consumption due to a greater dispersion of the building or to the prolonged heating time.

METHOD FOR CALCULATION OF SPECIFIC ENERGY CONSUMPTION

NORMALISATION OF THE ENERGY CONSUMPTION

In order to **normalise with respect to the average consumption of the sample**, the parameter **1.00 is attributed to the sample**, then certain consumption intervals, higher and lower than the average consumption, are parameterised proportionally, each of which corresponds to a range of S/V and number of daily hours for heating.

To carry out the parameterisation, the correlation found between the consumption of the schools in the sample and the relative factors is used.

The "**normalization**" of the school energy consumption is made by multiplying the energy consumption by the parameter corresponding to the class relative to the value of S/V or heating hours of the school.

School consumption needs to be corrected with so-called "normalisation" factors.

The corrected specific consumptions are called respectively:

- **ENI_H energy normalized indicator for heating**
  reference consumption is referred to the heated volume unit and the Day Degrees unit
- **ENI_E energy normalized indicator for electricity**
  reference consumption is referred is obtained from the ratio between average annual consumption and surface area on the floors, normalised with respect to the school's operating hours

METHOD FOR CALCULATION OF SPECIFIC ENERGY CONSUMPTION

CALCULATION STEPS – ENERGY CONSUMPTION

Energy consumption for heating and electricity consumption are taken from the bills for the last three years. Both fuel and electricity consumption over the three years are added together and are divided by 3 to obtain the average annual consumption.

AVERAGE ANNUAL CONSUMPTION OF HEATING FUEL

Energy carriers		Consumption			Average annual consumption
Fuel	u.m.	Year 0	Year -1	Year -2	
Natural gas	Sm^3				
Diesel fuel	l				
Fuel Oil	l				
LPG	kg				
Firewood	kg				
Coal	kg				
Electric Energy for heating	kWh				

AVERAGE ANNUAL CONSUMPTION OF ELECTRICITY

Electricity		Consumption			Average annual consumption
Contract ID	u.m.	Year 0	Year -1	Year -2	
Contract 1	kWh				
Contract 2	kWh				
Contract 3	kWh				
Contract 4	kWh				
Contract 5	kWh				
...	kWh				

METHOD FOR CALCULATION OF SPECIFIC ENERGY CONSUMPTION

CALCULATION STEPS – DIMENSIONAL & CLIMATIC DATA

- **Gross heated volume V [m^3]** It can be measured by the drawings, if available, or the building is measured from the outside. It includes the exterior walls. Unheated parts of the building must be excluded. If the school consists of several buildings, it represents the sum of the volumes of the individual buildings.
- **Dissipating surface S [m^2]** It is obtained from the plans of the buildings or through direct reliefs including also the partition walls, excluding the perimeter walls. If the school consists of several buildings, it represents the sum of the floor areas of the individual buildings.
- **Shape factor S/V [m^{-1}]** S/V ratio.
- **Gross floor Area Ap [m^2]** It is the sum of the individual surfaces surrounding the gross.
- **Degree Days [DD]** Heating degree days are a measure of how much (in degrees), and for how long (in days), the outside air temperature was below a certain level. It is a measurement designed to quantify the demand for energy needed to heat a building. Formally, DD are defined as **the sum of the differences between the internal design temperature (20 °C) and the average daily outdoor temperature for all heating days of the winter season in a given location**.

METHOD FOR CALCULATION OF SPECIFIC ENERGY CONSUMPTION

CALCULATION STEPS – NORMALISATION FACTORS

Heating Consumption Normalization Factor F_E

In order to make the specific consumption comparable with the reference consumption of the sample schools, it must be normalised with respect to the S/V ratio. The normalization factor F_E (to be multiplied by the specific consumption for heating) is obtained as a function of S/V and the type of school.

NORMALIZATION FACTOR FE

Kindergarten		Primary		Middle & High School	
S/V [m²/m³]	F_E	S/V [m²/m³]	F_E	S/V [m²/m³]	F_E
≤ 0,4	1,2	≤ 0,30	1,2	≤ 0,25	1,1
0,41 ÷ 0,50	1,1	0,31 ÷ 0,35	1,1	0,26 ÷ 0,30	1,0
0,51 ÷ 0,60	1,0	0,36 ÷ 0,40	1,0	0,31 ÷ 0,40	0,9
> 0,60	0,9	0,41 ÷ 0,45	0,9	> 0,40	0,8
		> 0,45	0,8		

NORMALIZATION FACTOR FH

Hours/day	F_H
≤ 6	1,2
7	1,1
8 ÷ 9	1,0
10 ÷ 11	0,9
> 11	0,8

Operating Time Normalization Factor F_H

The normalisation factor F_H depends on the operating time of the school buildings. F_H found for the school must be multiplied by the specific consumption for heating and the specific electricity consumption of the school.

METHOD FOR CALCULATION OF SPECIFIC ENERGY CONSUMPTION

CALCULATION STEPS - CALCULATION OF NORMALISED ENERGY INDICATORS

ENI_H energy normalized indicator for heating

ENI_H CALCULATION MODEL

Quantity	Symbol	u.m.	Symbol in Eq.
Average annual consumption of fuel for heating	-	kWht	[A]
Gross heated volume	V	m^3	[B]
Degree Days	DD	-	[C]
Heating consumption normalization factor	F_E	-	[D]
Operating time normalization factor	F_H	-	[E]

$$ENI_H = \frac{[A]\times[D]\times[E]\times 1.000}{[B]\times[C]} \qquad \left(\frac{Wh_t}{m^3 \cdot DD \cdot y}\right)$$

METHOD FOR CALCULATION OF SPECIFIC ENERGY CONSUMPTION

CALCULATION STEPS - CALCULATION OF NORMALISED ENERGY INDICATORS

ENI_E energy normalized indicator for electricity

ENI_E CALCULATION MODEL

Quantity	Symbol	u.m.	Symbol in Eq.
Average annual electricity consumption	-	kWhe	[A]
Gross floor area	Ap	m^2	[B]
Operating time normalization factor	Fh	-	[C]

$$ENI_E = \frac{[A]\times[C]}{[B]} \qquad \left(\frac{kWh_e}{m^2 \cdot y}\right)$$

5.1.2
Evaluation of schools' specific energy consumption

5.1.2 Objective

This unit let you know how the evaluation of the normalisation energy indicators is carried out by comparing this index to the specific reference consumption for a significant sample of schools.

EVALUATION OF SCHOOLS' SPECIFIC ENERGY CONSUMPTION

DEFINITION OF ENERGY CLASSES

The following tables show the specific reference consumption organized by school type an energy rating class (for heating and electricity) (**energy class**). The class of merit of the school is identified by using the reference tables of the NEI_H and NEI_E.

The reference table are calculated according to the consumption of the selected country and to the average standard of the country.

EVALUATION OF RESULTS

SUFFICIENT		The school is within the average of schools and should not show a significant "waste of energy". Especially if the index is close to the highest values of the ranges, energy efficiency can still be improved.
GOOD		The building should have efficient facilities and good management. Also, in this case it cannot be excluded that improvements can be made using mainly innovative technologies and management methods.
INSUFFICIENT		More in-depth energy assessments (energy audit) are necessary to identify the most suitable management and technological interventions for the specific situation of the building.

5.1.3
Use of web tool:
Energy profile module

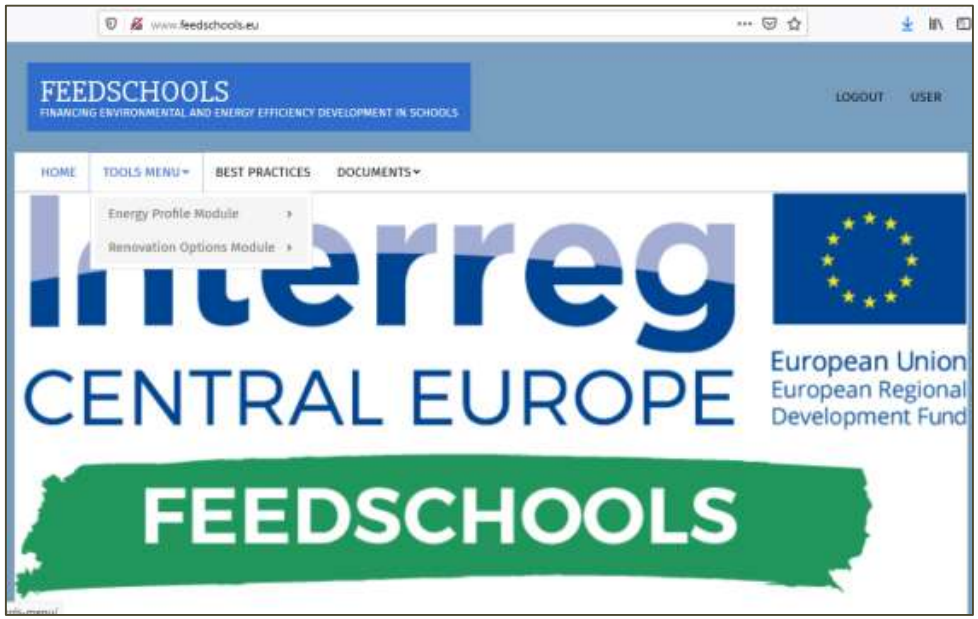
5.1.3 Objective

In this unit you will learn how the web tool modules work. In order to apply the procedure described in (ENI_H and ENI_E calculation method) and define energy classes for schools as defined, an example of a case study of a school building is shown.

USE OF WEB TOOL
ENERGY PROFILE MODULE

ENERGY PROFILE MODULE

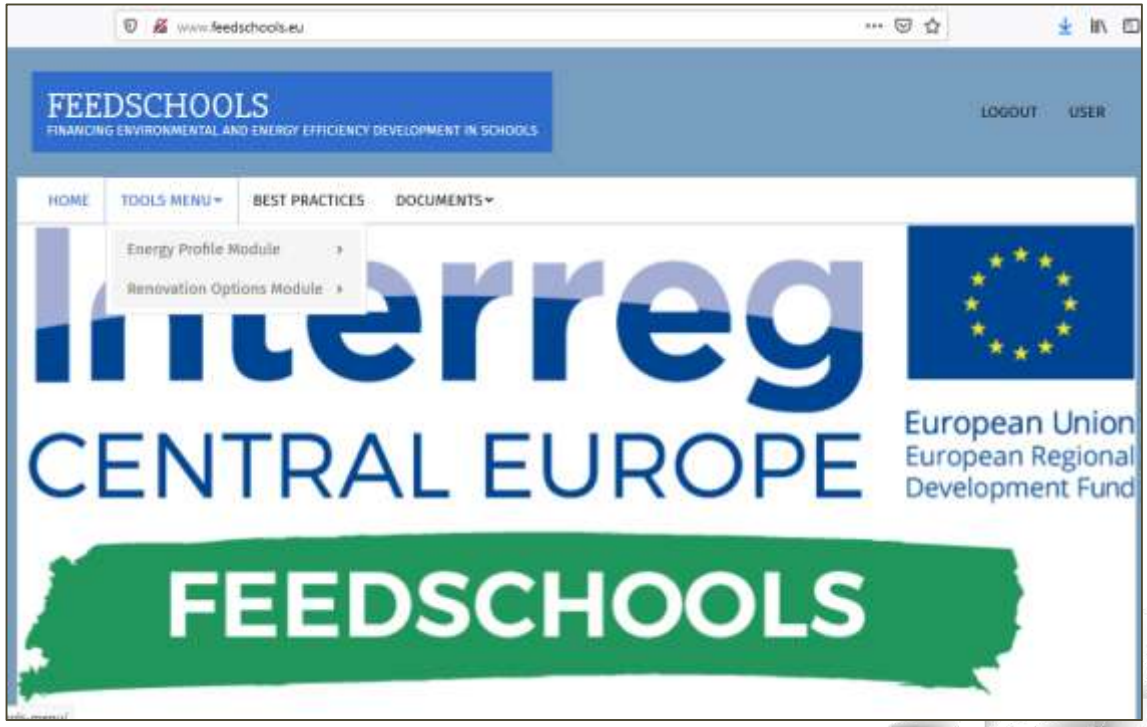
This module calculates the energy index of your school building and estimates its performance compared to the national benchmark. Starting by entering a few basic data, all easily available – **gross heated volume**, **dissipating surface** of the building, **gross floor area**, **annual fuel and electricity consumption over the last 3 years** webtool allows to determine the ENI_H and ENI_E indicators and therefore the energy rating class of the school and therefore whether or not improvement actions are needed. A case study is now being analysed as an example.



ENERGY PROFILE MODULE

After registering and logging in to your private area clicking on **Tools Menu**, you can see these options:

- ✓ **Energy Profile Module**
- ✓ **Renovation Options Module**



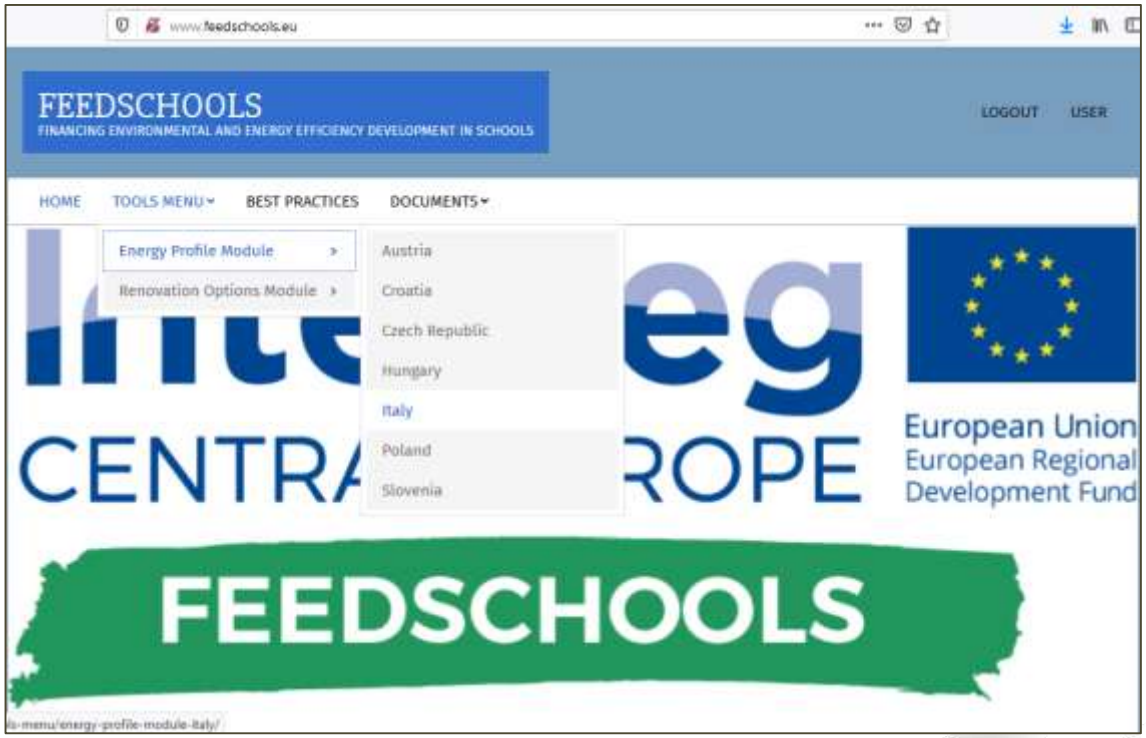
USE OF WEB TOOL
ENERGY PROFILE MODULE

ENERGY PROFILE MODULE

Click on **Energy Profile Module**

The tool is available to perform first level energy analysis and assess renovation options for the following countries:
Austria, Croatia, Czech Republic, Hungary, Italy, Poland, Slovenia

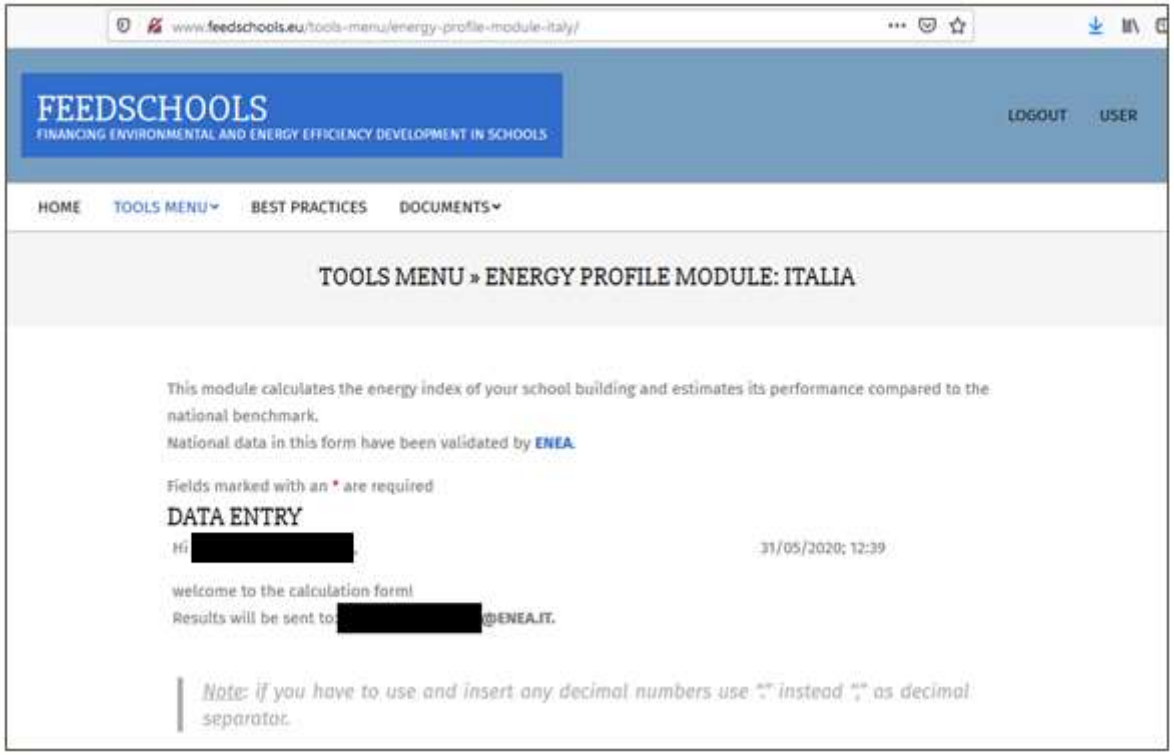
Selecting a Country from the drop-down list e.g. **Italy** you can access the module for the calculation of energy indices of your school building and estimate its performance compared to the national benchmark.



USE OF WEB TOOL
ENERGY PROFILE MODULE

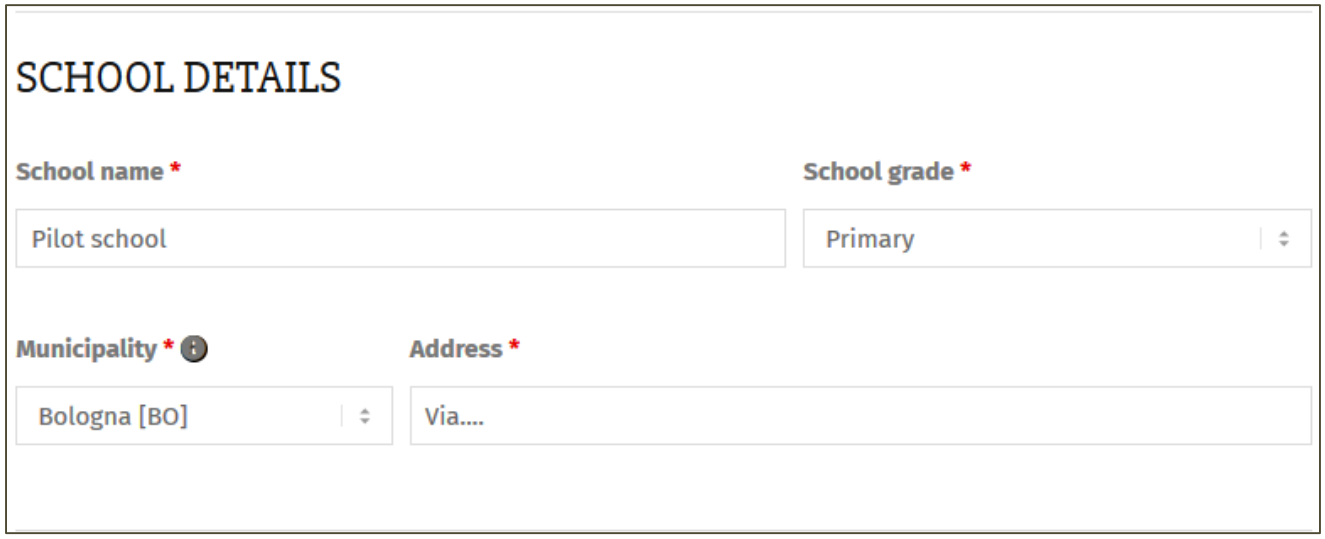
ENERGY PROFILE MODULE

Now we are in our personal area and the data entry process can start.



SCHOOL DETAILS

In the **School details** box, fill in general information fields as shown below:



ENERGY CONSUMPTION

HEATING ENERGY CONSUMPTION

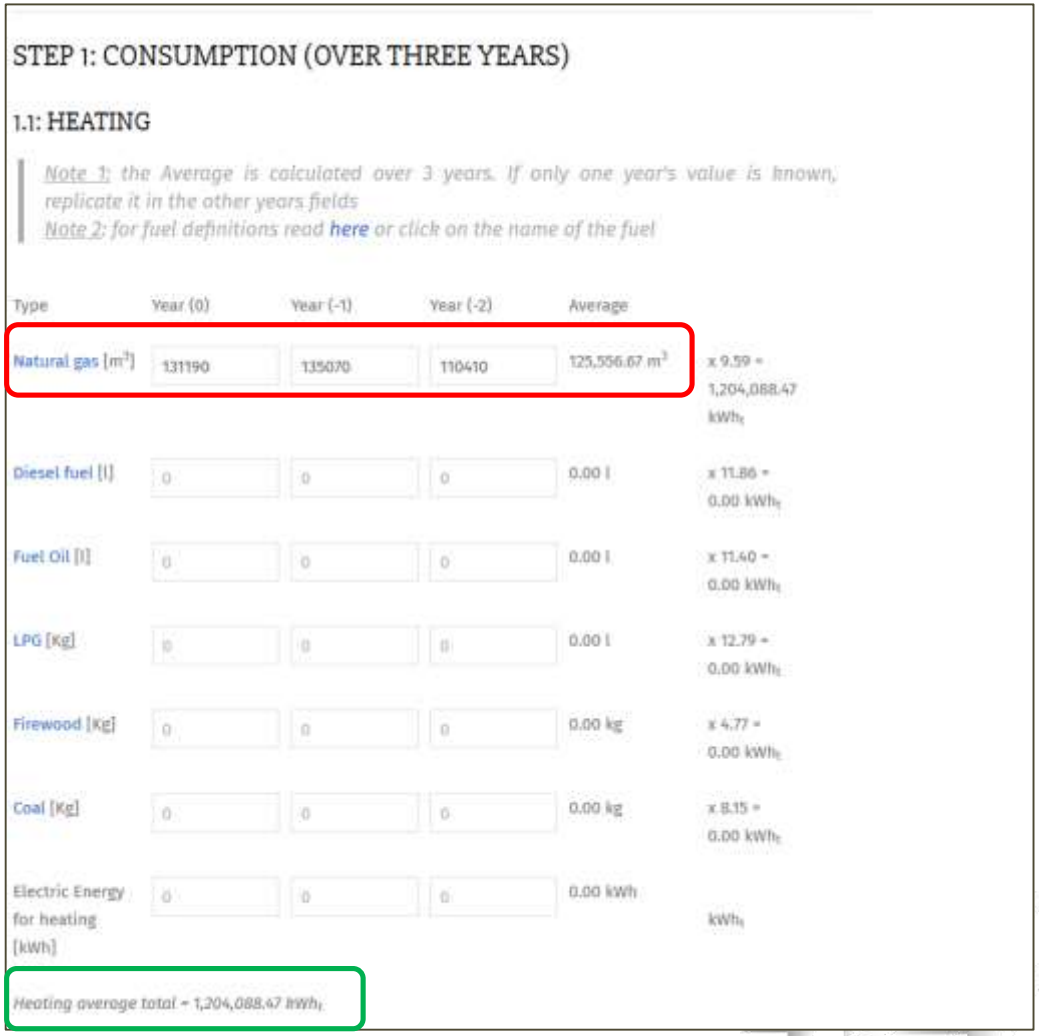
In Heating box, you can enter the consumption for several fuels (one or more than one) over the **last three years**.

For the school considered the only fuel is natural gas.

The value of the following quantities is shown as output **Heating average total [kWht]**

If you do not enter consumption for the all the three years, the result displayed is an incorrect value! In fact, the average consumption is calculated over three years

No spaces between thousands!


STEP 1: CONSUMPTION (OVER THREE YEARS)

1.1: HEATING

Note 1: the Average is calculated over 3 years. If only one year's value is known, replicate it in the other years fields
Note 2: for fuel definitions read here or click on the name of the fuel

Type	Year (0)	Year (-1)	Year (-2)	Average	
Natural gas [m³]	131190	135070	110410	125,556.67 m³	x 9.59 = 1,204,088.47 kWht
Diesel fuel [l]	0	0	0	0.00 l	x 11.86 = 0.00 kWht
Fuel Oil [l]	0	0	0	0.00 l	x 11.40 = 0.00 kWht
LPG [Kg]	0	0	0	0.00 l	x 12.79 = 0.00 kWht
Firewood [Kg]	0	0	0	0.00 kg	x 4.77 = 0.00 kWht
Coal [Kg]	0	0	0	0.00 kg	x 8.15 = 0.00 kWht
Electric Energy for heating [kWh]	0	0	0	0.00 kWh	kWht

Heating average total = 1,204,088.47 kWht

USE OF WEB TOOL
ENERGY PROFILE MODULE

ENERGY CONSUMPTION

ELECTRICITY CONSUMPTION

In **Electricity** box, the same way as for heating energy consumption, check the box corresponding to supply contracts (ID) and enter the energy consumption for **3 years for each contract**.

The value of the following quantities is shown as output: **Electricity average total [kWhe]**

If you do not enter consumption for the all the three years, the result displayed is an incorrect value! In fact, the average consumption is calculated over three years

No spaces between thousands!

USE OF WEB TOOL
ENERGY PROFILE MODULE

VOLUME AND SURFACES, DEGREE DAYS, NORMALISATION FACTORS

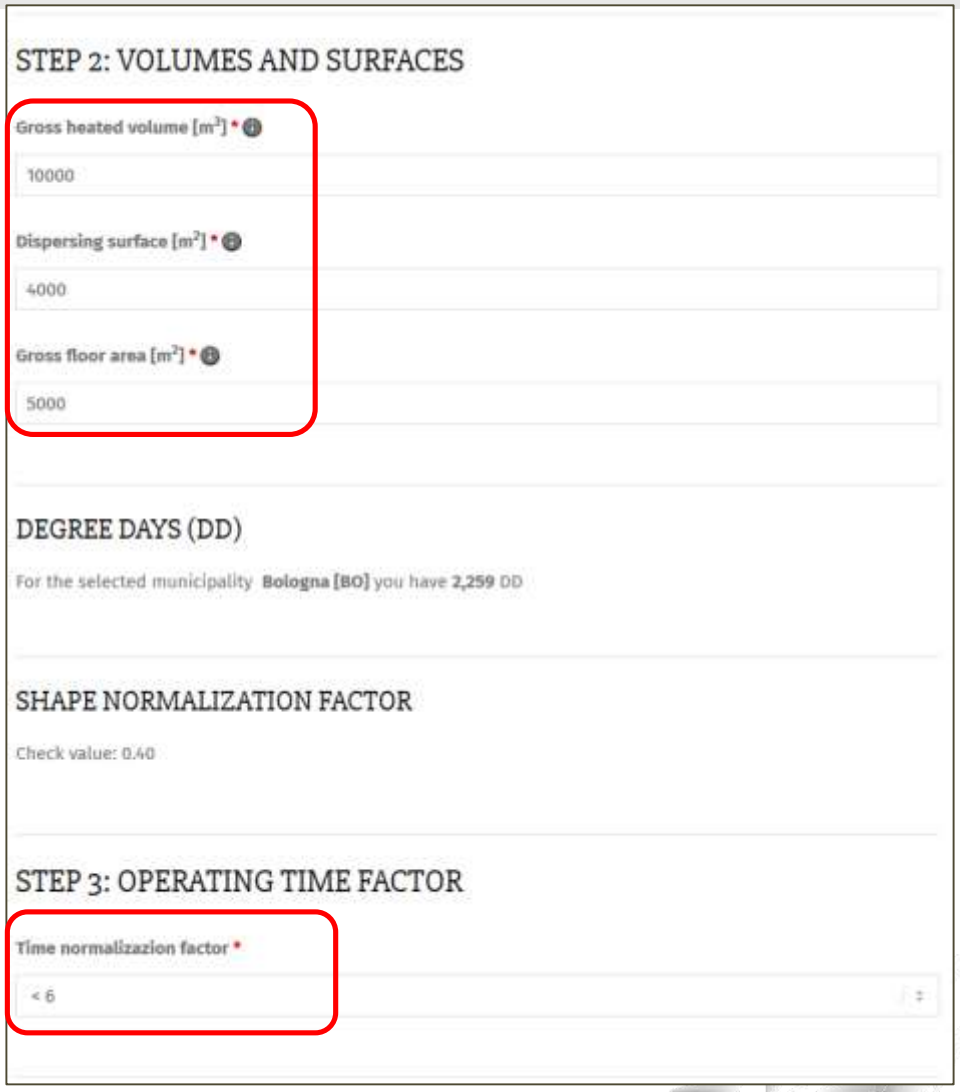
In **Volumes and surfaces** box, fill the fields related to **gross heated volume**, **dissipating surface** and **gross floor area**

The **Degree Days** of the location are calculated according to the location entered in the school details box.

In **Shape Normalisation factor** is provided according to the S/V ratio.

In **Operating Time Factor** box, you can choose a value from the list.

In this case the choice corresponds to a value F_H=1,2



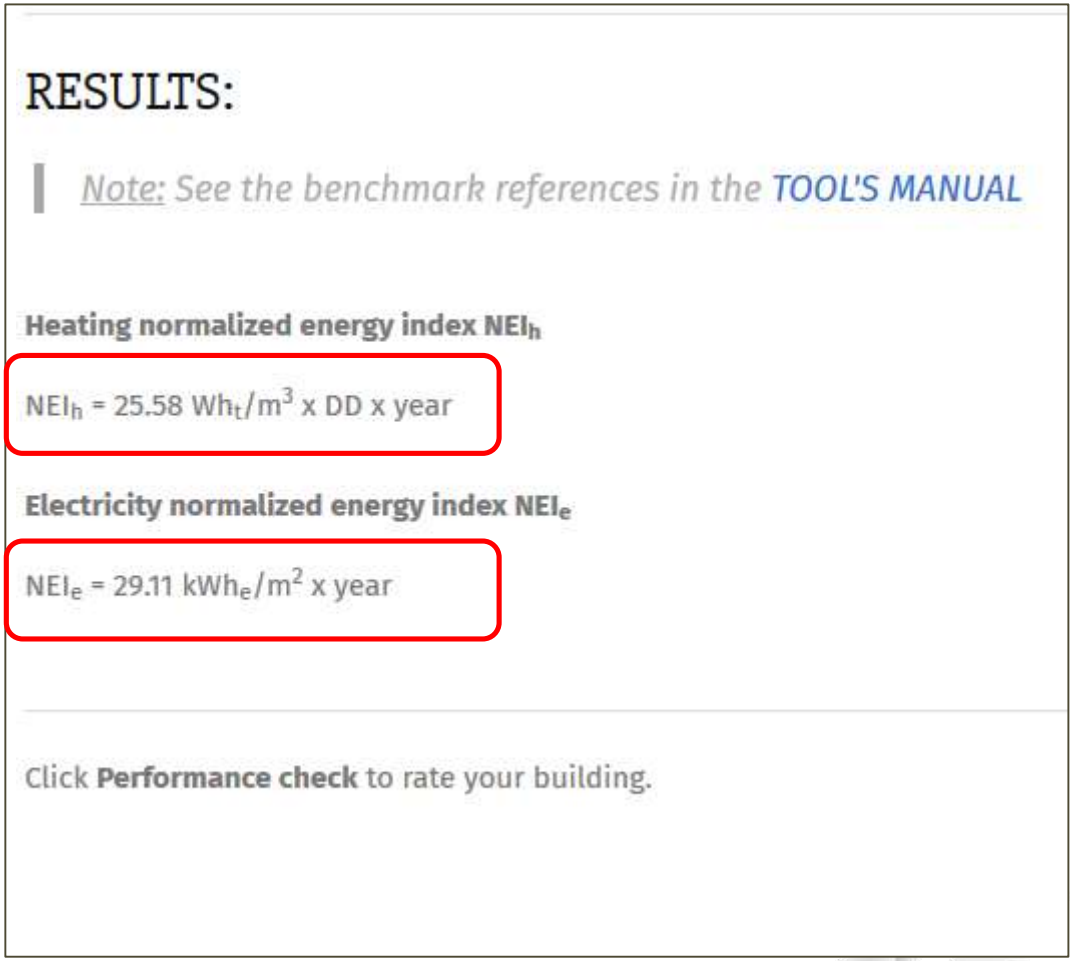
USE OF WEB TOOL
ENERGY PROFILE MODULE

RESULTS

At the end of the data input, Results box provides the values of:

- **ENI_H energy normalized indicator for heating**
- **ENI_E energy normalized indicator for electricity**

Click on **performance check to rate the building** to check the performance rate of building.



USE OF WEB TOOL
ENERGY PROFILE MODULE

RESULTS

In line with the definition of the energy classes the performance are insufficient from the point of view of heat and electricity consumption

ENI_H energy normalized indicator for heating

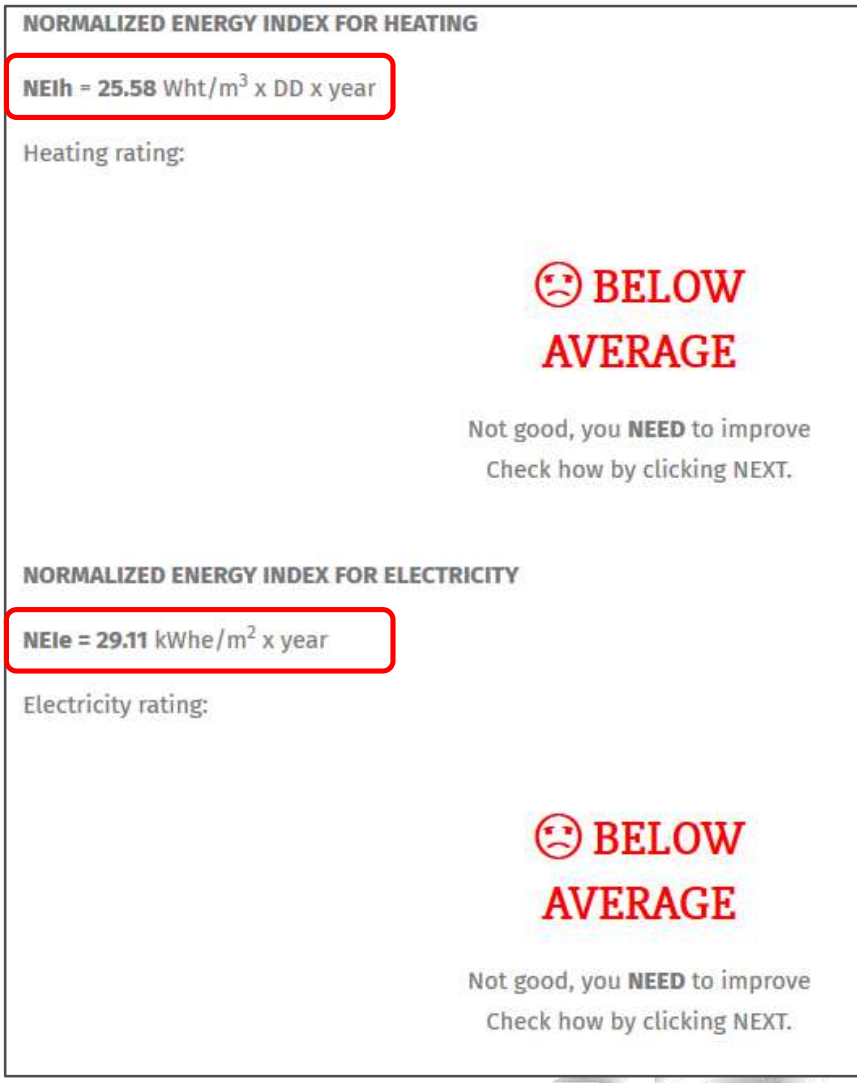
ENERGY CLASSES FOR NEI_H

ENERGY CLASSES FOR NEI_H			
	Good	Sufficient	Insufficient
Type of School	NEI_H	NEI_H	NEI_H
Kindergarten	< 18,5	18,5 ÷ 23,5	> 23,5
Primary	< 11,0	11,0 ÷ 17,5	> 17,5
Middle, High schools	< 11,5	11,5 ÷ 15,5	> 15,5

ENI_E energy normalized indicator for electricity

ENERGY CLASSES FOR NEI_E

ENERGY CLASSES FOR NEI_E			
	Good	Sufficient	Insufficient
Type of School	NEI_E	NEI_E	NEI_E
Nursery	< 11,0	11,0 ÷ 16,5	> 16,5
Primary, Middle, High school except for technical industrial institutes	< 9,0	9,0 ÷ 12,5	> 12,0
Technical industrial institutes	< 12,5	12,5 ÷ 15,5	> 15,5



5.1.4
Use of web tool: Renovation Options Module

5.1.4 Objective

In this unit you will learn how the web tool renovation option module work. This module calculates the potential energy savings of your building and helps in selection the most promising renovation action. Renovation Options Module takes into consideration a limited number of simple renovation options which we analyse in detail one by one.

USE OF WEB TOOL
RENOVATION OPTIONS MODULE

TWO WAYS TO USE THE RENOVATION OPTIONS MODULE

The Renovation Options Module can be accessed via two ways:

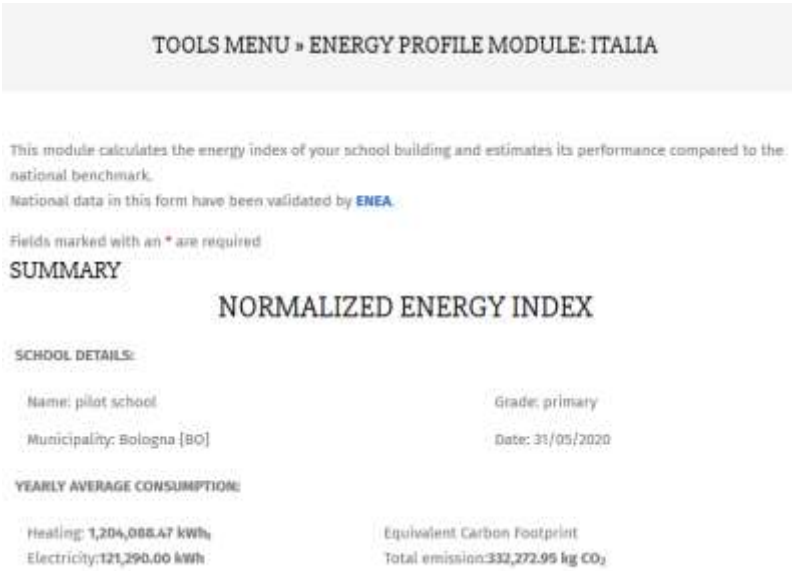
1) By accessing the **Renovation Options Module** at the end of the complete compilation of the **Energy profile Module** (as in the example shown below).

2) Directly from the **Renovation Options Module** by filling a reduced number of boxes than in the previous case: School Details, Consumption (over three years), Operating Degree Days boxes.

USE OF WEB TOOL
RENOVATION OPTIONS MODULE

TWO WAYS TO USE THE RENOVATION OPTIONS MODULE

We consider the case 1) to start filling the Renovation Options Module that can be accessed by clicking **Next** at the end of the page at the end of the last page of the Energy Profile Module that shows normalized indexes:


TOOLS MENU » ENERGY PROFILE MODULE: ITALIA

This module calculates the energy index of your school building and estimates its performance compared to the national benchmark.
National data in this form have been validated by ENEA.

Fields marked with an * are required

SUMMARY

NORMALIZED ENERGY INDEX

SCHOOL DETAILS:

Name: pilot school — Grade: primary

Municipality: Bologna [BO] — Date: 31/05/2020

YEARLY AVERAGE CONSUMPTION:

Heating: 1,204,088.47 kWh — Equivalent Carbon Footprint

Electricity:121,290.00 kWh — Total emission:332,272.95 kg CO_2


NORMALIZED ENERGY INDEX FOR HEATING

NEIh = 25.58 Wht/m² x DD x year

Heating rating:

☹ BELOW AVERAGE

Not good, you NEED to improve
Check how by clicking NEXT.

NORMALIZED ENERGY INDEX FOR ELECTRICITY

NEIe = 29.11 kWhe/m² x year

Electricity rating:

☹ BELOW AVERAGE

Not good, you NEED to improve
Check how by clicking NEXT.

To reach nZEB classification the COMMISSION RECOMMENDATION (EU) 2016/1318 suggests the following indicators for Mediterranean area:

Offices and Schools: 20-30 kWh/(m²y) of net primary energy with, typically, 80-90 kWh/(m²y) of primary energy use covered by 60 kWh/(m²y) of on-site renewable sources;

Click Next to send a summary to your e-mail address and go to the "Improvements" tool. Next

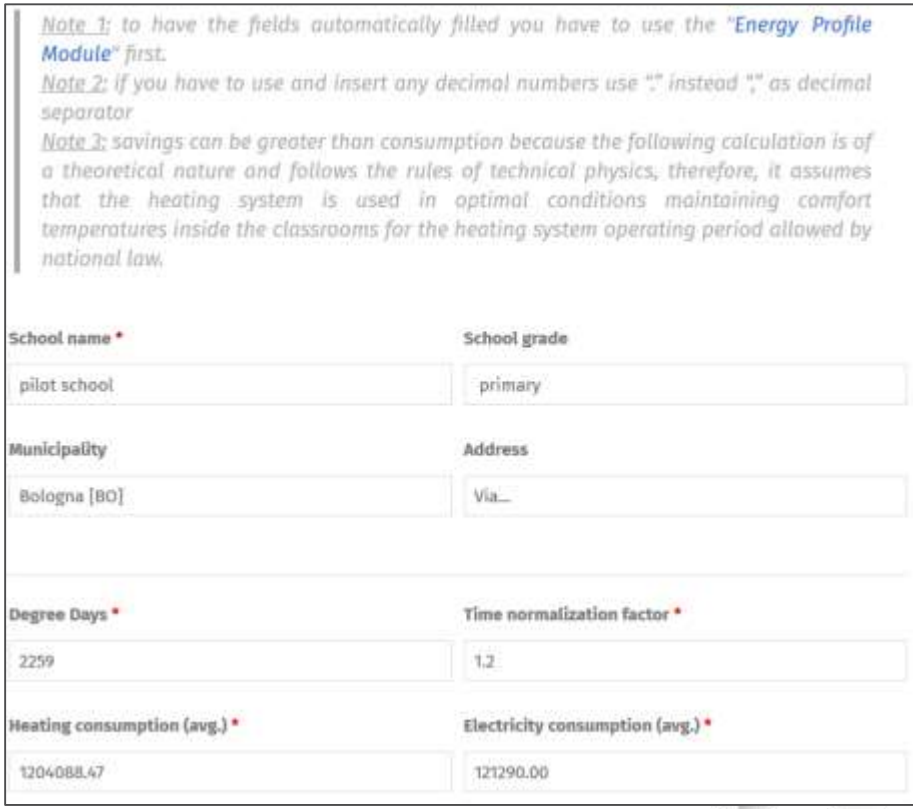
USE OF WEB TOOL
RENOVATION OPTIONS MODULE

TWO WAYS TO USE THE RENOVATION OPTIONS MODULE

The screen summarises the main information from the **Energy Profile Module** as:

- School details
- Degree Days
- Time normalisation factor
- Heating average consumption
- Electricity average consumption

Renovation Options Module takes into consideration a limited number of simple renovation options which we analyze in detail one by one.



USE OF WEB TOOL
RENOVATION OPTIONS MODULE

ARCHITECTURAL ELEMENTS

This section of **Renovation Options Module** allows to evaluate some energy improvement actions by identifying the simplest actions to improve the energy quality of school buildings and evaluating the opportunity to carry out, through an energy specialist, more in-depth energy audits.

FEEDSCHOOLS webtool allows to choose different improvement actions to evaluate the savings (kWh/y) and the percentage weight of the savings compared to the total savings.

It is possible to evaluate simple interventions on the envelope by selecting the category to which it belongs:

- **Glazing**
- **Roof**
- **Walls**
- **Floor**

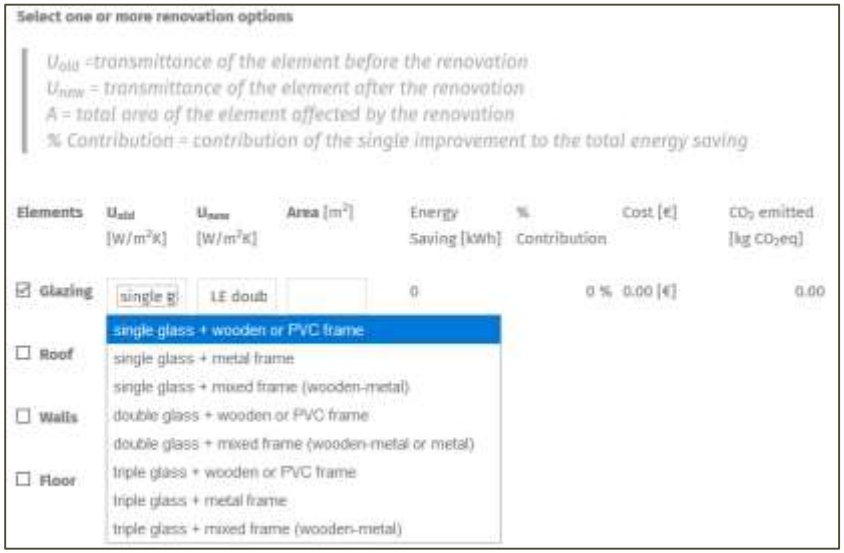
USE OF WEB TOOL
RENOVATION OPTIONS MODULE

ARCHITECTURAL ELEMENTS - GLAZING

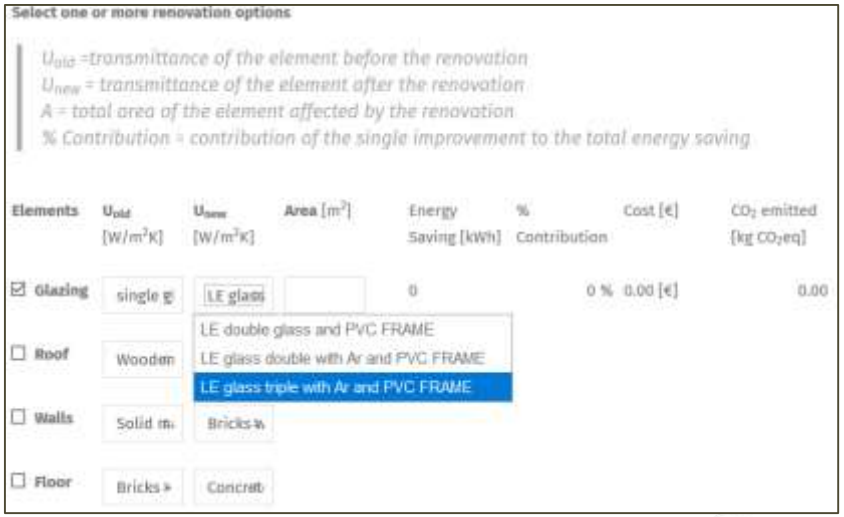
Checking the **Glazing**, within the U_{old} box you can select an option for the existing state from the list.

Within the U_{new} box you can select an option for the renovation option from the list.

Existing state



Renovation option



USE OF WEB TOOL
RENOVATION OPTIONS MODULE

ARCHITECTURAL ELEMENTS – GLAZING

Filling in the **Area** box, total area of the element affected by renovation we can obtain as output the absolute **energy savings** obtained and the (partial*) **contribution** of the single improvement to the total energy saving, the **cost** and the **CO_2 avoided emissions** (the final contribution of each improvement is obtained after considering all the interventions)

Select one or more renovation options

U_{old} =transmittance of the element before the renovation
U_{new} = transmittance of the element after the renovation
A = total area of the element affected by the renovation
% Contribution = contribution of the single improvement to the total energy saving

Elements	U_{old} [W/m²K]	U_{new} [W/m²K]	Area [m²]	Energy Saving [kWh]	% Contribution	Cost [€]	CO_2 emitted [kg CO_2eq]
☑ Glazing	single gl	LE glass	400	88,914	100.0 %	360,000.00 [€]	620.00
☐ Roof	Wooden	Concrete					
☐ Walls	Solid ma	Bricks w					
☐ Floor	Bricks +	Concrete					

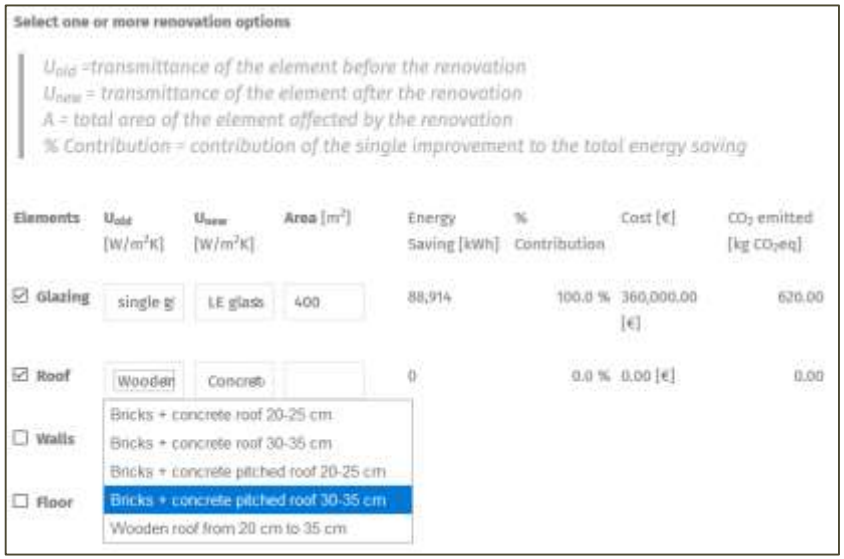
USE OF WEB TOOL
RENOVATION OPTIONS MODULE

ARCHITECTURAL ELEMENTS - ROOF

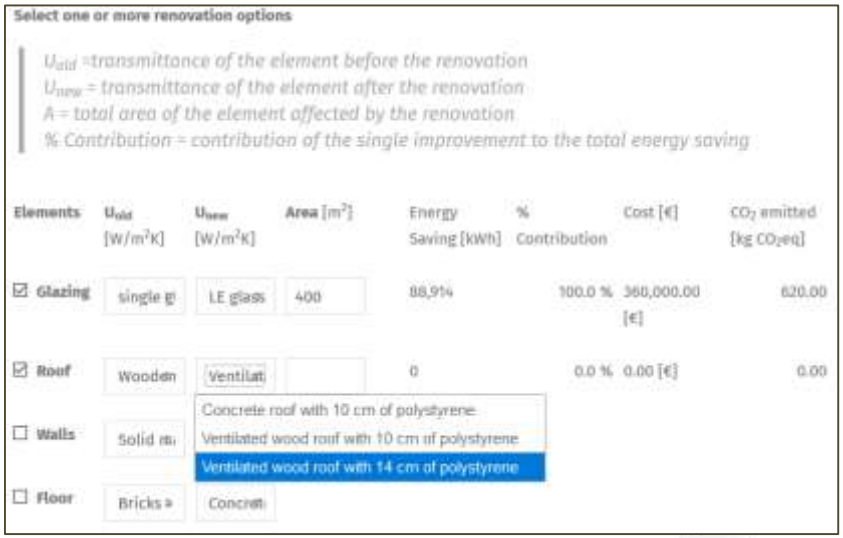
Checking the **Roof**, within the U_{old} box you can select an option for the existing state from the list.

Within the U_{new} box you can select an option for the renovation option from the list.

Existing state



Renovation option



USE OF WEB TOOL
RENOVATION OPTIONS MODULE

ARCHITECTURAL ELEMENTS - ROOF

Filling in the **Area** box, total area of the element affected by renovation we can obtain as output the absolute **energy savings** obtained and the (partial*) **contribution** of the single improvement to the total energy saving, the **cost** and the **CO_2 avoided emissions** (the final contribution of each improvement is obtained after considering all the interventions)

Select one or more renovation options

U_{old} =transmittance of the element before the renovation
U_{new} = transmittance of the element after the renovation
A = total area of the element affected by the renovation
% Contribution = contribution of the single improvement to the total energy saving

Elements	U_{old} [W/m²K]	U_{new} [W/m²K]	Area [m²]	Energy Saving [kWh]	% Contribution	Cost [€]	CO_2 emitted [kg CO_2eq]
☑ Glazing	single gl	LE glass	400	88,914	45.7 %	360,000.00 [€]	620.00
☑ Roof	Wooden	Ventilat	1250	105,721	54.3 %	137,500.00 [€]	650.00
☐ Walls	Solid ma	Bricks w					
☐ Floor	Bricks +	Concrete					

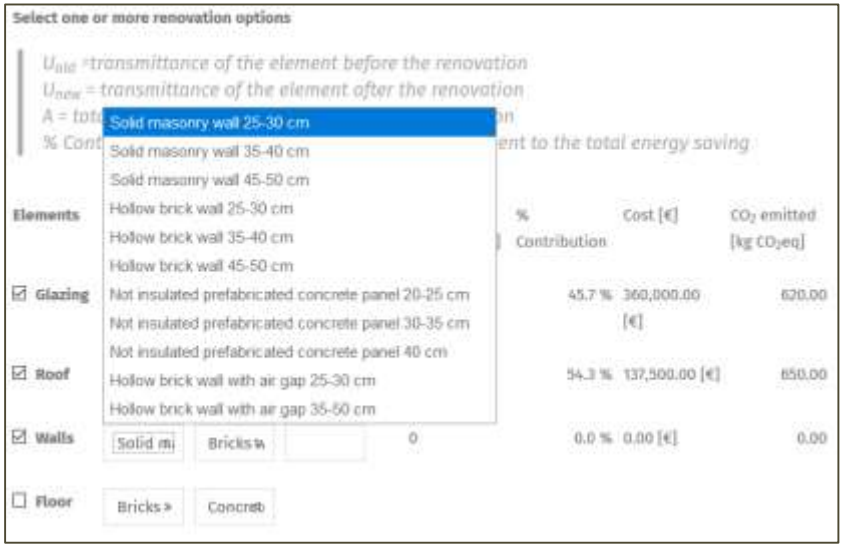
USE OF WEB TOOL
RENOVATION OPTIONS MODULE

ARCHITECTURAL ELEMENTS – WALLS

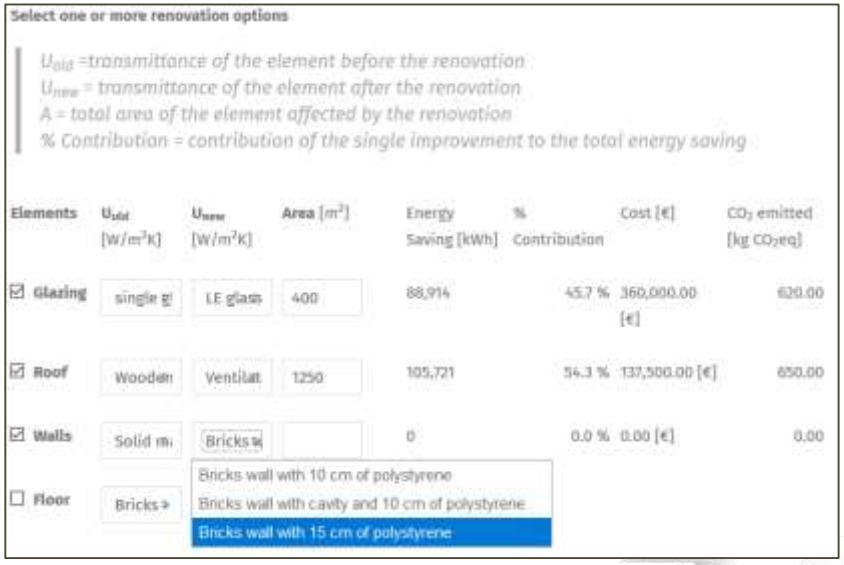
Checking the **Walls**, within the U_{old} box you can select an option for the existing state from the list.

Within the U_{new} box you can select an option for the renovation option from the list.

Existing state



Renovation option



USE OF WEB TOOL
RENOVATION OPTIONS MODULE

ARCHITECTURAL ELEMENTS - WALLS

Filling in the **Area** box, total area of the element affected by renovation we can obtain as output the absolute **energy savings** obtained and the (partial*) **contribution** of the single improvement to the total energy saving, the **cost** and the **CO_2 avoided emissions** (the final contribution of each improvement is obtained after considering all the interventions)

Select one or more renovation options

U_{old} =transmittance of the element before the renovation
U_{new} = transmittance of the element after the renovation
A = total area of the element affected by the renovation
% Contribution = contribution of the single improvement to the total energy saving

Elements	U_{old} [W/m^2K]	U_{new} [W/m^2K]	Area [m^2]	Energy Saving [kWh]	% Contribution	Cost [€]	CO_2 emitted [kg CO_2eq]
☑ Glazing	single gl	LE glass	400	88,914	17.1 %	360,000.00 [€]	620.00
☑ Roof	Wooden	Ventilat	1250	105,721	20.4 %	137,500.00 [€]	650.00
☑ Walls	Solid ma	Bricks w	3500	324,483	62.5 %	227,500.00 [€]	980.00
☐ Floor	Bricks +	Concrete					

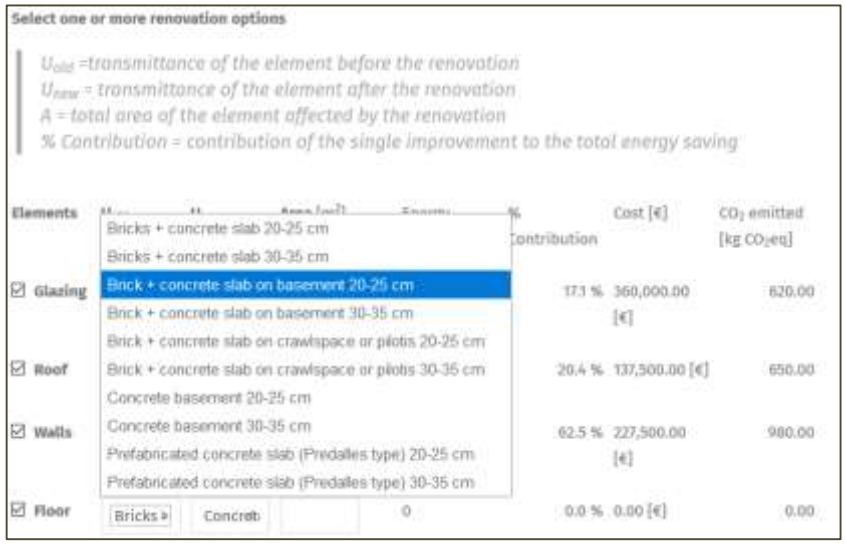
USE OF WEB TOOL
RENOVATION OPTIONS MODULE

ARCHITECTURAL ELEMENTS - FLOOR

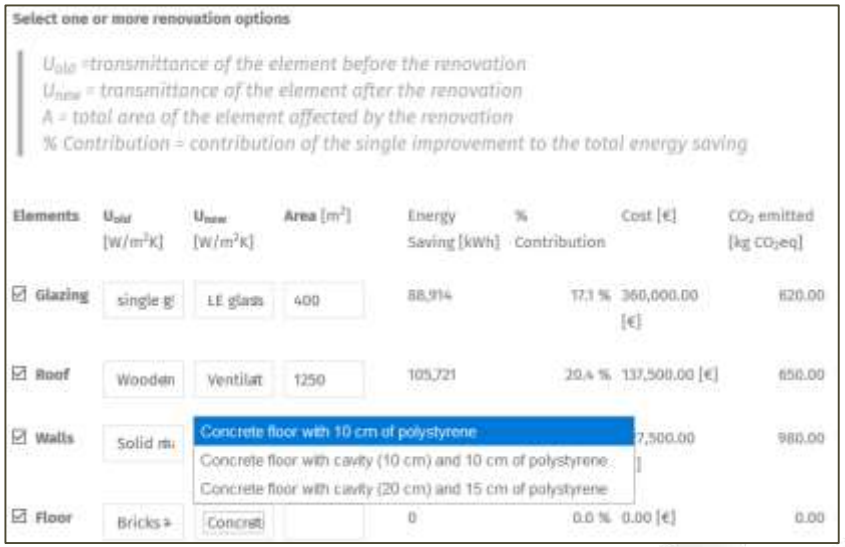
Checking the **Floor**, within the U_{old} box you can select an option for the existing state from the list.

Within the U_{new} box you can select an option for the renovation option from the list.

Existing state



Renovation option



USE OF WEB TOOL
RENOVATION OPTIONS MODULE

ARCHITECTURAL ELEMENTS - FLOOR

Filling in the **Area** box, total area of the element affected by renovation we can obtain as output the absolute **energy savings** obtained and the (partial*) **contribution** of the single improvement to the total energy saving, the **cost** and the **CO_2 avoided emissions** (the final contribution of each improvement is obtained after considering all the interventions)

Select one or more renovation options

> *U_{old} =transmittance of the element before the renovation*
> *U_{new} = transmittance of the element after the renovation*
> *A = total area of the element affected by the renovation*
> *% Contribution = contribution of the single improvement to the total energy saving*

Elements	U_{old} [W/m^2K]	U_{new} [W/m^2K]	Area [m^2]	Energy Saving [kWh]	% Contribution	Cost [€]	CO_2 emitted [kg CO_2eq]
☑ Glazing	single gl	LE glass	400	88,914	14.5 %	360,000.00 [€]	620.00
☑ Roof	Wooden	Ventilat	1250	105,721	17.2 %	137,500.00 [€]	650.00
☑ Walls	Solid ma	Bricks w	3500	324,483	52.8 %	227,500.00 [€]	980.00
☑ Floor	Bricks +	Concrete	1250	94,878	15.5 %	68,750.00 [€]	437.50

USE OF WEB TOOL
RENOVATION OPTIONS MODULE

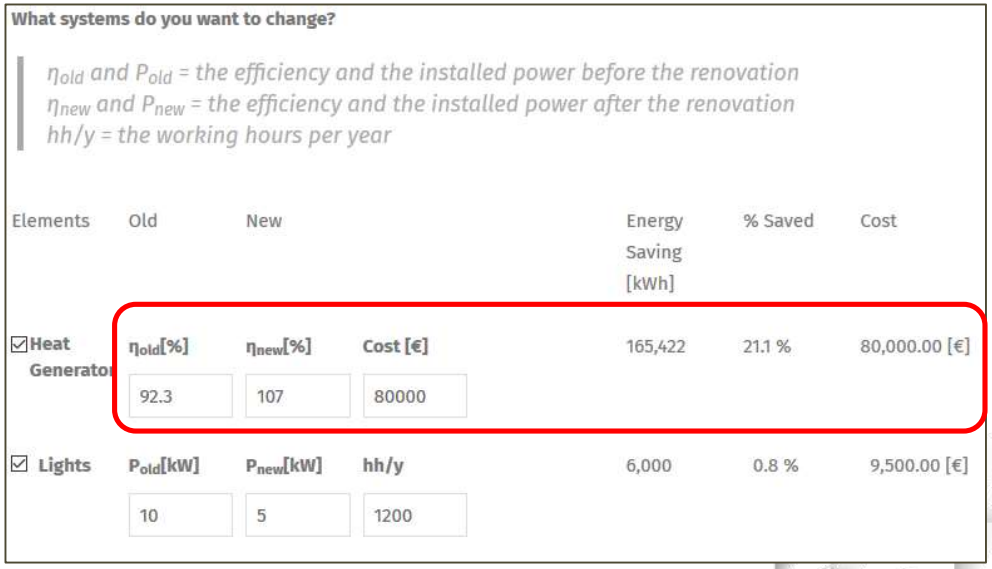
SYSTEMS

It is possible to evaluate simple interventions by selecting the relevant category: **Heat generator, Lights**

Checking the **Heat generator**, the value of the primary energy conversion efficiency of the system must be indicated. In the **Efficiency before renovation (η_{old})** field, you must enter the efficiency value of the heat generator to be replaced. The efficiency value of the new generator must be entered in the **Efficiency before renovation (η_{new})** filed and the **cost** of replacing the heat generator.

At the end of the data input, the values of the following quantities are displayed:

- **Energy saving [kWh]**
- **% contribution [%]**
- **CO_2 equivalent [kg CO_{2eq}]**



USE OF WEB TOOL
RENOVATION OPTIONS MODULE

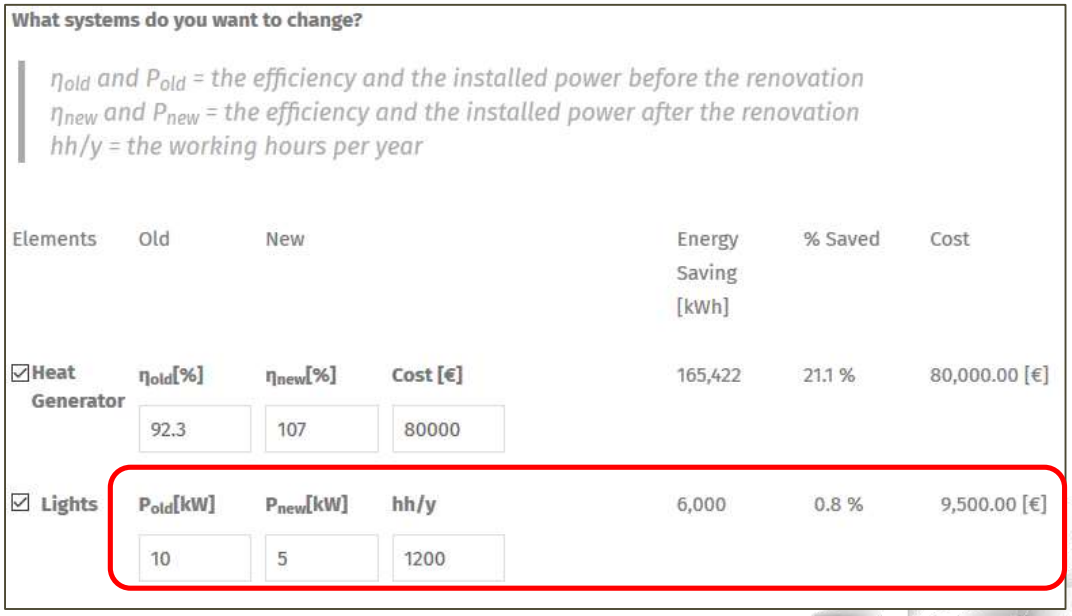
SYSTEMS

Checking the **Lights**, the **Power before renovation (P_{old})** and **Power after renovation (P_{new})** fields, it is necessary to enter the value of the total power of lighting system before and after the renovation.

In addition, in the **Working hours per year before renovation (hh/y)** field, it is necessary to indicate the indicative number of hours per year the system is switched on.

At the end of the data input, the values of the following quantities are displayed:

- **Energy saving [kWh]**
- **% contribution [%]**
- **CO_2 equivalent [kg CO_{2eq}]**



USE OF WEB TOOL
RENOVATION OPTIONS MODULE

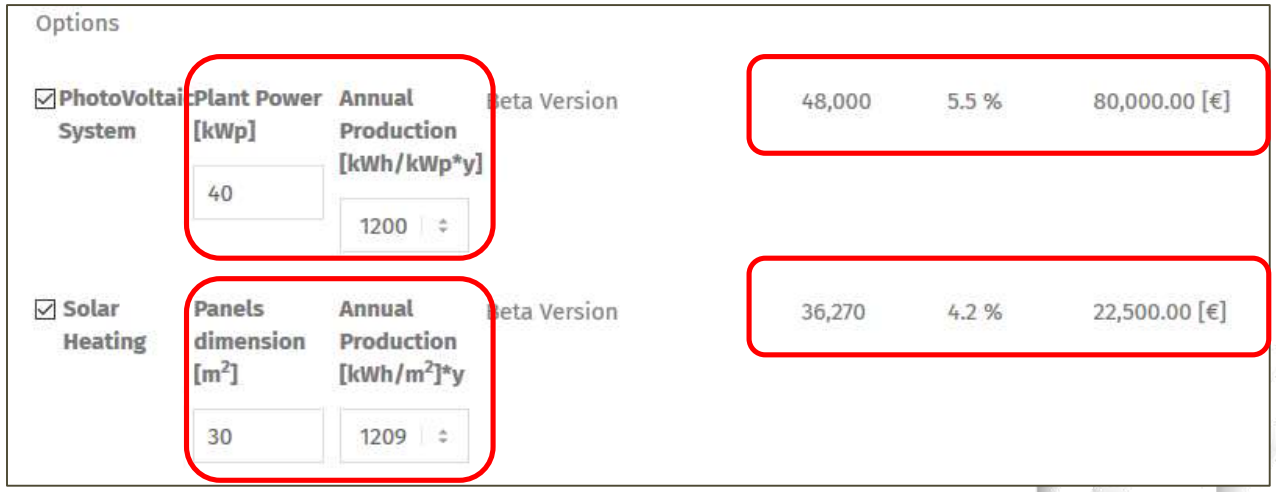
OPTIONS (BETA VERSION)

Checking the **Photovoltaic system** box, it is necessary to enter the **power plant (kWp)** value and select the estimated annual production option **(kWh/kWp*y)** from a drop-down list.

Checking the **Solar heating** box, it is necessary to enter the **panels dimension (m^2)** value and the estimated annual production option **(kWh/m^2*y)** from a drop-down list.

At the end of the data input, the values of the following quantities are displayed:

- **Energy saving [kWh]**
- **% contribution [%]**
- **CO_2 equivalent [kg CO_{2eq}]**



RESULTS

At the end of data input **Results** box provides the values of the following quantities are displayed:

- **Total THERMAL Energy saved [kWh]:** sum of the thermal energy saved from the single renovation options.
  - ✓ Equivalent to save [€]
  - ✓ Improvement action cost [€]
  - ✓ Fuel carbon footprint [$kgCO_2e$] for each fuel
- **Total ELECTRIC Energy saved [kWh]:** sum of the electric energy saved from the single renovation options.
  - ✓ Equivalent to save [€]
  - ✓ Improvement action cost [€]
  - ✓ Fuel carbon footprint [$kgCO_2e$] for electricity
- **Total PRIMARY Energy saved [kWh]**
- **Total improvement cost [€]**
- **Total CO2 saved [$kgCO_2e$]**
- **Total saved [€]**

USE OF WEB TOOL
RENOVATION OPTIONS MODULE

RESULTS

The table below shows the potential CO_2e* savings associated to the type of energy sources used for the heating system.

Total THERMAL Energy Saved:	**815,688 [kWh]**	**Fuel Carbon Footprint**	**kg CO_2e***
equivalent to save:	46,829.69 [€]	Natural Gas	196,581
Improvement action cost:	896,250.00 [€]		
Total ELECTRIC Energy Saved:	**54,000 [kWh]**	**Fuel Carbon Footprint**	**kg CO_2e***
equivalent to save:	9,180.00 [€]	Electric energy	18,738.00
Improvement action cost:	89,500.00 [€]		
Total Primary Energy Saved	**932,868.00 [kWh]**	**Total CO_2 Saved:**	**215,319.00 [kg CO_2e*]**
Total improvement cost	**985,750.00 [€]**	Improvement CO_2 emitted:	2,687.50 [kg CO_2e*]
Total saved	56,009.69 [€]		

USE OF WEB TOOL
RENOVATION OPTIONS MODULE

RESULTS

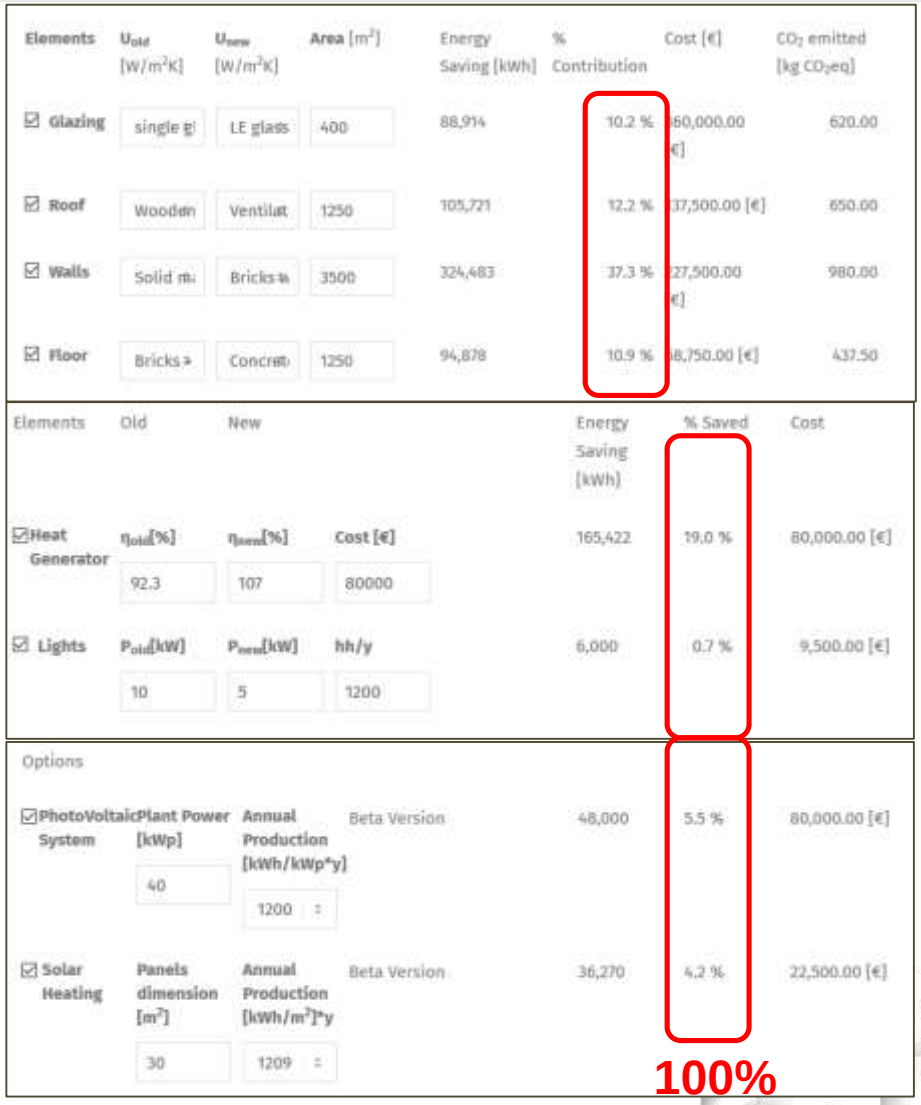
The **Results** box provides the **percent contribution** of the single improvement to the total energy saving.

As we can see the total is 100%.

Please note that the energy savings calculated using the tool is a value that does not take into account that multiple energy efficiency actions on the same building can generate additional savings due to mutual influences on the operation of the building system.

As a result...

...by carrying out multiple interventions energy savings may be higher than those resulting from the calculation!



SELF ASSESSMENT TEST

5.1.1 Method for calculation of specific energy consumption

Question 1 The normalization of the energy consumption:

- **A** is the process of correcting the fuel and electricity consumption of schools to make them comparable with the reference consumption of a significant sample of schools
- **B** is carried out in the same way for fuel and electricity
- **C** does not depend on the operating time of the school buildings

Mark the correct answer

SELF ASSESSMENT TEST

5.1.1 Method for calculation of specific energy consumption

Question 2 The normalised energy indicators:

A ENI_H and ENI_E can be calculated by knowing the energy consumption of the bills for the last three months

B ENI_H can be determined by knowing the consumption of fuel, surface area, gross heated volume and Degree Days of the location

C ENI_H and ENI_E are energy normalized indicator for heating and electricity respectively

Mark the correct answer

SELF ASSESSMENT TEST

5.1.2 Evaluation of school's specific energy consumption

Question 3 The values of normalized energy indicators:

- **A** have been covenantly grouped into 4 classes according to the type of school
- **B** allow to identify the performance rating of a school by means of classes of merit according to the type of school and the value of the indicators (energy classes)
- **C** vary little from school to school and therefore it makes no sense to define energy classes

Mark the correct answer

SELF ASSESSMENT TEST

5.1.2 Evaluation of school's specific energy consumption

Question 4 If a school belongs to the energy class defined as "sufficient":

- **A** the building does not have efficient facilities and good management
- **B** it may be too expensive to carry out energy efficiency measures on such a building
- **C** also, in this case it cannot be excluded that improvements can be made using mainly innovative technologies and management methods

Mark the correct answer

SELF ASSESSMENT TEST

5.1.3 Use of web tool: Energy Profile Module

Question 5 The “Energy Profile Module”:

- **A** for its use requires you to enter a lot of data of different types
- **B** it may be too expensive to carry out energy efficiency measures on such a building
- **C** calculates the energy index of school building and estimates its performance compared to the national benchmark

Mark the correct answer

SELF ASSESSMENT TEST

5.1.3 Use of web tool: Energy Profile Module

Question 6 Within the “Energy Profile Module”:

A. it is possible to enter the consumption even for only one year, because the average consumption is calculated correctly even in this case

B. it is necessary to enter data for all fuels over the last 3 years

C. the form returns warning messages in the case of data input that does not match each other

Mark the correct answer

SELF ASSESSMENT TEST

5.1.4 Use of web tool: Renovation Options Module

Question 7 When you use the “Renovation Options Module”:

A only interventions that affect the building envelope can be selected

B you can choose different improvement actions to evaluate the savings and the percentage contribution of the savings compared to the total savings

C the value of the U-value before (U_{old}) and after (U_{new}) the intervention on the building envelope (e.g. glazing, roof, walls, floor) must be known in order to evaluate the energy savings.

Mark the correct answer

SELF ASSESSMENT TEST

5.1.4 Use of web tool: Renovation Options Module

Question 8 In the box for the interventions on systems:

A old boilers can only be replaced with modern condensing boilers

B For lighting projects, the Power before renovation (P_{old}) and Power after renovation (P_{new}) are the value of the total power of LED system before and after the renovation

C it is possible to evaluate the energy and economic benefits linked to interventions related to the use of renewable sources plants

Mark the correct answer

SELECTED RESOURCES

Selected resources (click on text to access the resource)

- FEEDSCHOLS project website
  The FEEDSCHOOLS project aims to provide local authorities with new solutions, both technical and financial, which will help them to implement 'nearly Zero Energy Building' (NZEB) renovation activities in schools.
- TEESCHOOLS project website
  The project aims to support Local Autorithies to implement nZEB refurbishments in Mediterranean schools. An integrated set of user-friendly tools has been tested and validated by pilot actions in each partner region.
- Guida all'efficienza energetica negli edifici scolastici - ENEA
  Operational guide addressed to public administrators and school managers as a first information tool on the complex matter of energy requalification of buildings, in particular school buildings.
- SafeSchool 4.0 – ENEA
  The ENEA App for the seismic and energy assessment of schools.
- School of the Future: Towards Zero Emission with High Performance Indoor Environment
  The aim of the project is to design, demonstrate, evaluate and communicate shining examples of how to reach the future high-performance building level.

Alessandro Tallini(author and tutor)
Researcher of SEI Laboratory of ENEA
www.enea.it/en/
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SELF ASSESSMENT TEST RESULTS

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Question 1 The normalization of the energy consumption:

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- **C** does not depend on the operating time of the school buildings

Correct answer is green

SELF ASSESSMENT TEST RESULTS

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A can be calculated by knowing the energy consumption of the last three months bills

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C are energy normalized indicator for heating and electricity respectively

Correct answer is green

SELF ASSESSMENT TEST RESULTS

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- B: allow to identify the performance rating of a school by means of classes of merit according to the type of school and the value of the indicators (energy classes)
- C: vary little from school to school and therefore it makes no sense to define energy classes

Correct answer is green

SELF ASSESSMENT TEST RESULTS

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- **B** it may be too expensive to carry out energy efficiency measures on such a building
- **C** also, in this case it cannot be excluded that improvements can be made using mainly innovative technologies and management methods

Correct answer is green

SELF ASSESSMENT TEST RESULTS

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Correct answer is green

SELF ASSESSMENT TEST RESULTS

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SELF ASSESSMENT TEST RESULTS

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Correct answer is green

SELF ASSESSMENT TEST RESULTS

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Correct answer is green