Second Level: Update of Energy Database and Syntethic description of the monitoring Pilot

The ultimate goal the monitoring is to reduce energy costs through improved energy efficiency and energy management control. Other benefits generally include increased resource efficiency, improved production budgeting and reduction of greenhouse gas (GHG) emissions.

Through appropriate detection technologies, you can:

- Identify and explain excessive energy use,
- Detect instances when consumption is unexpectedly high than would usually have been the case,
- Draw energy consumption trends (weekly, seasonal, operational…),
- Determine future energy use when planning changes in the business,
- Diagnose specific areas of wasted energy,
- Observe how the building reacted to changes in the past,
- Develop performance targets for energy management programs,
- Manage their energy consumption, rather than accept it as a fixed cost that they have no control over.

To achieve these objectives, the main activities of monitoring includes:

- Key principles,
- Monitoring,
- Reporting,
- Procedures,
- Measure,
- Define the base-line,
- Monitor variations,
- Identify causes ,
- Set targets, Monitor results,
- Examples.

For the monitoring of thermal behaviour of buildings may be adopted various analysis systems ranging from energy audits dynamic (that will simulate the theoretical behaviour), to detection of physical data through appropriate instruments. The installation of some of this instrumentation will enable at the same time to introduce devices able to operate systems of regulation and control.

Finally, the data collected by mechanical instrumentation, have to be compared with the actual cost of the energy bill; this operation to be carried out by those who will manage the property of the buildings.

In the GovernEE framework we are trying to introduce a kind of monitoring system.

The methodology is based on carrying out energy audit of building and comparing the reduction of heat consumption (kWh/m² year and kWh/m^3 year) or GHG following energy efficiency measures. Then the result is compared with several indicators, for example with

the cost of the action.
This tack has some limitations in historic building, relating to:
- preservation of cultural and historic identity;
- conservation of historical elements;
- respect of legal obligations;
- use of traditional materials and technique.

HISTORIC BUILDINGS

In existing and/or historical buildings there is much less flexibility in the design and layout of energy efficiency measures. For this reason it may be difficult to compare the goodness of energy efficiency measures in different buildings. Also the energy analysis performed on existing buildings, particularly on historical ones, is often based on inaccurate data (lack of information on building components and systems).
For this reason the analysis is often not realistic.
We took into account different criteria and indicators to define energy and environmental performance of buildings aiming at monitoring energy efficiency trends and policy measures in public heating. The parameters included within the system cover sustainable building issues: environment, social and economic sectors.
The monitoring system is then supported by an excel file (see the attached example): each criteria is described through indicators and for each indicator value score and weight are assigned.
In order to assign a value to the indicators, Likert scale has been introduced:

SCORE	DESCRIPTION
-2	Much worse: relevant negative deviation from the status quo
-1	Worse: negative deviation from the status quo
0	Benchmark: respect to the status quo
+1	Better: compliance with the PA (public authority) aims
+2	Much better: better than the PA aims

In particular, the score:
"-2" means that the performance is significantly below the standard and current practice;
"-1" means that the performance is below the standard and current practice;
"0" represents the standard of comparison (benchmark) which could be for example the current construction practice in accordance with laws (European, national, local) or regulations in force and therefore represents the minimum acceptable performance defined by laws or regulations (for example, the Covenant of Mayors), or if there are no reference regulation is the current accepted practice;
"+1" represents an improved performance compared with existing regulations and practice;
"+2" represents a considerably advanced performance compared to the current best practice.

For each criteria and each indicator (sub-criteria) a weight is assigned expressed as a percentage and chosen by the PA.
The final value is the weighted average of the considered indicators.
The following list describes some indicators and for some of them a rating scale is proposed as example:
The list is not exhaustive and the identified criteria and indicators could be implemented or deleted (assigning a 0% weight) by the PA for the definition of the Strategic Toolkit or for other uses.

Instructions: modify, if necessary, the weights; put the score in the equivalent cell (for each indicator put only one score); read the final score and its evaluation in red cells.

Project improvement	**Much worse**	**Worse**	**Benchmark**	**Better**	**Much better**	**Weight**
Value	<<	<	=	>	>>	
Score	**-2 [a]**	**-1 [b]**	**0 [c]**	**1 [d]**	**2 [e]**	
Score x weight	a x w	b x w	c x w	d x w	e x w	**w**
Environmental context						**10%**
Integration into the surrounding cityscape					2	*20%*
Potential environmental impact of development				1		*20%*
Saving protected section of the historic building				1		*30%*
Cultural heritage compliance					2	*30%*
Energy efficiency						**30%**
Primary energy savings (PES) for heating				1		*40%*
Tonnes of Oil Equivalent (TOE)				1		*20%*
Renewable energy sources (%)			0			*40%*
Environmental loading						**15%**
CO_2 avoided emissions				1		*40%*
Greenhouse Gas Emission (GHG)				1		*40%*
SO_2 and NO_2 pollution		-1				*20%*
Technical aspects						**20%**
Adoption of Best Available Technologies (BAT)				1		*30%*
Space requirements/availability			0			*25%*
Employment of not high qualified worker/technician		-1				*20%*
Systematic maintenance				1		*25%*
Economic aspect						**25%**
Net Present Value (NPV)		-1				*30%*
Internal Rate of Return (IRR)		-1				*30%*
Payback Period (PP)	-2					*40%*
TOTAL	$A=\sum a_i w_i$	$B=\sum b_i w_i$	$C=\sum c_i w_i$	$D=\sum d_i w_i$	$E=\sum e_i w_i$	A+B+C+D+E
	-0,200	**-0,220**	**0,000**	**0,460**	**0,100**	**0,140**
						Benchmark

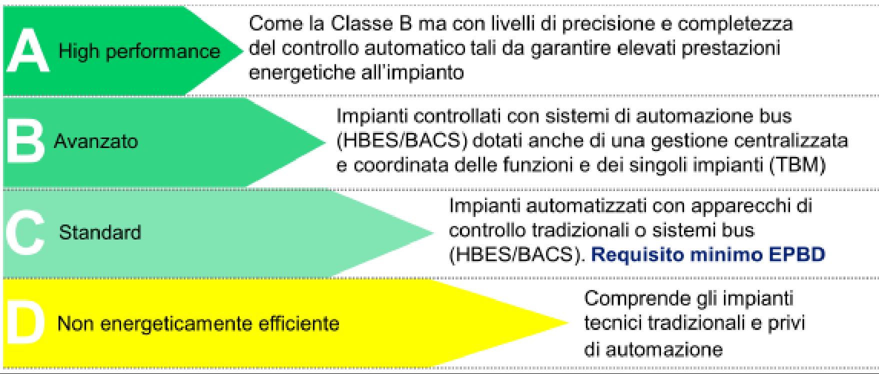
The European reference standard for the energy efficiency of the automation systems is the EN15232: BAC Factors define four different classes of energy efficiency for the classification of automation systems f $_{BAC,\ HC,}$ buildings for the efficiency of heating and cooling, which are valid for residential applications and for no-residential applications (here we list only values useful for public buildings).

A HIGT PERFORMANCE: automation systems with high levels of accuracy and completeness of automatic control to ensure high energy performance to technological systems

B ADVANCED: controlled systems with automation systems BUS (HBES/BACS). With centralized management and coordinate the functions and individual system (TBM).

C STANDARD: automated systems with conventional control devices or BUS (HBES/BACS) systems.

D NOT ENERGY EFFICIENT: traditional technical installations without automation.



Reference by: ABB Italy – Sesto San Giovanni – MI

Below we compare the savings achievable with the installation of automation systems.

Heating / Cooling in residential and no-residential buildings (*Table by ABB Italy- Sesto San Giovanni – MI*)								
	D	**B**	**C**	**A**	Savings adopting the classes A and B instead of C and D			
	No Automation	Standard Automation	Advance Automation	High Efficiency	Saving B/C	Saving B/D	Saving A/C	Saving A/D
Offices	1,51	1,00	0,80	0,70	20%	47%	30%	54%
Reading room	1,24	1,00	0,75	0,50	25%	40%	50%	60%

Below we listed the necessary actions to monitor the behaviour of the building and its consumption, also the systems of analysis and control currently in use on the market.

TYPE OF ANALYSIS	What	How	What you get
DYNAMIC SIMULATION	Analysis of the energy behaviour of the state of art	With dynamic software	The dynamic simulation provides the reference values of EP, which represents the index value of energy performance for heating the building.
	Comparison between the status quo and after the realized interventions	To refer to the detection data of the status quo prior to the intervention of retrofit, to be compared after the intervention	Allow to have a parameter to be compared with the actual consumption recorded in the energy bills.
INSTRUMENTS OF DETECTION	Measurements of the internal and external conditions (via WSN).	Identification of measurement points. The measurements include both the WSN system installed in study areas (for a period of at least one year) that the measurements required to micro-climatic characteristics IEQ (Indoor Environmental Quality).	Assessment of the overall level of microclimatic comfort by measurement of thermo-hygrometric-environmental parameters. Measure the following environmental parameters: - Temperature and Humidity - Speed - Radiometry - Heat flow - Gas concentration - Meteorological parameters - Air speed; - Vertical difference in temperature; - Radiant asymmetry.
	Infrared thermography (IRT)	Acquisition of different sequences of images in different thermal situations.	Evaluation of the heat loss of the walls
	The measurement of the thermal transmittance of the walls	R-Log in combination with a calculation software	Allow to determine the factor "U", thus defining the insulation characteristics of the building envelope.
THERMOREGULATION AND ANALYSIS OF CONSUMPTION	Thermoregulation instruments	- Actuators for fan coils and fans - Controllers for electro thermal positioners and valves - Electronic Actuators for control of electro thermal positioners	Saving on the use of cooling/heating air conditioning: switch on, off and regulation. Based on the presence of people; Based of time sheet (on only during the day; Based on signals / contacts (e.g. opening windows)
	Energy Management	Interface for counters	Monitoring and visualization of electrical consumption. Accounting, optimization of the consumption, supervision, assessment for energy savings with the use of building automation. Exposition on web

			of the consumption and savings energy trend (IP interface)
		Comfort Touch Module of monitoring and loads control	Monitoring of energy consumption: consumption metering, monitoring and supervision. Export (manual or automatic) of the data, format .csv; Possibility to automatically export data stored in a folder dedicated network. Improving energy efficiency in buildings and at the same time, integration of electrical appliances also in the process of energy demand management. Control / switching loads: on an hourly basis, on the basis of consumption thresholds
	Room Automation	Room Master Room controller	Use a single device for automation and control of all functionality of a room (lighting, temperature control, roller shutters, window contacts / leads, ...). The considerable reduction in wiring simplifies the plant installation, which can be extended as desired with the addition of new modules (Room Controller) or by exploiting the input / output available (Master Room).
	Access Control	Readers of transponder Pocket transponder Room thermostat	Activation of electrical users and thermoregulation plant system of a single room in the presence of people. Possibility to find a comfortable climate to arrival through the use of scenarios controlled by the monitoring software. Checking the status of each room (employment, cleaning / maintenance), and it's possible send messages and notifications.
	Checking the energy bills and / or requests for transmission of annual consumption	Evaluate the cost in the energy bill of real consumption	This operation (which must be done by the operator or by the administration itself) allows you to check costs and verify it with consumption data collected by instrumentation
REMOTE CONTROL	Programs on PC	Analysis of data collected	• Program automatic data transfer from module "Master" on PC, also via GSM / GPRS

			modem and radio • Program management data (tables, graphs and measurement reports) • Program for the calculation of microclimatic indices (modules moderate rooms, hot and cold) • Program for the calculation of thermal insulation of walls (factor "U")

The monitoring is important to evaluate it through sophisticated environmental control systems, to measure temperature, relative humidity, lighting, and it should take into account the various external and internal environmental issues to which they are subjected the buildings and their technical systems of which it's necessary assess the activity.

	wood (floors, inlays, furniture, structures)	**silk tapestries and velvet**	**marble and stone**	**paintings on canvas**	**books and manuscripts**
Factors thermo-hygrometric and air quality	Ur = 45-60 %, t = 19°-24° C	Ur = 30%-50%, t = 19°-24° C	Ur = 30%-60%, t = 15°-25° C	Ur = 40%-55%, t = 19°-24° C	Ur = 50%-60%, t = 13°-18° C

Matrices of congruence between environmental factors for the conservation of materials and the conditions of comfort for individuals

LEGEND			
	High	**Ur**	Relative humidity
	Medium	**t**	Temperature
	Low		