TEESCHOOLS
Transferring Energy Efficiency in Mediterranean Schools

PRIORITY AXIS:

OBJECTIVE:

DELIVERABLE NUMBER: 3.4.1

TITLE OF DELIVERABLE: METHOD FOR THE APPLICATION OF THE TOOL

WP n. 3:

ACTIVITY n. 3.4:

PARTNER IN CHARGE: ENEA

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SUMMARY

1. GUIDE

1.1. CONTENTS OF THE GUIDE

The schools buildings, like all the other buildings, consume energy for space heating, for the production of hot domestic water, for lighting and for other services.

Sometimes the types of energy used aren't the most appropriate for the product service, other times the system for the production and the energy distribution have low performances or the energy use doesn't take place in the best way (high heat losses, overheating). In all these cases there is a greater use of resources than necessary, with negative effects both on the users comfort and on the waste of money.

To help stakeholders interested in school buildings, a web tool has been developed with the aim of simplifying the analysis of the actual state of a school building and the implementation of energy improvement actions.

The web tool allows knowing the energy quality of the schools building, evaluated with respect to the average value of the national school consumption. It also allows to identify the easier interventions and the lower costs to improve the energy quality and to evaluate the opportunity of carrying out , through more deepen energy audits, more complex analysis.

The evaluation of energy quality of the school building takes place through the comparison with a representative sample of similar schools. The examples used for the comparison were originated from a series of complex energy audits performed in different European countries (TEESCHOOLS project partners).

Formattato: Inglese (Stati Uniti)

1.1.1. CHARACTERISTICS OF SCHOOLS AND AREAS OF APPLICATION

School type:

- Kindergarten
- Primary
- Secondary
- High school

ANNUAL ENERGY CONSUMPTIONS IN PUBLIC SCHOOLS IN ITALY

1.1.2. PRESENCE OF KITCHENS AND HEATED POOLS

Fuel consumption for kitchen use isn't always separated from the fuel consumption for heating use because of the low incidence on total consumptions (2-4%), then they will be considered together.

In case of heated pools, the consumption must be disaggregated from the heating consumptions.

2 CALCULATION METHOD FOR SPECIFIC ENERGY CONSUMPTION IN THE SCHOOL BUILDINGS

2.1 BUILDINGS

The fuel and electricity consumptions must be calculated by comparing them with the reference consumption of a significant samples.

The school buildings consumption should be corrected through normalization factors.

The specific normalized consumption are called **energy normalized indicators for heating ENI_R** and **energy normalized indicators for electricity ENI_E.** The indicators are drawn by the ratio between the annual middle consumption and the area of the floor, normalized in comparison to the operating time of the school.

To determine the energy indicators the single phases below indicated must be follow:

2.1.1 PHASE 1 - CONSUMPTION EVALUATION

The energy consumption for heating per year detected by the bills relating to the previous 3 years the energy evaluation will be collected. The fuel consumption of three years is added together and divided by obtaining the annual average fuel consumption.
The same will be done for electricity.

The data of annual consumption of fuel and electricity should be registered in specific tables as shown below:

Type	Year (0)	Year (-1)	Year (-2)	Average	
Methane gas	0	0	0	0.00 m^3	x 9.59 = 0.00 kWh_t
Diesel fuel	0	0	0	0.00 l	x 11.86 = 0.00 kWh_t
Fuel Oil	0	0	0	0.00 l	x 11.40 = 0.00 kWh_t
L P G	0	0	0	0.00 l	x 12.79 = 0.00 kWh_t
Firewood	0	0	0	0.00 kg	x 4.77 = 0.00 kWh_t
Coal	0	0	0	0.00 kg	x 8.15 = 0.00 kWh_t
Electric Energy	0	0	0	0.00 kWh	kWh_t

Contract ID	Year (0)	Year (-1)	Year (-2)	Average
Electric Contra	kWh	kWh	kWh	0.00 kWh
Electric Contra	kWh	kWh	kWh	0.00 kWh
Electric Contra	kWh	kWh	kWh	0.00 kWh

Electricity average total = 0.00 kWh_t

2.1.2 PHASE 2 - GROSS HEATED VOLUME, GROSS AREA OF THE FLOORS AND DISPERSING SURFACE OF BUILDINGS COLLECTION

The gross heated volume (V)

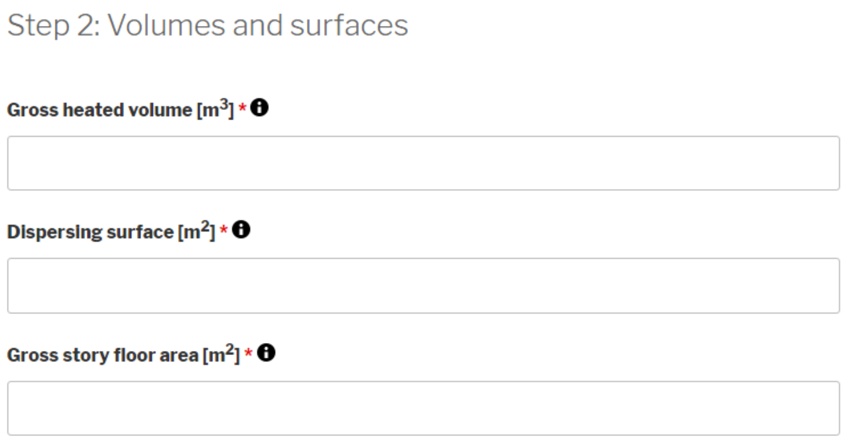
It is obtained from the drawings, if they are available, or the building is measured from the outside. In the gross heated volume, the external walls must be included and the not heated parts of the buildings must be excluded (undergrounds, attics, stores, garage...). If the school building consists of several buildings, V will be the sum of the volumes of the individual building.

The gross floor Area (Ap)

The area of the floors is obtained from the drawings of buildings or, if these are not available, with direct measures of the area. The floor areas include internal walls that separate different rooms. If the school consists several buildings Ap will be the sum of the areas of the individual buildings.

The dispersing surface (S)

The dispersing surface is obtained from the sum of the individual surface of the gross heated volume V (walls, roofs, ground floor slabs). Is not considered as a dispersing surface all walls or slabs that are connected to other heated buildings. If the school consists of several buildings S will be the sum of the dispersing surfaces of the individual buildings.



2.1.3 PHASE 3 - DEGREES DAYS (K_D) OF THE CITY IN WHICH IS LOCATED THE SCHOOL

To compare heating consumptions, it is necessary to consider the climatic differences in the country and the city in which the school buildings are located. According to this issue, consumption is released from climatic differences through the use of degrees day (k_D). K_D is obtained as the sum of the positive differences between the internal comfort temperature (20 °C) and the outdoor daily average temperature. The summation is extended to all the heating days of the winter season.

Step 3: Degree days (DD)

For the selected municipality **Bologna** you have **2,259.00** DD

2.1.4 PHASE 4 - HEATING CONSUMPTION NORMALIZATION FACTOR, DEPENDING ON THE SHAPE OF THE BUILDINGS

The specific consumption of schools buildings must be normalized with a factor depending on shape. It is expressed by the ratio between the buildings dispersing surface and its heated volume (S/V). The normalization factor Fe is obtained from the following value:

V = A m^3

S =B m^2

S/V = B/A m^2/m^3

NORMALIZATION FACTOR Fe

Kindergarten

S/V m^2/m^3	Fe
up to 1	1,2
0,41 - 0,50	1,1
0,51 - 0,60	1,0
Over 0,60	0.9

Primary

S/V m^2/m^3	Fe
up to 0,30	1,2
0,31 - 0,35	1,1
0,36 - 0,40	1,0
0,41 - 0,45	0,9
Over 0,45	0,8

Middle and High school

S/V m^2/m^3	Fe
up to 0,25	1,1
0,26 - 0,30	1,0
0,31 - 0,40	0,9
Over 0,40	0,8

2.1.5 PHASE 5 - THE OPERATING TIME NORMALIZATION FACTOR FH -

The normalization factor Fh depends on the operating time of the school buildings.
The factor Fh, found according to the type of school, will be multiplied by the heating consumption and the electricity consumption of the school buildings.
The table below shows the values used for the normalization factor Fh

hours/ days	**Fh**
Up to 6	1,2
7	1,1
8 – 9	1,0
10 – 11	0,9
Over 11	0,8

2.1.6 PHASE 6 - NORMALIZED ENERGY INDICATORS CALCULATION

NEI_h= (PHASE 1 x PHASE 4 x PHASE 5 x 1000)/(PHASE 2 x PHASE 3) **Wh_t/m^3xDDxy**

NEI_e= (PHASE 1 x PHASE 3)/(PHASE 2) **kWh_e/m^2xy**

3. EVALUATION OF SCHOOLS SPECIFIC ENERGY CONSUMPTION

3.1 REFERENCE SAMPLE

The evaluation of the specific consumption is carried out by comparing the specific consumption data with those from the reference sample.

3.2 IDENTIFICATION OF ENERGY CLASSES

The energy class of the school building is identified according to the reference tables shown below.

Energy classes of for heating consumption

			Wh_t/m^3 x DD x year
	Good	**Sufficient**	**Insufficient**
Kindergarten	**Less than 18,5**	**18,5 – 23,5**	**greater than 23,5**
Primary	**Less than 11,0**	**11,0 – 17,5**	**greater than 17,5**
Middle, High schools	**Less than 11,5**	**11,5 – 15,5**	**greater than 15,5**

Energy classes for electric consumption

			kWh_t/m^2 x year
	Good	**Sufficient**	**Insufficient**
Nursery	**Less than 11,0**	**11,0 – 16,5**	**greater than 16,5**
Primary, Middle, High except for technical industrial institutes	**Less than 9,0**	**9,0 – 12,0**	**greater than 12,0**
Technical industrial institutes	**Less than 12,5**	**12,5 – 15,5**	**greater than 15,5**

3.3 Evaluation of results

If the NEI value is "sufficient", to the school building is associated an average consumption and it is advisable to propose improvement actions
If the NEI value is "good", the school building has efficient systems and good management than no improvement actions is obliged But it is advisable to propose improvement actions to reach the nZEB class.
If the NEI value is "insufficient", it is necessary identify deep interventions to improve school building energy efficiency.

4. INTERVENTIONS OF RATIONAL ENERGY USE OF FOR SCHOOLS

The energy efficiency improvement can be obtained with several actions; above some examples are shown:

- Improvement actions on the building envelope to reduce heat losses
- Improvement actions on heat production systems for heating and hot domestic water
- More conscious behavior on energy management of school buildings.
- Adoption of innovative technological or management systems

5. MAINTENANCE IN GOOD CONDITIONS ALL ENERGY SYSTEMS INCLUDING SAFETY ASPECTS.

The tool aims to verify the energy quality of school buildings and to identify improvement actions to reach best energy conditions and to reduce energy managing costs. A good management plan can help to solve problems related to energy waste and can anticipate problems that if identified late make the expenses grow enormously.

A good plan can include:

- Designation of an activity manager
- Preventive maintenance program
- Periodic evaluation of the contractual conditions of energy supplies
- Evaluation of electrical and thermal systems for safety and compliance with energy legislation