Project co-financed by the European Regional Development Fund

EduFootprint

**School Low Carbon Footprint in Mediterranean cities**

Deliverable 3.3.2

# Guideline for energy efficiency monitor and management in public buildings

Interreg
EUROPEAN UNION
Mediterranean
EduFootprint

# Guideline for energy efficiency monitor and management in public buildings

# EDUFOOTPRINT

# School Low Carbon Footprint in Mediterranean Cities

**PRIORITY AXIS:** Fostering Low-carbon strategies and energy efficiency in specific MED territories: cities, islands and remote areas

**OBJECTIVE:** 2.1 To raise capacity for better management of energy in public buildings at transnational level

**DELIVERABLE NUMBER**: 3.2.2

**TITLE OF DELIVERABLE:** Guideline for energy efficiency monitor and management in public Buildings

**WP n. 3:** Testing

**ACTIVITY N. 3.3.2**

**NAME OF ACTIVITY:** Preliminary activities

**PARTNER IN CHARGE:** Province of Treviso

**PARTNERS INVOLVED:** ALL PARTNERS

*Date: 10th November 2017*

# Summary

# 1. INTRODUCTION

The general objective of EduFootprint Project is to better manage, plan and monitor the energy consumption in public buildings in the Mediterranean area. Specifically, EduFootprint will reach this aim working focused in public school buildings with an innovative Life Cycle Assessment (LCA) approach, considering not just direct energy impacts of buildings (consumption), but also indirect ones (public procurement or general human awareness and behavior).

These guidelines are one of the main deliverables of the EduFootprint project and are intended to guide and support owners, users and managers of school public buildings in defining an energy action plan for the buildings to be implemented also within the SEAP/SECAP (Sustainable Energy Action Plan and Sustainable Energy and Climate Action Plan) drawn up by the Municipalities involved. It's a useful tool both for the planning phase (submission of the Plan) and for the monitoring phase to do periodically.

Given that the project is aimed at schools, we will focus on education-related constructions, nursery schools, primary schools, secondary schools of the 1st and 2nd grade and universities.

These guidelines will cover issues related to direct energy consumption (electricity, heat and water), as the aspects of indirect consumption are already covered in the guidelines on the calculation of the environmental footprint of the building (deliverable 3.2.3).

About the transposition of the school-based action plans within the SEAP/SECAP prepared by the Municipalities, the approach that will be followed will integrate in the general reduction targets only the reduction of $CO_2$ emissions obtained the "direct" consumptions, that are those related to the use of energy sources such as electric and thermal carriers, to give continuity with the methodology used in the SEAP/SECAP.

These guidelines have the **following objectives** too:

- Establish a **common procedure** to be used in the various pilot areas during the development of project activities;
- Create **synergy among the various figures involved** in the use of school buildings, i.e. owners, operators and end users;
- Define a **data collection methodology** that allows to find information about the direct consumption of the building and its use by establishing the protocols to be followed to facilitate the data collection itself;
- Define a methodology for implementing the **building monitoring**;

- Define a **building action plan** aimed at improving an overall management including the first indications to assess any corrective action to be implemented by comparing existing building uses with a more efficient management.

These guidelines will not contain strictly technical interventions aimed at the efficiency of the plant-building system since many energy efficiency guides for public buildings[1] have been on the market for many issues such as:

- The problem of excessive energy consumption of public buildings;
- The analysis of the various efficiency systems and their potential;
- The importance of carrying out audits and energy diagnosis downstream of any decision;
- The research on the consumption of existing public buildings;
- Innovative techniques and materials for the renovation and construction of public buildings.

These guidelines are intended to be a "management" tool to be used by people who are not properly involved in these issues (such as students and teachers) but who play a decisive role in the environmental footprint of the building.

## 2. MAIN PROBLEMS ENCOUNTERED IN THE ENERGY MANAGEMENT OF BUILDINGS

One of the main problems encountered in the management of buildings is the **lack of awareness by the owners and managers of public buildings,** especially the school buildings used by different subjects, not only in terms of actual consumption but also in relation to the use that is done.

Often, the biggest difficulty is to **gather the starting information in a clear and reliable way** because the data available to local administrations are often limited and poorly archived, since the way they are collected is responsibility of several offices. It also happens that managers and owners do not talk and that one takes the decisions of the other without first having to compare how best to move to effectively engage all the activities planned within the building.

These problems are mainly due to:

- The property does not live in the first person the building therefore it is not aware of the real needs of end users;

[1] [1] REFERENCES:
- Indagine sui consumi degli edifici pubblici (direzionale e scuole) e potenzialità degli interventi di efficienza energetica (Report RSE/2009/165), RSE, Enea, Ministero Sviluppo Economico (2009);
- Innovazione e sostenibilità nel settore edilizio. Costruire il futuro, Legambiente, CGIL (2013).
- Guida all'efficienza energetica negli edifici scolastici. ENEA (2016). These guidelines are an effective tool for the energy efficiency interventions in the schools.
- GENERATION, Simplified Energy Audit Tool. Generation is a software dedicated to the simplified energy audit, built within the European project "GENERATION".
-

- School users (in particular the students) are often subject to a frequent turn over and therefore there is the need to constantly form they awareness about an efficient energy use;
- Within the administrations there isn't often a reference figure that can provide a third party with all the information useful and necessary to analyze the state of the art of a building not only from the point of view of the energy efficiency but also from the point of view of consumption and use;
- Lack of systematic gathering of useful data by staff responsible for storing energy consumption data;
- Segmenting tasks within administrative offices: due to the complexity of Public Administrations, sensitive energy information is the responsibility of several offices; for example, energy bills can be collected and archived by the Accounting Office, while building energy data are in the hands of the Technical Office. Perhaps, the amount of methane gas paid with a given bill is recorded, but the number of cubic meters of gas consumed at that time is not recorded at the same time, which is crucial to determining the fare paid;
- Diversified users within schools: often, some areas of schools such as gyms are also used in extracurricular multipurpose hours; the same school premises may be required for afternoon and / or even afternoon use by external associations (armaments associations, volunteer associations, cultural associations) or private entities that organize specialized courses (language courses, computer courses, music schools, painting classes, etc.). Local rooms such as magna, auditorium, libraries and reading rooms may be open for some days for extra-school use (for exhibitions, theatrical performances, congresses and conferences, etc.);
- Plurality of offices that manage relationships with associations: relationships and conventions with sports associations are managed by the sports bureau, those with associations operating in the social are managed by the social services office, etc.; moreover, in the conventions stipulated, preferential tariff policies are being implemented, or even energy consumption remains the responsibility of the municipality. Associations do not have any incentive (or disincentive) to have an energy saving optic;
- The number of classes varies annually depending on the number of enrollments to the specific institute;

Relatively low level of awareness among various interest groups on the necessity of applying energy efficiency policies and other aspects of energy management of buildings – local policy makers do not prioritize environmental policies in their agenda. From the other side, even the parents of the students don't have the right level of awareness regarding these issues and don't exercise the right pressure on decision-makers regarding the issues related to energy management of buildings.

Below are those that are valid solutions to the emerging issues.

# 3. THE PROCEDURE FOR AN EFFECTIVE ENERGY MANAGEMENT OF THE SCHOOL BUILDINGS

The procedure for a proper management described and developed within these guidelines is summarized below:

- **Establishment of an Energy Team (ET)** supervising the data collection phase;
- Introduction of a methodology for collecting and archiving data to obtain an updated and detailed **building file**;
- Implementation of a consumptions' **monitoring plan**;
- Introduction of an **analytical phase** of these elements: usage profiles, users' behaviors, envelope and installations;
- Definition of an **energy action plan**;
- Undertaking an **awareness-raising campaign** for various interest groups related to the need for an effective energy management of the school buildings.

In the following chapters each of these issues will be described in detail.

# 4. SETTING UP AN ENERGY TEAM COORDINATED BY AN ENERGY MANAGER

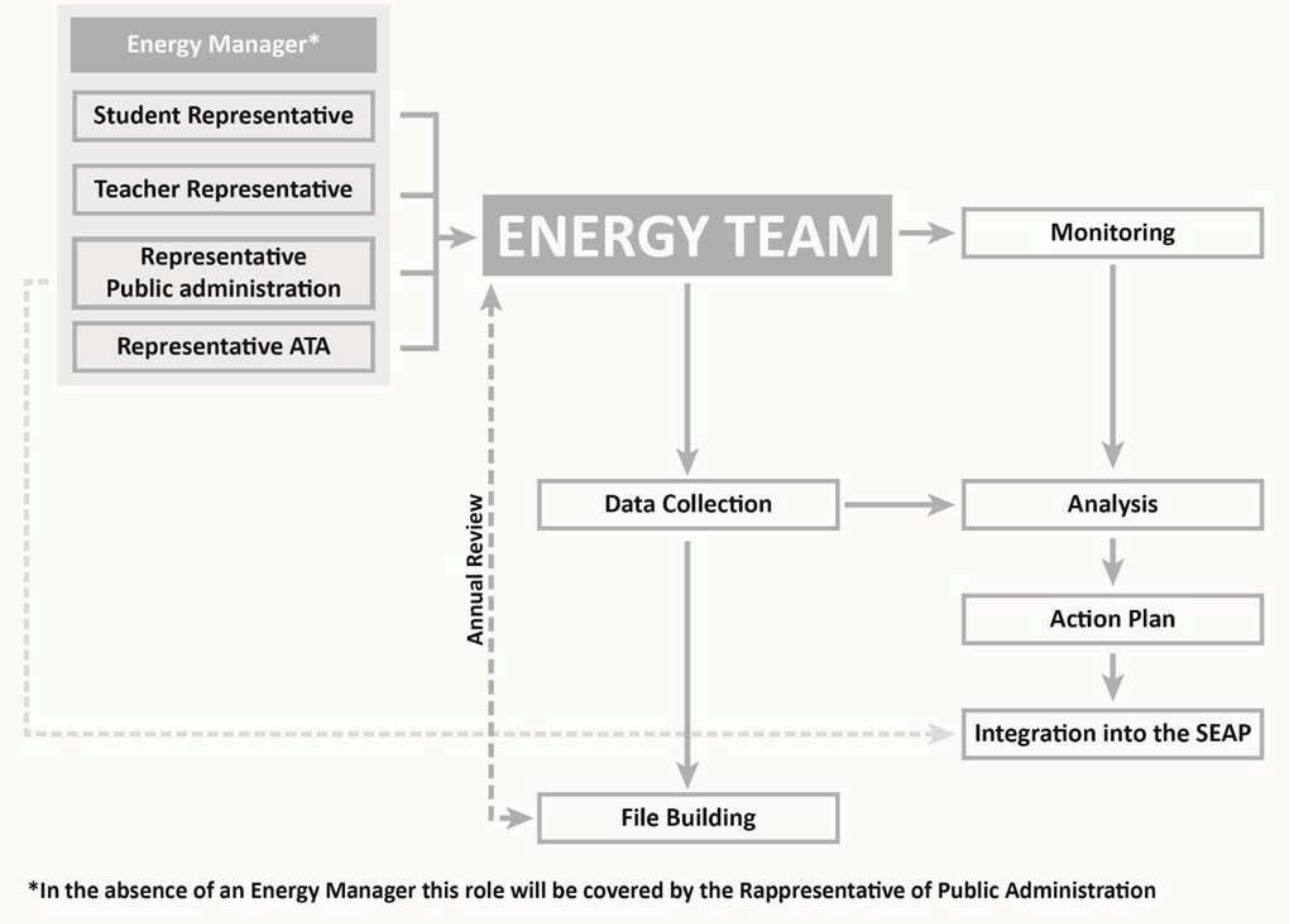
To create effective synergy among the various users of the building, it is proposed to appoint an **Energy Team (ET)** for each structure with the task of collecting and storing all information related to the energy aspects of that building. The ET should interfere with all the institutions involved in the use of the school such as:

- Property (various public administration offices);
- Managers (Comprehensive Institutes, various Public Administration Offices);
- Users (school managers, sport associations, other associations, etc.).

It should also be the reference for collecting any problems and needs from users and evaluating possible solutions with the Administration. In principle, the ET could consist of:

- Two representatives for the school (one for the students and one for the teachers);
- A representative for the public administration;
- A representative for the ATA staff (Administrative, Technical and Auxiliary staff, i.e. bureaus and school staff).

It would be advisable, to make the synergy even more effective, that the ET be coordinated by an **Energy Manager (EM)** appointed by the property of the building (typically the Public Administration).




The figure of the EM was introduced in Italy by Law 10/91 to promote consumer control and the dissemination of good energy efficiency practices to public and private entities characterized by significant consumption. For Public Administrations, the appointment of the EM is mandatory for a consumption threshold expressed in tons of oil equivalent (TOE) of more than 1,000 toe per year.

EM can be an employee of the technical area or an external consultant with technical skills; there are no regulatory obligations on the powers of the EM, but for its role to be effective, it should be a qualified technician with energy expertise.

The main tasks of the EM are:

- Collect and analyze energy consumption data and provide performance indicators;
- Monitor the trend of consumption over time;
- Identify interventions aimed at reducing or eliminating existing waste;
- Identify energy retraining interventions on envelopes and plants;
- Promote the efficient use of energy in the structure;
- Support the body in accessing national and / or European incentives;

- Supporting the definition of guaranteed energy performance contracts (EPCs) so as not to exaggerate the entity's financial statements;
- Effectively affect the energy choices of the body by also providing support in the definition of territorial policies aimed at the efficient use of energy.

In the absence of the possibility of appointing an EM, this coordination role must be carried out by the Municipal Technical Office.

A calendar of meetings between the ET and the EM components is proposed with the aim of scheduling optimal use of spaces, promoting an active comparison of how the building is used and signaling any problems that have emerged.

With regard to the role played by associations that use the building, these could be involved not within the energy team, but providing a time for comparison both in the data collection phase for creating the building file (in particular on the use of part of the building's portions is referred to in Chapters 5.6 and 5.7) and in the conclusion to illustrate the results of the monitoring plan (smart metering data) and the conclusions resulting from the analysis of the behaviors reported in Chapter 8.

Below is a table of possible dating calendars and a timeline:

| **Meeting period** | **Subjects discussed** |
|---|---|
| 1. Beginning of the school year | - Knowledge of the various components;<br>- Analyze problems in the initial state;<br>- Analysis of opportunities;<br>- Explain how to collect and store data; |
| 2. Beginning of the school year | - Objectives to be achieved during the school year;<br>- Subdivision of tasks;<br>- Collection and definition of the hours of use of the various spaces and possible optimization solutions;<br>- Definition of behavioral rules to be applied; |
| 3. Mid-Year School | - Verification of consumption trends and comparison with previous year;<br>- Check the correct use of spaces;<br>- Debate on any issues that emerged;<br>- Implementation of any corrective actions; |
| 4. Late school year | - Verification of consumption trends and comparison with the |

| | |
|---|---|
| | previous year;<br>- Check the correct use of spaces;<br>- Debate on any issues that emerged;<br>- Compiling and / or updating the cards on the building;<br>- Upgrading the building file;<br>- Undertake a SWOT analysis and determine the Action Plan for the coming year |

Reference figures may coincide with those who already have coordination roles within the present project so that they may continue with the knowledge of the current themes and dynamics of each building.

To facilitate dialogue and confrontation on the problems and opportunities offered by the project, during the first meeting set at the beginning of the school year, a SWOT analysis is expected. SWOT analysis is a strategic planning tool used to evaluate strengths, weaknesses, opportunities and threats of a project. The SWOT analysis presented below is just a prime example and a starting point and it will have to be developed during the first meeting. This procedure must be done periodically, for example at each school year beginning.

| **STRENGHTS** | **WEAKNESSES** |
|---|---|
| • Recently built building<br>• Energy renovation works already carried out on the building<br>• Interaction between the Public Administration and the schools | • Many different subjects who use the building often in very different ways<br>• Poor building management than energy efficiency |
| **OPPORTUNITIES** | **THREATS** |
| • Energy saving<br>• Economic saving<br>• Financing of works is facilitated by project activities<br>• Raising awareness among stakeholders<br>• Training on energy efficiency issues | • Failure to implement the expected interventions<br>• Failure to achieve the expected energy efficiency targets<br>• Behavioral habits in contrast to good practices |

# 5. DATA COLLECTION AND DATA STORAGE: THE BUILDING FILE

The collection and archiving phase of the initial data and updating them is very important in establishing the reference and starting conditions and then starting a process of efficiency for the building.

Methods are proposed for the collection and storage of data on energy consumption and use of the building that once collected and compiled they formulate a real **building file**, which must be constantly updated (at least once a year).

It is desirable that the collected data might be computerized and managed through web applications so that they can be easily accessible by any person interested in building management.

These data collection sheets are divided into:

- Context data;
- Dimensional characteristics;
- Envelope features;
- Installations features;
- Energy consumptions;
- Usage profiles of the installations;
- Usage profiles of zones and rooms;
- Diary of interventions (extraordinary maintenance, retraining, restructuring, extensions, etc.).

For each sheet, a possible reference manager is assigned to collect the required data by interfacing with the various figures involved.

## 5.1. CONTEXT DATA

This sheet collects:

- General information about the building (building name, address, cadastral data, year of construction, photos from outside of the building)
- Information about owners, operators and user entities (Ownership Data, Key Operator Data (such as Inclusive Institute) and Data from Other User Entities (e.g., multipurpose, associations, etc.) and their respective addresses (telephone, mail, etc.)
- For each user body, indicate the number of users (for example, in the case of a school indicate the number of students, the number of teachers, the number of employees, the number of sportsmen, etc.)

- Data on plant and service providers: enter the company and reference person data for each outsourced service (Electricity Maintenance, Air Conditioning Maintenance, Thermal System Manager, Cleaning Services, Meal Service, Fitness Manager, etc.).

# DATA SHEET N. 1 – CONTEXT DATA

| Generality | | PHOTO |
|---|---|---|
| **Building name** | | |
| **Address** | | |
| **Cadastral data** | | |
| **Year of construction** | | |

## Management data

| | | | | |
|---|---|---|---|---|
| **Bodies / Managers** | | | | |
| | | | | |
| **User Entities** (for example, divide by students, teachers, non-teaching staff, sports clubs, associations, etc.) | **Name** | **Type** | **User Number** | **Notes** |
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## Plant and Service Management

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|---|---|---|---|---|
| **Services** (include, for example, companies that have the heat supply and management contract, photovoltaic systems management, catering contractors, cleaners, etc.) | **Type of Service** | **Company and / or Reference Person** | **Delivery** | **Notes** |
| | | | | |
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## Reference Documents / Credentials*

| **Type** | **Codes / Reference** | |
|---|---|---|
| Plant Book | Key Code: | Cadastral Code: |
| APE | Regional Code: | |

*****The data in this section are those referenced to the Veneto Region, for other regions or nations it is necessary to update this section*

## 5.2. DIMENSIONAL CHARACTERISTICS DATA

This sheet collects:

- Updated drawings of the building (each floor) in pdf and dwg format with indication of surface and net height of each room;
- Report on the drawings which rooms are heated and which are not equipped with a heating system: for example, different symbols may be set depending on whether the rooms are heated, cooled, unheated or heated or cooled; another symbol could be used for the presence or absence of domestic hot water (in bathrooms, in strippers, etc.)
- Report the main dimensional data:
  - Total gross heated surface;
  - Total heated surface area;
  - Total cooled surface area;
  - Heated gross volume;
- Report the macro zones to which a building can be divided and report their most significant data (net surface area and net volume), for example:
  - Zone 1: Classrooms;
  - Zone 2: Laboratories and technical classrooms;
  - Zone 3: Gym and changing rooms;
  - Zone 4: Library and reading room;
  - Zone 5: Auditorium, Magna Hall;
  - Zone 6: Offices;
  - Zone 7: toilet facilities, storages, archives;
  - Zone 8: Bar, canteen;
  - Zone 9: Passing zones: corridors, halls and entrances.

For this sheet a municipal manager (typically a public office worker) will need to provide the drawing of the building to a school manager (teacher) who must indicate the denomination of each room in relation to its actual use and report any difference between what is stated in the drawing and what is found. Once the drawing has been returned to the technical office of the Municipality, it will update it with the instructions received from the school and divide it into the various macro zones.

# DATA SHEET N. 2 - DIMENSIONAL CHARACTERISTICS

## Main dimensional data

| | |
|---|---|
| **Total gross heated surface** | |
| **Total heated surface area** | |
| **Total cooled surface area** | |
| **Heated gross volume** | |

## Macrozone Building

| Macrozone | net surface | net volume | Notes |
|---|---|---|---|
| Classrooms | | | |
| Laboratories and technical classrooms | | | |
| Gym and changing rooms | | | |
| Library and reading room | | | |
| Auditorium, aula magna | | | |
| Offices | | | |
| Toilets, storage rooms, archives | | | |
| Bar, canteen | | | |
| Passing zones: corridors, atriums, androns | | | |
| Other | | | |

## Attachments

| Name, Type of Attachment and storage path | Notes |
|---|---|
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## 5.3. ENERGY CONSUMPTIONS DATA

This sheet reports the information can be obtained from the bills; the building's consumption must be collected for each point of purchase pertaining to that building: if a building has multiple collection points, the data must be referred to each pick point and to its related structure and must also be indicated the part of the building it is referred.

- Electricity consumption: monthly bills (in kWh) can be obtained by hourly timeframes (for Italy F1, F2, F3). It should be reported on a table (in Excel) the monthly consumption divided by hourly time, as well as the cost of the bill in € divided between production, energy transport, system charges and taxes, and specifying whether it is cost-inclusive of VAT (Value Added Tax); in addition, it is necessary to specify the month in which the entered data refers to;
- Fuel consumption (gas, diesel, etc.): from the bills it is possible to obtain the consumption (in $Sm^3$, liters, kg, depending on the type of fuel); a table (in Excel) should be prepared for each reference period shown in the bill as well as the cost of the bill in € divided between production, energy transport, system charges and taxes and specifying whether it is inclusive of cost of VAT or not;
- Water consumption: from the bills it is possible to obtain the consumption (in $m^3$); it should be reported on a table (in Excel) the consumption for each reference period shown in the bill, as well as the cost of the bill in €, specifying whether if the cost is inclusive of VAT;
- Data on the production of photovoltaic systems: the energy (in kWh) produced monthly from the plant and the one in the network and not used must be collected; these data, if not measured with dedicated systems, are available from the portals that issued the incentives (e.g. in Italy the GSE) or by registering on the site of the energy distributor (in the province of Treviso the distributor is Enel Distribuzione).

# DATA SHEET N. 3 - ENERGY CONSUMPTION

## Electricity consumption

| POD: | Power available (kW): | Supplier: |
|---|---|---|

| Reference period (enter month-by-month data from electricity bills) | Consumption (divided by hourly time) KWh | | | | Expense (€) (specify if VAT included or excluded) and subdivide the cost between energy, energy transport, system charges and taxes) | Energy Cost (€ / kWh) (Spending / TOT) | Notes |
|---|---|---|---|---|---|---|---|
| | F1 | F2 | F3 | TOT (F1+F2+F3) | | | |
| JANUARY 2016 | | | | | | | |
| FEBRUARY 2016 | | | | | | | |
| MARCH 2016 | | | | | | | |
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| …. | | | | | | | |
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| DECEMBER 2016 | | | | | | | |
| TOTAL YEAR | | | | | | | |
| % CONSUMPTION | Tot F1/TOT_ YEAR | Tot F2/TOT_ YEAR | Tot F3/TOT_ YEAR | 100 % | | | |

## Fuel Consumption

| Code of the fuel delivery point: | Supplier: |
|---|---|

| Reference period | Fuel Type | Consumption (u.m.) (indicate if Smc, liters, kg, etc.) | Expense (€) (specify if VAT included or excluded) and subdivide the cost between energy, energy transport, system charges and taxes) | Fuel Cost (€ / u.m.) (Spending / consumption) | Notes (Indicate whether it is estimated or accurate readings, if a prepay or offset invoice)) |
|---|---|---|---|---|---|
| JANUARY 2016 | | | | | |
| FEBRUARY 2016 | | | | | |
| MARCH 2016 | | | | | |
| …. | | | | | |
| …. | | | | | |
| …. | | | | | |
| | | | | | |
| DECEMBER 2016 | | | | | |

| | | | | | |
|---|---|---|---|---|---|
| **TOTAL YEAR** | | | | | |

| **Water consumption** | | | |
|---|---|---|---|
| **Reference period** | **Consumption (m³)** | **Expense (€)** | **Notes** |
| **JANUARY - MARCH** | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| **TOTAL YEAR** | | | |

| **Photovoltaic plants (if present)** | | | | |
|---|---|---|---|---|
| **Reference period** | **Produced Energy (kWh)** | **Network Power (kWh)** | **Self-Consuming Energy (kWh)** (Output-Input) | **Notes** |
| **JANUARY 2016** | | | | |
| **FEBRUARY 2016** | | | | |
| **MARCH 2016** | | | | |
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| **….** | | | | |
| **….** | | | | |
| **….** | | | | |
| **….** | | | | |
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| **DECEMBER 2016** | | | | |
| **TOTAL YEAR** | | | | |
| **%** | **100%** | **TOTAL YEAR IMMEDIATE / TOTAL PRODUCED** | **TOTAL AUTOCONSUMED YEAR / TOTAL PRODUCED** | |

## 5.4. CHARACTERISTICS OF THE OUTER ENVELOPE OF THE BUILDING

This sheet collects:

- Year of the building
- Any extension or renovation work carried out in subsequent years on the outer envelope (walls and windows);
- Construction features (thickness, stratigraphy and materials) of each external wall and walls towards unheated rooms;
- Construction features (thickness, stratigraphy and materials) of ground floor or unheated rooms;
- Construction features (thickness, stratigraphy and materials) of ceilings towards unheated or outdoors areas;
- Type of window frames (single or double glass, type of frame - material and presence or not of thermal cut);

It would be important to understand:

- If opaque surfaces (vertical walls, roofs, floors) are isolated or not. If present, investigate the thickness of the insulation;
- If the windows are equipped with low emissive or solar control glasses and the type of gas contained in any glassware.

Often the biggest difficulty in collecting this data is since the buildings are dated and the documentation has been stored or, in the worst case, even lost. It would be important to try to trace these data as truly as possible to understand immediately what parts most need any efficiency improvement. When collecting these information, the Public Works Office of the Municipality and, if possible, the subjects reported in the documents (project designers, project managers, construction companies, etc.) should be involved.

Sometimes it is necessary to use a more invasive and costly method, that consists in doing surveys to determine the presence or not of isolation or in thermographic analyzes that also allow to detect thermal bridges.

For this sheet a municipal manager (typically a public work office employer or technical office employer) must report on the drawings of the building compiled with the sheet 4.2 described above the type of walls and windows facing outwards and towards unheated rooms indicating the location with the corresponding codes (classroom, toilets, entrance etc.).

## DATA SHEET N. 4 - CHARACTERISTICS OF THE ENVELOPE

| | | | | |
|---|---|---|---|---|
| **Year of construction** (if building constructed in several excerpts indicate the construction of each plot) | | | | |
| **Extension or restructuring interventions** (describe briefly each intervention and refer to the project or project code) | | | | |
| | | | | |
| | | | | |
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| | | | | |
| **Constructive features of countertop floors or unheated rooms** (please return the symbol on the section) | **Code** | **Total thickness (cm)** | **Stratigraphy and Materials** | **Insulation thickness** |
| | | | | |
| | | | | |
| | | | | |
| **Ceiling construction features for unheated or outdoors areas** (Return the symbol on the section) | **Code** | **Total thickness (cm)** | **Stratigraphy and Materials** | **Insulation thickness** |
| | | | | |
| | | | | |
| **Building characteristics of the walls towards unheated or outdoors areas** (Put the acronym on the plant) | **Code** | **Total thickness (cm)** | **Stratigraphy and Materials** | **Insulation thickness** |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| **Type of window frames** (return the acronym to the plant) | **Code** | **Frame material** | **Glass type** (indicate whether single, double or triple, if low emission and low gas) | **Chassis type** (indicate whether with or without thermal cut) |
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## 5.5. CHARACTERISTICS OF THE INSTALLATIONS

This sheet collects:

- Data on the winter air conditioning system:
    - Type, characteristics and year of installation of the existing heat generator;
    - Type and characteristics of the circulator fluid flow (electric pumps);
    - Type and characteristics of the heating elements;
    - Number of heating circuits present;
    - System setting data: set flow temperatures for each circuit, settings for the thermal system control and temperature management in the rooms
- Data on the hot water system:
    - Type, characteristics and year of installation of heat generator for hot water;
    - Presence of any flow regulators for hot water;
- Data on the summer air conditioning system:
    - Type, characteristics and year of installation of cold generators;
    - Type and characteristics of the emitters;
    - Number of circuits if present;
    - Technical data of any air handling units present
- Data on the lighting system:
    - Type, characteristics and number of electric light fixtures
- Data on any renewable energy production facilities.

The office in charge of collecting data for this sheet is the Public Works Office of the Municipality. If no data is available, the manager can interfere with the school students (through their representatives) who can indicate in each room the different heating zones and the different types, for example:

- Heated zones, Unheated zones, Cooled zones, Heated and Cooled zones;
- For heated zones, those having different emission systems must be highlighted using different colors in the drawings (e.g. differentiate rooms with radiators from those operating with fan convectors);
- The rooms where the hot water is present must be highlighted too.
- Once compiled, the drawing with all this information must be delivered to the person responsible for the Municipality who will update the data and the drawings.

## DATA SHEET N. 5 - CHARACTERISTICS OF THE INSTALLATIONS

### Winter air conditioning system

| | |
|---|---|
| **Fuel type** | □ methane □ diesel □ lpg □ biomass<br>□ district heating □ electricity □ other (specify) |
| **Generator type 1** (state the characteristics for each generator present) | □ traditional □ condensation □ modulating<br>Power (Kw) __________ |
| **Year of installation 1** | |
| **Generator type 2** (state the characteristics for each generator present) | □ traditional □ condensation □ modulating<br>Power (Kw) __________ |
| **Year of installation 2** | |
| **Generator type 3** (state the characteristics for each generator present) | □ traditional □ condensation □ modulating<br>Power (Kw) __________ |
| **Year of installation 3** | |
| **Type of heating bodies** | □ radiators (thermostatic valves present □ yes □ no)<br>□ Fan convectors<br>□ radiant panels |

**CIRCUITS** (Reconstruct Circuit Perimeter)

| Number | Zone | Regulation | Delivery Temperature | Notes |
|---|---|---|---|---|
| | | | | |
| | | | | |
| | | | | |

### Hot water system

**CIRCUITS** (Reconstruct Circuit Perimeter)

| Number | Year of installation | Zone / Local | Type (electric or fuel) | Power (kW) | Notes |
|---|---|---|---|---|---|
| | | | | | |
| | | | | | |
| | | | | | |

| | |
|---|---|
| **Flow regulators on showers and faucets** | □ present □ not present |

### Summer air conditioning system

| | |
|---|---|
| **Typology of cold generators** | |

| | |
|---|---|
| **Power (kW)** | |
| **Year of installation** | |
| **Type of issuing bodies** | |
| **Any air handling units present** (indicate key features) | |

## Lighting system

| Local | Type | Number | Power (kW) | Notes |
|---|---|---|---|---|
| | | | | |
| | | | | |
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| | |
|---|---|
| **Sensors in Services** | □ not present □ Of presence □ timed |
| **Sensors on corridors and stairs** | □ not present □ Of presence □ timed |
| **Outdoor lighting** | □ turn on and off with twilight operation<br>□ Manual on and off |

## 5.6. USAGE PROFILE OF THE INSTALLATIONS

This sheet collects the usage profiles of the installations such as:

- For each heating circuit and for each day of the week (week type) indicate the start time and the shutdown time set for the heating system;
- For each room and for each day of the week, indicate the lights on;
- For each day of the week indicate the number of showers made by the users of the gyms;
- Indicate the average use of air conditioning systems.

For the compilation of this sheet, both the public works office (regarding the use of heating systems) and the school referents (regarding the use of lights, heating systems and showers) must be involved. Compilation could be facilitated by providing a survey sheet which has to be provided to each classroom and office, as well as to any association that uses the gym. About the use of lights in the common areas, the survey sheet must be filled out by the teaching staff.

## DATA SHEET N. 6 - USAGE PROFILE OF THE INSTALLATIONS

### Heating system

| Circuit | Use (indicate weekly type hours) | | | | | | | Notes (Indicate operating times) |
|---|---|---|---|---|---|---|---|---|
| | M | T | W | T | F | S | S | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |

### Lights turn on

| Room | Use (indicate weekly type hours) | | | | | | | Notes |
|---|---|---|---|---|---|---|---|---|
| | M | T | W | T | F | S | S | |
| | | | | | | | | |
| | | | | | | | | |
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| | | | | | | | | |
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### Showers

| Weekly Day | Number | Notes |
|---|---|---|
| Monday | | |
| Tuesday | | |
| Wednesday | | |
| Thursday | | |
| Friday | | |
| Saturday | | |
| Sunday | | |

### Conditioning equipment

| Local | Use | Notes |
|---|---|---|

| | M | T | W | T | F | S | S | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |

**Closing times or unused installations**

| Period / day | Zone / circuit | Notes |
|---|---|---|
| | | |
| | | |
| | | |
| | | |
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| | | |

## 5.7. USAGE PROFILE OF MACRO-AREAS AND SINGLE ROOMS

In this sheet it's needed to collect, for each period of the year and for each user body, the information on the way the building is used, for example:

- Office hours and times;
- Hours and periods of use of gyms;
- Classroom hours and periods of use;
- Etc.

Also, any special features must be reported.

For the compilation of this sheet, both the municipal offices which coordinate the external associations that use the areas (such as sports associations, volunteers, etc.) and the school references (for the use of gym, laboratories, aula magna, offices, canteen, library, etc.) must be involved.

## DATA SHEET N. 7- USAGE PROFILE OF MACRO-AREAS AND SINGLE ROOMS

| Zone | User | Period of Use | Timetables | Note |
|---|---|---|---|---|
| Classrooms | | | | |
| | | | | |
| Laboratories and technical classrooms | | | | |
| | | | | |
| Gym and changing rooms | | | | |
| | | | | |
| Library and reading room | | | | |
| | | | | |
| Auditorium, aula magna | | | | |
| | | | | |
| Offices | | | | |
| | | | | |
| Toilets, storage rooms, archives | | | | |
| | | | | |
| Bar, canteen | | | | |
| | | | | |
| Passing zones: corridors, atriums, androns | | | | |
| | | | | |
| Other ________________ | | | | |
| | | | | |
| Other ________________ | | | | |
| | | | | |
| Other ________________ | | | | |
| | | | | |

## 5.8. DIARY OF INTERVENTIONS

This sheet collects all the information regarding the energy efficiency interventions made on the building by indicating date, type of intervention, company that carried it and a brief description.

This creates a sort of history of the building, with all the information collected in a single sheet.

This form must be filled in by the public works office, which will have to take into consideration the management interventions proposed and implemented by the schools. Once per year, as a minimum (for example during the annual meeting of the energy team), the school referent reports any changes that has occurred in the using the areas and rooms.

**DATA SHEET N. 8 – DIARY OF INTERVENTIONS**

| Date | Type of Intervention (indicate whether it is ordinary or extraordinary maintenance or management intervention, such as change of zone use or change of setting of plant regulation) | Action | Taken by | Notes |
|---|---|---|---|---|
| | | | | |
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# 6. IMPLEMENTATION OF A MONITORING PLAN

Collecting energy consumption from reading bills is an indispensable tool but it is not sufficient to analyze the consumption of a building:

- Indispensable because it allows to study the trend of consumption in the first few months of the year and to identify any critical issues due to mismanagement of energy consumption. For example, if during the summer months (from mid-June to early September), where a school building is typically not used by students, consumption is not drastically reduced, it is necessary to investigate the causes of this abnormal consumption (such as the case of the use of air conditioners for cooling the offices that are generally used in the summer months) traying to understand if it's a waste due to equipment left on and/or standby.
- Not sufficient because it does not identify specific and sectoral wastes and inefficiencies but only analyze the posterior consumption and in any case, refer to a wide (typically monthly) time laps.

To have a direct measurement feedback, it's necessary to implement a building consumption monitoring system by installing devices (also called "smart meters") that allow to view the real-time consumption trend and record the data that therefore can be analyzed at any time. The use of smart meters allows to analyze the consumption trend over the desired time laps and can be limited to one hour and a specific day.

The main advantages of installing monitoring devices therefore are:

- Have a real-time measurement of consumptions;
- Provide instant and immediate feedback on a monitor;
- Strengthening the involvement of users;
- Reduce consumption time with respect to a system based on manual reading;
- Helping to make changes in the behavior of users and to monitor the effectiveness of actions already taken;
- Adopt better behavioral and / or management procedures;
- Identify possible peaks and / or abnormal trends in the use of the building and act to resolve the problem and / or eliminate the waste.

A monitoring system should be implemented in several phases:

- First phase: collection of consumption from the various bills for the purchase of energy carriers as shown in table 5.3;
- Second phase: installation of the above-mentioned devices on the generic counters of the energy (electric, thermal and water) vectors: this phase, in addition to the above-mentioned advantages, allows to identify serious waste and inefficiencies and to compare consumption trends with the use

of building. From the analysis and processing of the measured data and the characteristics of the systems it will be possible to implement a first indication of the incidence of consumption in the various areas of the building and in the various areas (an example in the table).

| ZONE | PERCENTAGE CONSUMPTION IMPACT | | |
|---|---|---|---|
| | ELECTRICAL | THERMICS (HEATING) | THERMICS (ACS) |
| School | 60% | 70% | 10% |
| Gym | 30% | 25% | 90% |
| Aula Magna | 5% | 3% | 0% |
| Library | 5% | 2% | 0% |
| TOTAL | 100 % | 100 % | 100% |

Example of subdivision of the consumption

| ZONE | PERCENTAGE CONSUMPTION IMPACT: ELECTRICAL |
|---|---|
| Lighting | 50% |
| Thermal system auxiliaries | 10% |
| Cooling system | 5% |
| Electrical equipment | 30% |
| Other | 5% |
| TOTAL | 100 % |

Example of subdivision of the electrical consumption

| ZONE | PERCENTAGE CONSUMPTION IMPACT: THERMICS |
|---|---|
| Classroom Circuit | 50% |
| Gym circuit | 30% |
| Aula Magna Circuit | 5% |
| ACS circuit | 15% |
| TOTAL | 100 % |

Example of subdivision of the heat consumption

- Third phase: installation of sectoral devices to analyze the trend of consumption in areas worthy of more in-depth analysis. Typically, in a school building, these dedicated counters can be implemented for gyms, or they may involve monitoring the lighting line or sockets. The higher the degree of detail the more you will be able to detect inefficiencies and waste even small.

Obviously, those who already have a data collection system as indicated in the first phase will start directly from the second phase, while those who have already implemented and analyzed a general monitoring system can start from the third stage.

Already from the second phase, monitoring should be equipped with a tele control system that has the following advantages:

- Direct control of energy consumption in real time;
- Remote control of plant's parameters;
- Identify operating anomalies and action promptly to restore ideal operating conditions:
- Plan maintenance of the devices.

A tele control system consists of:

- Peripheral units: controlled units are defined peripheral units. They are in the territory, they are made up of equipment for data acquisition and the execution of automatic control and command systems. Communication between peripheral units and the central station can be either: with switched telephone lines, with GSM digital telephone lines or with ethernet networks with TCP IP communication protocols.
- Central station: normally located at the headquarters of the operator, from which the whole system can be controlled. Communicate with peripheral units using the means described above.
- Central view station: normally located at the customer's offices, from which it is possible to control the operating of the plants, make or not make changing and calibration in according to the access level to the software.

The implementation of a tele control system could also be carried out by involving the operators or third parties responsible for the installations or by entering this service as worthy of an additional score in the choice of a public procurement.

# 7. USAGE PROFILE ANALYSIS

To start, basing on the data collected in sheets 5.6 and 5.7, it's necessary to build an usage profile of the building and relate it wherever possible to the energy consumption of the building.

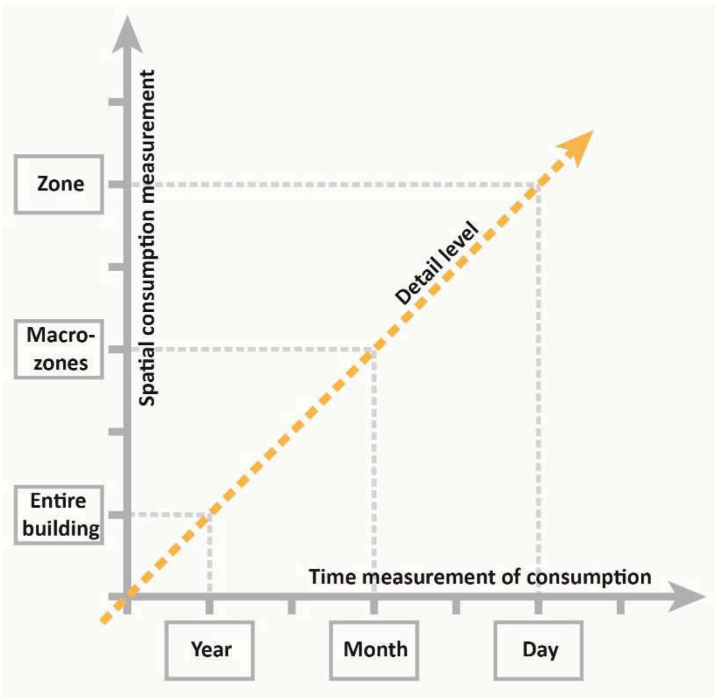
The usage profile can be traced with graphs and tables where reporting, for each month or day of the week, and for each macro area or single room, if they are used or not. An example of such a table is provided below:

| CLASSROOMS GROUND FLOOR | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | AM | | | | | PM | | | | | | | |
| | 0:00 - 1:00 | ..:.. ..:.. | 7:00 - 8:00 | 8:00 - 9:00 | ..:.. ..:.. | 0:00 - 1:00 | 1:00 - 2:00 | 2:00 - 3:00 | 3:00 - 4:00 | 4:00 - 5:00 | 5:00 - 6:00 | ..:.. - ..:.. | 11:00 - 12:00 |
| MONDAY | | | | | | | | | | | | | |
| TUESDAY | | | | | | | | | | | | | |
| … | | | | | | | | | | | | | |
| SATURDAY | | | | | | | | | | | | | |
| SUNDAY | | | | | | | | | | | | | |
| CLASSROOMS FIRST FLOOR | | | | | | | | | | | | | |
| | 0:00 - 1:00 | 2:00 - 3:00 | 7:00 - 8:00 | 8:00 - 9:00 | 9:00 - 10:00 | 0:00 - 1:00 | 1:00 - 2:00 | 2:00 - 3:00 | 3:00 - 4:00 | 4:00 - 5:00 | 5:00 - 6:00 | 6:00 - 7:00 | 11:00 - 12:00 |
| MONDAY | | | | | | | | | | | | | |
| TUESDAY | | | | | | | | | | | | | |
| … | | | | | | | | | | | | | |
| SATURDAY | | | | | | | | | | | | | |
| SUNDAY | | | | | | | | | | | | | |
| OFFICE | | | | | | | | | | | | | |
| | 0:00 - 1:00 | 2:00 - 3:00 | 7:00 - 8:00 | 8:00 - 9:00 | 9:00 - 10:00 | 0:00 - 1:00 | 1:00 - 2:00 | 2:00 - 3:00 | 3:00 - 4:00 | 4:00 - 5:00 | 5:00 - 6:00 | 6:00 - 7:00 | 11:00 - 12:00 |
| MONDAY | | | | | | | | | | | | | |
| TUESDAY | | | | | | | | | | | | | |
| … | | | | | | | | | | | | | |
| SATURDAY | | | | | | | | | | | | | |
| SUNDAY | | | | | | | | | | | | | |
| GYM | | | | | | | | | | | | | |
| | 0:00 - 1:00 | 2:00 - 3:00 | 7:00 - 8:00 | 8:00 - 9:00 | 9:00 - 10:00 | 0:00 - 1:00 | 1:00 - 2:00 | 2:00 - 3:00 | 3:00 - 4:00 | 4:00 - 5:00 | 5:00 - 6:00 | 6:00 - 7:00 | 11:00 - 12:00 |
| MONDAY | | | | | | | | | | | | | |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TUESDAY | | | | | | | | | | | | | |
| WEDNESDAY | | | | | | | | | | | | | |
| … | | | | | | | | | | | | | |
| SATURDAY | | | | | | | | | | | | | |
| SUNDAY | | | | | | | | | | | | | |

As far as the analysis is concerned, one can only start by analyzing the monthly data of the entire building both in terms of employment and consumption (perhaps taking the weekly average of the usage profile).

Analysis will always start from a general level and then go into detail when implementing the various monitoring systems: one can choose to analyze each macro area (for example, subdividing the analysis into classrooms, gym, offices, library, etc.) or, entering in a more detail, to analyze each room or area (e.g. ground floor, first floor, laboratories, classrooms, or even executive offices, administrative offices, secretarial offices, etc.). A graph showing the highest level of detail of the analyzes according to the spaces and times considered is shown below.

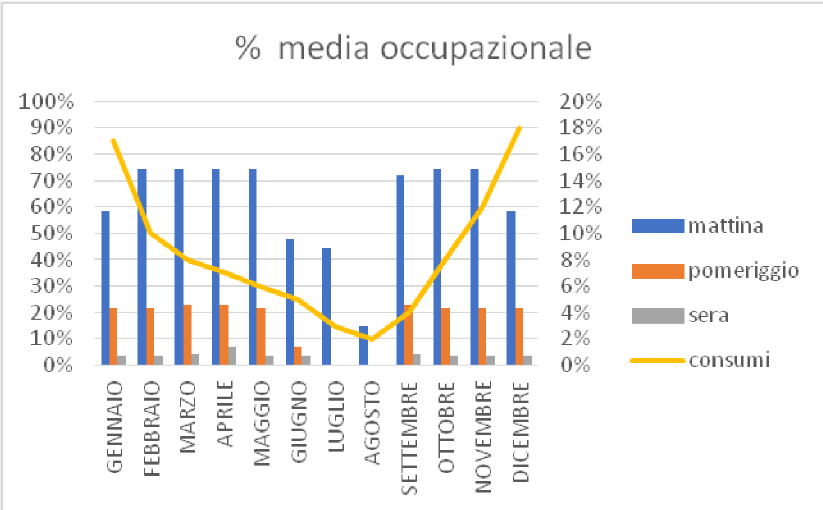



Below is an example in which for the entire building the month-to-month usage profile of a week was reconstructed and was reported on a table referring to the energy consumption.

The usage profile report with the trend in consumption is more useful when you have a greater level of detail.

| | MONDAY | | | ..... ( until Sunday) | | | WEEK OF THE WEEK | | |
|---|---|---|---|---|---|---|---|---|---|
| | morning 07:00 - 13:00 | afternoon 13:00 - 19:00 | evening 19:00 - 24:00 | morning 07:00 - 13:00 | afternoon 13:00 - 19:00 | evening 19:00 - 24:00 | morning 07:00 - 13:00 | afternoon 13:00 - 19:00 | evening 19:00 - 24:00 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| JANUARY | 80% | 20% | 5% | 80% | 5% | 5% | 59% | 21% | 4% |
| FEBRUARY | 100% | 20% | 5% | 100% | 5% | 5% | 74% | 21% | 4% |
| MARCH | 100% | 20% | 10% | 100% | 10% | 5% | 74% | 23% | 4% |
| APRIL | 100% | 20% | 10% | 100% | 10% | 10% | 74% | 23% | 7% |
| MAY | 100% | 20% | 5% | 100% | 5% | 5% | 74% | 21% | 4% |
| JUNE | 70% | 20% | 5% | 60% | 5% | 5% | 48% | 7% | 4% |
| JULY | 60% | 0% | 0% | 60% | 0% | 0% | 44% | 0% | 0% |
| AUGUST | 20% | 0% | 0% | 20% | 0% | 0% | 15% | 0% | 0% |
| SEPTEMBER | 90% | 20% | 10% | 100% | 10% | 5% | 72% | 23% | 4% |
| OCTOBER | 100% | 20% | 5% | 100% | 5% | 5% | 74% | 21% | 4% |
| NOVEMBER | 100% | 20% | 5% | 100% | 5% | 5% | 74% | 21% | 4% |
| DECEMBER | 80% | 20% | 5% | 80% | 5% | 5% | 59% | 74% | 21% |




The analysis of the usage profile also gives the first information on the management of the building's time and makes it possible to identify easily any possible improvement. The analysis allows you to:

- Optimize the usage profile of the building both in terms of time and space: you can decide to move some activities to other rooms or at different times to optimize them with the overall use of the building;

  For example, a corrective action might be to move all the afternoon activities of a school to a single floor to avoid that the lights of the halls of all the floors are turned on and even to operate the heating circuit only on that plane;
- Optimize the ignition, shutdown and adjustment of the installations according to the occupational profile of the building, also taking into consideration the feedback from the end users; the installations manager, through the ET, could make questionnaires on the level of comfort perceived by the users inside the rooms and within the common spaces and, if necessary, adjust the parameters (start times, flow temperature circuits, climatic curve settings, etc.). In addition, this approach can highlight any priority to install e.g. thermostatic valves or zone controllers;

- Increase the knowledge of the spaces in each building in the same users.

# 8. USERS' BEHAVIORS ANALYSIS

Based on the data collected in sheets 5.6 and 5.7 and the implementation of monitoring, it will be possible to identify and correct those behaviours of the users that affect energy consumption.

If, for example, it is noticed that when the usage profile of the building is low there is no consequential reduction in consumption, the first cause must be sought in incorrect behaviours such as lights and installations left on, windows left open, etc.

Please refer to the School Environmental Footprint Guidelines (SFEGs), for a comprehensive overview of good behaviours of users, while in this section we will focus on the so-called "top down" actions, that is, guided by the manager / owner and that can affect the behaviours of users.

For this reason, it is crucial to increase consumer awareness using different techniques, such as for example the Demand Side Management (DSM): this system includes a whole series of actions aimed to modify the mode and extent of consumption of end users, to optimize the loading curve ("smoothing" the peaks and the valleys of the curve). This management system promotes energy efficiency and stimulates the best choice from users. DSM is divided into two categories:

- Behavioural DSM: It addresses consumer education and encourages individual participation to achieve energy savings (B-DSM); this technique also has a social and psychological implication as users, once assimilate, tend to use it even outside the school context;
- Analytic DSM: Finds savings opportunities through device tracking and data analysis (A-DSM).

The DSM can be adopted through:

- Simulation, education and training tools such as:
  - reading exercises of electricity meters (including those relating to the recording of energy produced by any photovoltaic installations installed), methane gas and, if applicable, aqueduct, if easily accessible;
  - exercises for reading / understanding energy bills, which the latter could then replicate even in their homes, thus taking a "conscience" of energy consumption and the relative units of measurement;
  - Establish a "mini Energy Team" among students for the collection of energy parameters such as temperature and degree of illumination within school rooms and with different environmental conditions so that they are aware of the use made of the heating system and lighting inside the rooms; this "exercise" also allows to report any issues to the ET which in turn will report it to the managers of the installations. This approach can be useful to help operators by providing them

with useful information to determine the start times and calibration of the flow temperature control curves in a thermal power plant;

- Deliver a virtuous behaviour based on conscious ventilation and consists in installing in each classroom (or some significant ones) a tool that displays and records the temperature / humidity / $CO_2$ concentration in the environment and allows to properly manage ventilation of the rooms.

- Instant feedback tools such as, for example, giving users the ability to view and interact directly with PCs;
- Educational and gambling entertainment tools such as simulating games or competitions between the various classes or between schools aimed at reducing waste;
- Financial and economic incentives or breakdown of the benefits obtained with the savings obtained with premiums or benefits for the building or its users (it does not necessarily have to be a cash prize, but could include, for example, the organization of a free day at the pool or a guided tour if you achieve a specific saving target or purchase of multimedia material or technology devices to monitor environmental parameters on the premises);
- Possible approval of a reorganization plan for the occupation of spaces and time by all the "actors" involved;
- Possible proposal of a confrontation, exchange and reflection course with ATA staff playing a key role in school management.

Some actions that act on the behaviour and can reduce energy waste and consumption are reported below:

- *Air conditioning and hygienic water:*
  - Cleaning (radiators, nozzles, filters, etc.);
  - Verify and optimize the setpoint temperatures of winter and summer air conditioning systems (if present), as well as the witch-on and switch-off times of air conditioning and ventilation systems (e.g. may be switched off 20 minutes before leaving);
  - Check the position of the thermostats and the possible integration of sensors;
  - Avoid furniture or other obstructions that may interfere with the air conditioning terminals;
  - Close windows and doors when the air conditioning systems are active (or whenever possible);
  - Privilege natural ventilation to cool the rooms;
  - Use window shading systems (summer and winter);
  - Avoid water leakage (close taps when water is not used, check for dripping, install flow regulators or timers, etc.).
- *Lighting:*

  - Cleaning (windows, lamps);
  - Replace whenever possible general illumination with focused or local lighting;
  - Decrease the number of lit lamps or the illumination level depending on the natural illumination (also with the help of presence sensors, brightness sensors and dimmer systems) or partitioning of the plants;
  - Orient the workstations to make the most of natural lighting and avoid glare;
  - Move any furniture or obstacles that could shade the workstations;
  - Provide different room lighting scenarios depending on the various activities planned;
  - Organize working hours to reduce the lighting time of the lights;
  - Turn off the lights when leaving the rooms.
- *Electrical equipment:*
  - Introducing solar charging systems for mobile phones or other portable devices;
  - Activate the "energy save" mode on the devices;
  - Turn off inactive devices when leaving workstations;
  - Turn off unused monitors and stand by;
  - Maintain the brightness of the screens at medium values;
  - Choose screensavers and background images for dark-colored monitors;
  - Reduce the number of printers by preferring few devices shared on the network;
  - Avoid position of refrigerators near to heat sources, check and repair any faults in the refrigerator doors, use them at appropriate temperatures, prefer "eco" programs on household appliances (washing machines, dishwashers, ovens, etc.)
  - Purchase appliances with low-consumption;
  - using stairs instead of lifts, and do not call more than one elevator when commanded by separate buttons.
- *Work organization:*
  - Reorganize working hours to reduce heating and cooling times (if present) and light-up time
- *Information and education:*
  - Share energy bill details with users;
  - Making the view in real time of consumption;
  - Panels and other information systems;
  - Games, Challenges, and Campaigns that involve users actively.

# 9. ENERGY AUDIT ON ENVELOPE AND INSTALLATIONS

This analysis will be carried out by a qualified technician who, thanks to the building file drawn up by the ET, can identify the first energy efficiency intervention to be done within the school.

The most common efficiency improvements for public buildings are listed below:

- Isolation of perimeter walls: can be realized from the inside, from the outside or from the interspace. The choice of intervention to be taken depends mainly on the type of construction, the state of degradation of the building and the capital available for the construction;
- Insulation of the cover: can be made from the inside, from the outside or into the gap depending on the different types of roofing (roof cover or flat cover, presence of practicable or unusable roof), the available internal heights and the problems to be solved (e.g. leaks for infiltrations, plaster scrapes, etc.);
- Isolation of the floors: in this case, these are very costly interventions because if they are made to the extreme, they imply the modification of the windows and the reconstruction of the parcel over the slab. If it is possible, it is advisable to lay the insulating material on the floor if it disperses to an unheated room or to a porch;
- Efficiency of window frames: the most used techniques (from the cheapest to the most expensive) are:
  - Adhesive film applications (Low Emissive, Reflective Solar)
  - Insulation of the bins;
  - Installing a double glazing;
  - Replacement of glass (with high thermal insulation, reduced solar factor, warm edge, double glass, triple glass);
  - Replacement of the entire window frame (multicamera pvc frames, multi-chamber thermal cut aluminum frames, low density wood frames).
- Install sunscreens that control solar radiation and increase the thermal resistance of the window frames as well as allow for adjusting the natural and artificial lighting level inside the rooms. The choice of solar shielding devices must be made considering the climatic conditions of the site, the characteristics of the building as the orientation and the presence of adjacent buildings, the size and exposure of the transparent surfaces.
- Ordinary maintenance of the installations: it involves the cleaning of the various components and the regulation of the flows and the temperatures.

- Installation of room temperature control systems such as thermostatic valves, electrothermal valves, zone valves, etc., which regulate the flow rate of the heating fluid based on the ambient temperature reached.
- Replacement of fluid circulation pumps with inverter pumps that adjust the flow according to the actual demand.
- Condensation heat generator replacement, instead of a traditional boiler.
- Heat pump installation: for existing buildings it requires a complete renovation of the entire thermal and electrical system, resulting in greater initial investment and an opportunity check: if, for example, the outdoor temperatures are very low and there is no air conditioning summer consumption of a heat pump can even increase and in winter it may be necessary to integrate to not use the heat pump with low levels of efficiency.
- Implementation of controlled mechanical ventilation.
- Use for timed circuit lighting in bathrooms, hallways, and stairs that turn off the lights automatically after a predetermined time.
- Provide automatic shutdown of all the lamps after the evening closure of the building.
- Replacing old lamps with newer, more efficient models.
- Installation of photovoltaic plants to produce electricity;
- Installation of solar thermal systems to produce hot water: this intervention is strongly recommended if the structure has a high consumption of hot water even during the summer months while it is unresolved if the facility is closed or has no hot water health during the months of higher production (summer ones).

A technician based on the building's characteristics, consumption and occupational profile will be able to identify the most appropriate interventions and for each of them to estimate achievable savings (payback of the intervention), costs to be incurred, any contributions and funding available and time to return investment.

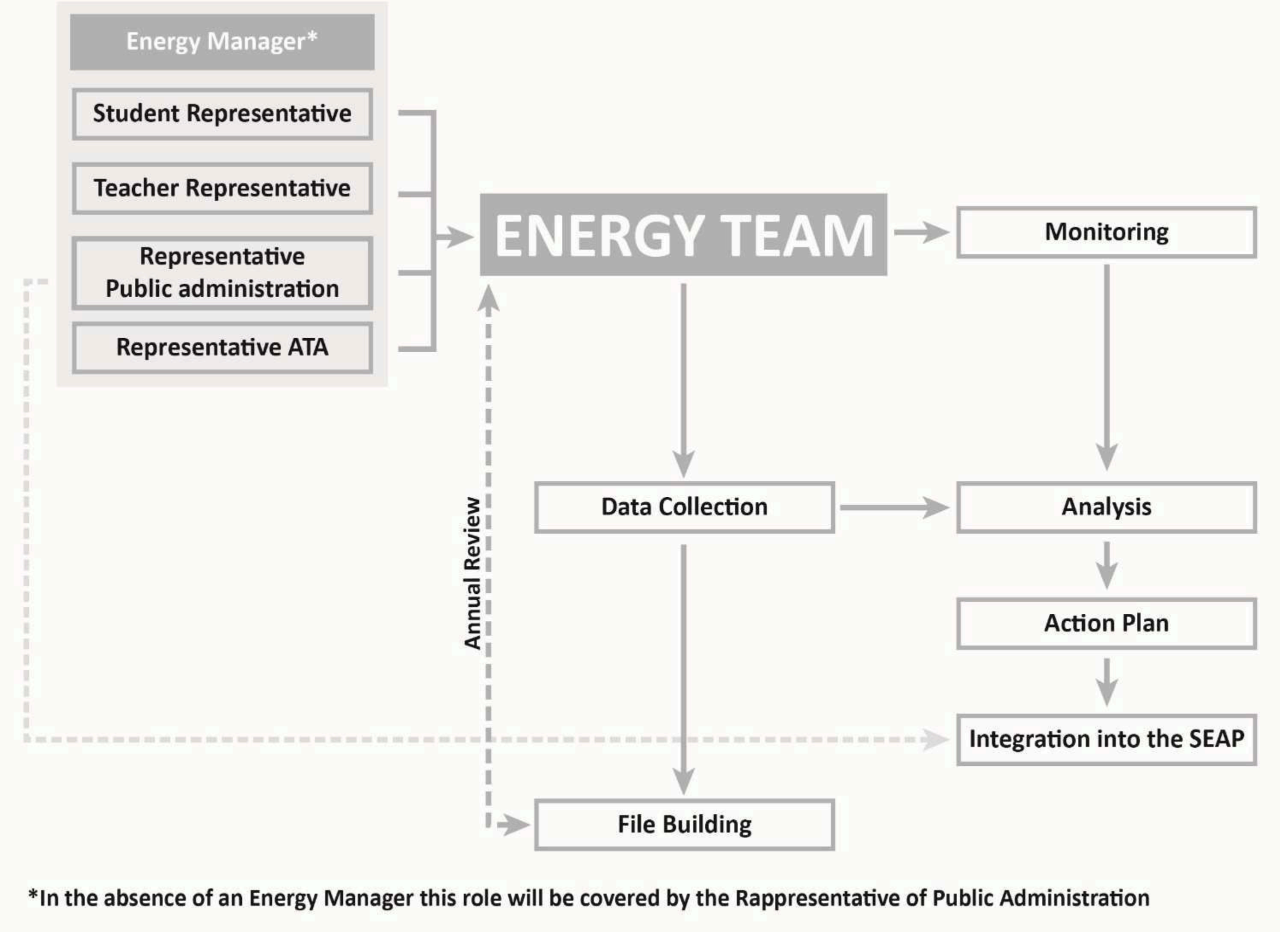
# 10. DEFINITION OF THE ENERGY ACTION PLAN FOR THE BUILDING

After completing actions to gather the building data (building file), the EM analyzes all the collected data, assessing the issues and opportunities emerging also from meetings with the ET, as well as the results from the monitoring of the building. From this analysis it is possible to identify an energy action plan for the building that consists of:

- Implementation of management actions: to improve the management of time and space within the building by putting synergy among the various users;
- Implementation of behavioral actions: to implement a set of rules to eliminate energy waste, raise awareness, reduce consumption;
- Implementation of direct actions: to implement energy efficiency measures.

It is important that the building file is updated annually and that the ET maintains its functionality even after the energy action plan has been defined since the school buildings are characterized by a large change of users since students and athletes have a temporary presence inside the building which is subject to generational replacement every year.

The figure below shows a flowchart on the management of the building and reconstructs the entire path described in these guidelines: from the analysis of collected data and consumption comes a definition of a building action plan that can be implemented as an action to be inserted within the local SEAP.




The energy action plan will result in a building sheet that will contain the actions to efficiently manage it from the management, behavioral and energetic point of view (envelope and installations). Management and behavioral actions, depending about the building and the level of development, of the maturity and experience gained by each municipality, can be taken with one of the three approaches listed below:

- BASIC APPROACH: Provides at least the establishment of the ET and a methodology for collecting the data, starting from what is indicated in Chapters 4 and 5; from the collected data you can make the first considerations and eventually go to the next step;
- IMPROVEMENT APPROACH: improvement of existing measures by implementing a timely and specific monitoring system for the building;
- EVOLUTIONARY APPROACH: application of more specific tools such as the adoption of Energy Management, energy performance contracts (EPC), financial instruments and financing.

The sheet will be presented by the ET and, once validated by the EM, will be transposed by the Municipality to be integrated into the SEAP.

Below is an example of an action sheet.

<table>
<tr><th>AZIONE EP_00</th><th colspan="15">Efficientamento Edifici Pubblici: Scuola Secondaria del Comune</th></tr>
<tr><td rowspan="14">Edifici, Attrezzature, Impianti Comunali (EP)</td><td>OBIETTIVO</td><td colspan="14">Ridurre i consumi energetici attraverso buone pratiche gestionali e possibili interventi di efficienza e risparmio energeticoenergetica</td></tr>
<tr><td>LUOGO</td><td colspan="5">Scuola Secondaria del Comune</td><td colspan="3">AREA INTERVENTO</td><td colspan="6">Efficienza energetica degli edifici</td></tr>
<tr><td>SETTORE</td><td colspan="5">Edifici, Attrezzature, Impianti Comunali (EP)</td><td colspan="3">POLICY</td><td colspan="6">Risorse interne, Appalti pubblici, etc.</td></tr>
<tr><td>DESCRIZIONE</td><td colspan="14">L'efficientamento prevede una riduzione dei consumi attraverso un percorso che parte da una sinergia tra proprietario, gestore e utilizzatore finale finalizzata a:<br>- raccogliere i dati principali sull'edificio e sull'utilizzo dello stesso;<br>- raccogliere e archiviare in modo corretto i dati sui consumi energetici;<br>- garantire una buona gestione dell'edificio in temini di utilizzo degli spazi e degli impianti;<br>- introdurre sistemi di monitoraggio diretto dell'edificio (smart meters);<br>- introdurre buone pratiche comportamentali;<br>- effettuare una corretta manuenzione degli impianti;<br>- effettuare interventi di efficeinza energetica.</td></tr>
<tr><td>FIGURA RESPONSABILE</td><td colspan="4">Ufficio Tecnico</td><td colspan="2">ATTORI COINVOLTI</td><td colspan="8">Insegnanti, Alunni, Personale non docente, Gestori degli impianti, Associazioni sportive e culturali, Comitati locali, Cittadini</td></tr>
<tr><td>CRONO - PROGRAMMA</td><td>2007</td><td>2008</td><td>2009</td><td>2010</td><td>2011</td><td>2012</td><td>2013</td><td>2014</td><td>2015</td><td>2016</td><td>2017</td><td>2018</td><td>2019</td><td>2020</td></tr>
<tr><td rowspan="2">MODALITA' DI CALCOLO</td><td colspan="6" rowspan="2">Il calcolo sarà effettuato sulla base di un'analisi energetica redatta da un energy manager anche sulla base dei dati raccolti nel fascicolo dell'edificio da parte dell'energy team</td><td colspan="3">% ATTUAZIONE</td><td colspan="5">da realizzare - 0%</td></tr>
<tr><td colspan="3">INTERAZIONE CON ALTRE AZIONI</td><td colspan="5"></td></tr>
<tr><td rowspan="3">RISULTATI</td><td colspan="6" rowspan="3">Minori emissioni dovute al risparmio energetico conseguito grazie alla effettiva realizzazione degli interventi previsti.</td><td colspan="3">Energia da FER (MWh)</td><td colspan="5">N/A</td></tr>
<tr><td colspan="3">Risparmio energetico (MWh)</td><td colspan="5">inserire dato</td></tr>
<tr><td colspan="3">Riduzione emissioni (tCO2)</td><td colspan="5">inserire dato</td></tr>
<tr><td>FINANZIAMENTI</td><td colspan="6">Inserire eventuali finanziamenti possibili<br>Finanziamenti Europei<br>Banca Europea per gli Investimenti (BEI - European Investment Bank)<br>Finanziamenti regionali<br>POR FESR 2014-2020<br>Finanziamenti nazionali<br>Conto termico GSE<br>FTT (Finanziamento Tramite Terzi)<br>ESCo (Energy Service Company)<br>Risorse Comunali</td><td colspan="3">COSTI PREVISTI</td><td colspan="5">Inserire i costi che l'Amministrazione sosterrà per questa azione</td></tr>
<tr><td>MONITORAGGIO</td><td colspan="14">Si confronteranno i consum ienergetici di partenza raccolti dall'energy team con i consumi post azione che verranno raccolti sempre dall'energy team</td></tr>
</table>

The action plan inserted in the SEAP will become a real action to achieve the objectives set by the Plan for the reduction of $CO_2$ emissions in the atmosphere by the Municipality.

After the implementation of the action plan by the Municipality, a monitoring and control phase will be started with respect to the objectives and interventions envisaged.

For the project to be successful, it is essential that actions are implemented (changes in behavior and / or building management) and lead to a reduction in school building consumption and to a reduction of $CO_2$ emissions as far as the objectives of the local SEAP are concerned.

It will then be necessary to establish a mid-term review plan, during which a comparison will be made with respect to the level of implementation of the interventions and policies envisaged; in addition, all useful data on consumption should be collected not only to verify the energy efficiency obtained but also to review the initial goals compared to possible changes made to the school buildings, especially in relation to uses.

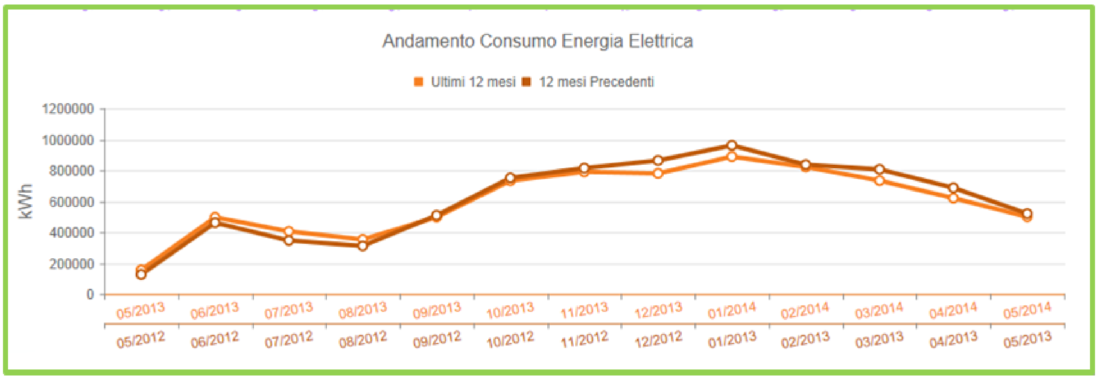
In this regard, it might be necessary to identify indicators that show which variables can affect data and define standardization steps that will allow to properly interpret consumer data (for example on day grades, surface use, hours of use, etc.) so as not to affect the variations in consumption from external factors. Even in the SEFGs guidelines, normalization is reported with respect to the actual days degrees, limited to inputs for thermal energy, where the footprint calculates the effect of climatic conditions.

# 11. GOOD PRACTICES OF THE PROVINCE OF TREVISO

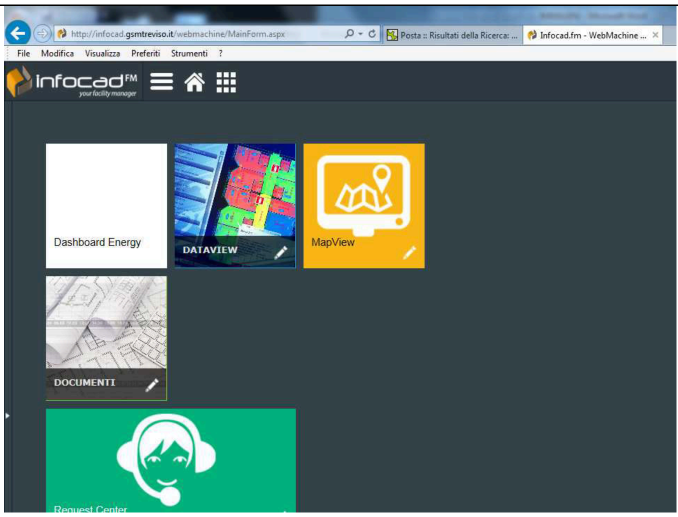
The Province of Treviso is very active and attentive to the management of its school buildings.

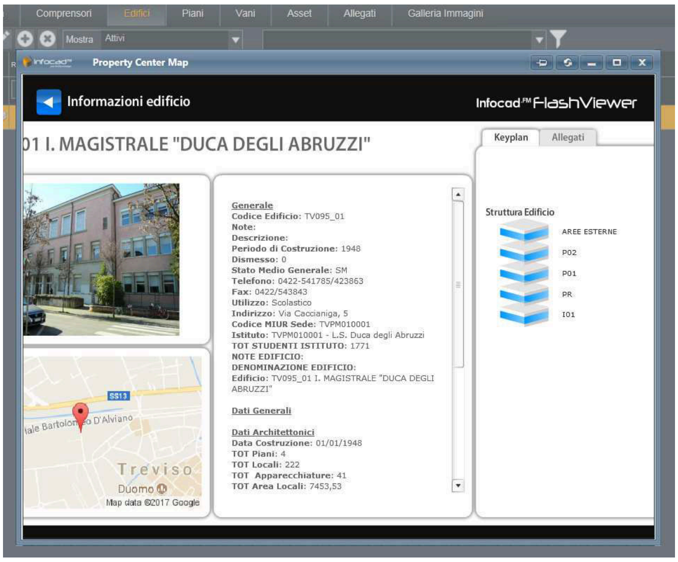
Among the best practices used to collect energy consumption, we can certainly quote:

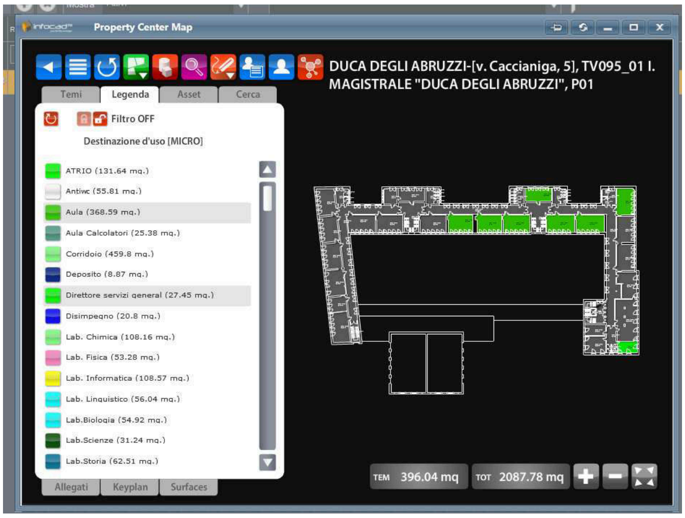
- SMART METERING: all public buildings in the province of Treviso have been equipped with thermal and electrical energy meters that allow the display and storage of energy consumption data and allow to analyze consumptions with a high degree of in-depth: energy bills provide monthly consumption, at a time-banded limit, but there is no trace of daily or hourly consumption or load profiles; with measuring instruments it is possible to access this information and analyze and compare consumption trends at different times.


- INFORMATIVE SYSTEM INFOCAD: the province of Treviso has created a dedicated portal from which it can access any building of its own competence and display:
  - Building General Card;
  - Planimetric data of each floor of the building;
  - Displaying the division of the rooms and the various areas for its destinations (classrooms, corridors, laboratories, gyms, services, etc.) and their surfaces;
  - View the various materials and constituent components of the casing;
  - Displaying energy consumption;
  - Managing building maintenance by reporting by a school referent who places the request on the portal which is handled by the plant manager.


Infocad FM
Dashboard Energy
DATAVIEW
MapView
DOCUMENTI


Comprensori
Edifici
Piani
Vani
Asset
Allegati
Galleria Immagini
Property Center Map
Informazioni edificio
01 I. MAGISTRALE "DUCA DEGLI ABRUZZI"
Keyplan
Allegati
Struttura Edificio
AREE ESTERNE
P02
P01
PR
I01
Treviso


Property Center Map
DUCA DEGLI ABRUZZI-[v. Caccianiga, 5], TV095_01 I. MAGISTRALE "DUCA DEGLI ABRUZZI", P01
Temi
Legenda
Asset
Cerca
Filtro OFF
Destinazione d'uso [MICRO]
Allegati
Keyplan
Surfaces
TEM 396.04 mq
TOT 2087.78 mq