Ref. Ares(2014)2230392 - 04/07/2014

EUROPEAN COMMISSION
INFORMATION SOCIETY AND MEDIA DIRECTORATE-GENERAL

competitiveness and innovation framework programme 2007–2013

DELIVERABLE

Project Acronym:	**VERYSchool**
Grant Agreement number:	**297313 for CIP-Pilot actions**
Project Title:	**Valuable EneRgY for a smart School**

D6.1 Pilots Implementation

Revision: V4.1

Due date of deliverable:	**31/07/2013 (M20)** (as in Annex 1)
Draft submission date:	**01/12/2013 (M24) - version 3.0**
Final submission date:	**11/12/2013 (M24) - version 4.0**
Review submission date:	**03/07/2014 (M30) - version 4.1**

Main Authors: **Paolo Onesti (DOKI), Stefano Ranuzzini (AESS)**
Co Authors: **Liyana Adjarova (EAP), Sara Piana (CDG), Neuza Rosa (EPRO)**

Project co-funded by the European Commission within the ICT Policy Support Programme		
Dissemination Level		
PU	**Public**	**√**
PP	Restricted to other programme participants (including the Commission Services)	
RE	Restricted to a group specified by the consortium (including the Commission Services)	
CO	Confidential, only for members of the consortium (including the Commission Services)	

REVISION HISTORY AND STATEMENT OF ORIGINALITY

D6.1 Pilots Implementation

WP6:**Demonstration** (*putting into action*)

Document Control

Project Coordinator: **AESS** (*Alfio Galatà*)

Work Package Leader: **EAP** (*Liyana Adjarova*)

Task 6.1: Pilot Preparation - Leader: **AESS** (*Stefano Ranuzzini*)

Task 6.2: Pilot Installation - Leader: **DOKI** (Paolo Onesti)

Deliverable 6.1 - Leader: **EAP** (*Liyana Adjarova*)

File Reference: **D6.1 Pilot Implementation**

Statement of originality:

This deliverable contains original unpublished work except where clearly indicated otherwise. Acknowledgement of previously published material and of the work of others has been made through appropriate citation, quotation or both.

Version Control Record

Rev.	Date	Description	Author
V4.1	03/07/2014	Revised Final Version	AGa
V4.0	11/12/2012	Final Version	AGa
V3.1	07/12/2013	Review of the final version with Appendixes	Pilot Leaders
V3.0	01/12/2013	Draft version submission to the EC PO	AGa
V2.3	29/11/2013	Review D6.1 and creation of Appendix D: LISBON Pilot	POn, JSa
V2.2	29/11/2013	Review D6.1 and creation of Appendix C: PLOVDIV Pilot	POn, LAd
V2.1	29/11/2013	Review D6.1 and creation of Appendix B: GENOA Pilot	POn, SPi
V2.0	29/11/2013	Review D6.1 and creation of Appendix A: LESA Pilot	POn, SRa
V1.0	20/11/2013	First document delivered for comments and additional content.	POn

Table of Contents

Table of Figures

1 Executive Summary

The integration of Pilot **BEMS** into VERYSchool platform is one of the core aspects of the overall application called **VSNavigator**. Deliverable **D6.1** ***Pilots Implementation*** describes the result of Tasks 6.1 *Pilot Preparation* and Task 6.2 *Pilot Installation*, both developed under Work Package WP6 Demonstration (putting into action), and it refers to the activities carried out in the four project Pilots: Lesa, Genoa, Plovdiv, Lisbon.

More in detail, deliverable D6.1, considered with its Annexes A ÷ D, provide an exhaustive documentation of the four real-size DOKI BEMS installed in the Pilots, as results of:

- **Task 6.1** ***Pilot Preparation***, which includes the following activities:
  - Pilot Committee meetings and planning;
  - review of the general information and state of the existing plants gathered with the energy audits performed with Task 5.1 in the four Pilots;
  - review of the Pilot area taking account of the boundaries related to the different environments and needs of everyday operation;
  - adaptation of the initially selected technical solutions to the peculiarities of the four installations, considering feedbacks received by the Entities supporting every Pilot;
  - considering for implementation the recommendations provided by the Project Reviewers "*to commit the project to further optimising its eventual results' replicability by integrating at least one further communication protocol with its solution*", as well as to guarantee "*Replicability and Interoperability*";
  - consultancy of external technologies suppliers and with project partners, specially with those responsible of the High Level SW of VSNavigator;
  - preparation of all necessary documentation for the single component, for the wiring of every classroom/premise and for the complete Pilot;
  - all preparatory works, such as masonry work and drafting of electrical cables, necessary for the DOKI BEMS installation.
- **Task 6.2** ***Pilot Installation***, which includes the following activities:
  - phases of design, commissioning, production and purchase, as well as the equipment configuration or customization (hardware & software) for the DOKI BEMS installation in the four Pilots;
  - delivery of all equipment to individual Pilots;
  - physical installation of the DOKI BEMS in each Pilot;
  - management of emergencies and last minute changes;
  - on-site Pilot's visits to check and perform functional tests of the installed equipment, in order to be ready for start the experimental campaign with the local automatic monitoring and control system and remote communication with VSNavigator, so leading to a full operativity of the four Pilots and VSNavigator.

1.1 Working Group

AESS led task T6.1 Pilot Installation whereas **DOKI** led task T6.2 Pilot Installation. **Pilot Leaders EAP**, **CDG** and **EPro** were actively involved in the development of both tasks. Enerit, IES provided contents and contribution to Task 6.2 activities. Feedbacks and progresses of work were assessed through regular web conferences or Pilot Committee and Consortium Technical Meetings.

1.2 Document layout

The content of the document is structured in several chapters, as detailed in the following table.

Chapter 2	**The VERYSchool Pilots**. It describes the general aspects of the VERYSchool Pilots, the preparation activities to select the Pilot area and to design the Pilot customized BEMS. The boundaries deriving from different, but existing, infrastructures and operation needs of the Schools are also highlighted and detailed in terms of buildings, users and project constrains.
Chapter 3	**The VERYSchool BEMS**.It analyzes the guidelines to delivery a BEMS with common performances to all Pilots, although the BEMS design has been customized in terms of control networks with communication protocols implemented on wired and wireless solutions. More in details, this chapter describes, between other aspects, • the criteria for selecting a BEMS solution able to be applied in all Pilots, • the need for developing a standardized and pre-configured project control box to simplify the installation and communication processes, • the adaptation of the identified BEMS solution to the peculiarities of the four installation, • the criteria of selection of the sensors, actuators, and controls, with quantitative information of the equipment supplied and installed in all Pilots. • examples of drawings depicting the layout of a Pilot BEMS control network as well as drawings of the control performances in a typical classroom.
Chapter 4	**DOKI BEMS: Technical manual** It contains the DOKI User Manual, with the objective of suppling a document able to document and facilitate the use the DOKI System and investigate on the status of the different Pilots.

Moreover, the following Annexes are delivered as external document to provide contents of the Pilot BEMS design and how to put in practice, in each Pilot, the local and remote management of sensors, actuators and controls for maintaining the settled environmental parameters.

Annex A	**LESA Pilot**, which is the first demonstration and validation scenario of VSNavigator.
Annex B	**GENOA Pilot**, which is the second demonstration and validation scenario of VSNavigator.
Annex V	**PLOVDIV Pilot**, which is the third demonstration and validation scenario of VSNavigator.
Annex D	**LISBON Pilot**, which is the fourth demonstration and validation scenario of VSNavigator.

1.3 Glossary and Acronyms

BAS = Building Automation System
BMS = Building Management System
BEMS = Building Energy Management System
EAM = Energy Action Management
EAN = Energy Action Navigator
EPDB = Energy Performance of Buildings Directive
EMP = Energy Management Programme
EnMS = Energy Management System
ESAC = Energy System Automated Control
ESP = Energy Saving Program
HLS = High Level (Very School) Software
HQDS = High Quality Data Sets
HVAC = Heating, Ventilation and Air-Conditioning
KPI = Key Performance Indicators
ICT = Information and Communication Technology
IP= Internet Protocol
IPMVP = International Performance Measurement and Verification Protocol
LAN = Local Area Network
M&T = Monitoring & Targeting
OS = Optimization Scenario
RET = Renewable Energy Technology
SEU = Significant Energy Users
SL = Smart Lighting
SM = Smart Metering
TCP= Transmission Control Protocol
URS = User Requirement Specification
VPN= Virtual Private Network
VSNavigator = VERYSchool Navigator
WAN = Wide Area Network

2 The VERYSchool Pilots

One of the main challenges of the VERYSchool Project is to address "*four different but existing school buildings*", in which there are clear limits of possible interventions to optimize energy consumption.

From the indoor comfort conditions, affecting thermal and visual requirements, schools are a specific because, normally, they apply without any Energy Management Programme (EMP) aimed at the optimization of both energy consumptions and comfort.

In particular, in most buildings the temperature set point is taken at best in one specific place, e.g. in each floor, and the user's comfort, which normally sitting in the class/activity rooms, is obtained by a very loose correlation.

Indeed, optimal lighting is mostly achieved by the designing of lamps and luminaries in each environment, but there is no guarantee that visual comfort conditions are maintained regardless of their actual need and power consumption. Moreover, in most cases, there is no feedback on the actual results and on the lighting energy consumption, as the main "measurement system" is the sensation of good or poor comfort as perceived by the school students/pupils, teachers and staff.

The DOKI BEMS (Building Energy Management System) or Energy System Automated Control (ESAC) is an evolution, as it has the main objective of managing the energy patterns within the each room of the school Pilot area, basically controlling sensors and actuators to obtain and maintain the optimal comfort conditions requested by the regulatory standards and the specific school EMP. The result for VSNavigator is the local optimization of energy consumptions and an open environment which allow, on request, to implement any "*energy management scenarios*". In particular, DOKI BEMS allows to transform the "*school scenarios*" affecting the automation performances proposed by the VSNavigator into "*real time execution scenarios*", extended to the whole Pilot area or specific rooms, thanks to the distributed, sensors and actuators, monitoring and control network.

In general, and for all Pilots, preparation activities can be reported as following:

- analysis of Pilot schools' main characteristics;
- analysis of Pilot schools' main equipment and plants;
- analysis of Pilot schools' boundaries;
- discussion of special requests of the Pilots schools' managers;
- selection of internal communication solutions able to overcome the practical boundaries of the existing buildings and
- selection of the Pilot dimensions and of the type and number of the rooms to be equipped with the DOKI devices.

2.1 Survey of the general aspects of the VERYSchool Pilots

With the modest goal of representing the European school dimensions, the VERYSchool Pilots are differentiated by type of school activities, e.g. nursery, elementary, primary and secondary schools, and they are scattered in different European Countries, e.g. Italy, Bulgaria and Portugal.

Figure 2-1: the four VERYSchool Pilots

The Pilot schools incorporate the following main and common characteristics:

- they have different construction years and construction methods, leading to a different evolution;
- they have followed, and still follow, different building and plant rules as well as different regulations;

- they have very different energy's plant installations, both from the technological point of view and methodology of use;
- over the years, they have received several retrofitting actions, still generating non-homogeneous solutions in the same building or complex of buildings.

As a basic starting point, the main buildings reference data are included in the following figure [1]:

Figure 2-2: Comparison table of basic characteristics of school Pilots

Some basic characteristics of the buildings of the Pilots					
		Lesa	**Plovdiv**	**Lisbon**	**Genoa**
1	Country	Italy	Bulgaria	Portugal	Italy
2	Construction year	1970	1962 & 1985	1900	1985
3	Climatic area	Continental temperate	South East Europe continental	Atlantic	Mediterranean
4	Type of school	Primary school	Secondary school	Secondary school	Nursery, Kindergarten
5	Type of structure	Single building	Multi building	Multi building	Multi building
6	Pilot floors	1	1	2	2
7	Construction materials	Mixed, bricks and concrete	Mainly reinforced concrete	Mixed, stones and bricks	Mainly reinforced concrete
8	Energy Indicator	**35,56** [kWh/m^3]	**44,92** [kWh/m^3]	**10,73** [kWh/m^3]	**25,14** [kWh/m^3]

These features convince for getting a more specific vision to set the requirements for designing the best BEMS solution for VSNavigator in the four schools. On-site technical visits and robust preliminary investigations of all the features in the four Pilot Schools immediately demonstrated that:

- energy consumptions were poorly optimized, due to the age of buildings and the existing installations;
- the objective to manage a huge amount of rooms were rarely considered together with the limited diffusion of BEMS;
- the implementation of cost-effective solutions, even in the current economic difficulties which affect school managers, are always not a priority.

The selection of the Pilots areas, considering the budget availability in the VERYSchool project, was homogeneously limited to a total number of classrooms, corridors, toilets and other rooms of about 20 premises in every Pilot [2]. LESA and PLOVDIV have the Pilot area on the same floor; GENOA and LISBON have Pilot area on two floors.

The following figure is a resume of the type and number of rooms for each Pilot.

Figure 2-3: Type of indoor spaces selected on the Schools Pilots.

Dimensions of the premises of the selected Pilots					
		Lesa	**Genoa**	**Plovdiv**	**Lisbon**
1	Pilot floors	1	2	1	2
2	Class rooms	9	9	9	7
3	Entrance, Lobby, Corridors, Stairs	1	4	5	2
4	Libraries	-	-	2	1
5	Office rooms	-	-	-	1
6	Bathrooms	3	2	2	1

The requirement to develop the BEMS followed the guideline of a unique Monitoring & Control application

[1] These data are a very limited selection of those assessed with the accurate energy audits, described in detail in the project deliverable D5.1 and its Annexes.

[2] During the Pilot preparation activities, the number of premises and the type of equipment of some Pilot areas changed, depending on specific needs of the Schools Managers (Plovdiv) and on change of destination of one part of the building itself (Lisbon).

which has:

a) to fit with a large variety of indoor space needs and existing plants in remote geographical areas;
b) distributed architecture with modules embedding firmware and software and more than one communication protocols;
c) to allow both a local and remote management (web access tool).

2.2 Boundaries deriving from different environments and operation needs of the Schools

Buildings constraints:

- The differences in the ages of the School Buildings implies several different types of construction materials and technologies, spacing from bricks to concrete and from stone to new materials.
- Different types of technical installations (i.e. electric and heating or cooling plants) impose a customized project and solutions.
- Pilot areas are in the situation of not being able to be electrically and thermal isolated from rest of buildings, as energy supply to the whole school building and to the Pilot selected area pretty much in common.
- Great difficulty in executing wiring and piping concealed in the walls as it would require a massive work not planned, nor budgeted for.
- Large distance between classrooms/utility areas and control rooms: this suggested in some situation the use of a point to point Wireless connection (i.e. in Lisbon and Genoa).
- Large physical distance from SCE/DOKI (Modena) with two of the Pilots and need of interfacing several different plant installers, speaking different languages, with waste of time and energies.

User constraints:

- Security (regulated access to the building, to the installations and to the local network, based on the need of respecting legal and regulatory issues, to avoid risks of various type, i.e. electric shocks, etc.).
- Accessibility (most deployments must be done during school holidays, or must be developed in hours in which are not provided school activities).
- Aesthetic aspects as is not possible to “hide” completely the wiring and the modules requested to install the DOKI/SCE BEMS, and new wiring should be made with materials similar to that of the existing ones.

Project constraints:

- Manage severe costs limitations for the materials and the installations.
- Obtain a truly scalable solution, with a unique customization of firmware on an industrial existing and proven hardware.
- Guarantee maximum interoperability with minimum effort.
- Set up an easy and friendly interfacing structure.
- Set up a system serviceable and manageable in both local and remote mode.
- Set up a low cost and high reliability communication system to link several points, transmitting and managing data with high level of security.
- Guarantee the correct operation of each room’s BEMS also in isolated and local operation, in case of failure of the supervisor or of the LAN.

3 The VERYSchool BEMS

3.1 Selection of a BEMS solution able to be applied in all Pilots

The requirement for the VERYSchool project was for a proven hardware solution of the customized DOKI BEMS technology that should avoid basic problems of functionality and reliability. Putting into practice this requirement, the choice also contributes to optimize the costs of the project as the development of a new industrial HW are very high.

But, typically, a BEMS requires a fair amount of electrical and plumbing installation and a strong interference with the activities of the school itself. And, the installation of monitoring and control modules, including the power supply, connection of terminal blocks, power switches and network connections, can lead to a number of errors in wiring, disruption of achievement, and needs of redesign the wiring documentation after the completion of the installation.

This constrain was evident during the installation of Lesa, the first Pilot equipped. In the first BEMS installation, wiring the naked EVO modules and power supplies into the existing old plants and electrical cabinets, together with the:

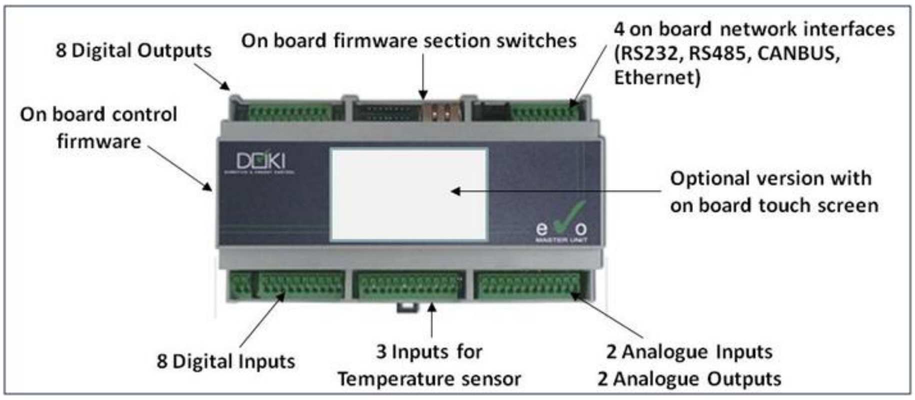
- lighting, presence, temperature and windows contact sensors,
- electrical valves actuators,
- energy meters,
- EVO master units, and
- interface, networking and communication devices.

required a big amount of manual work.

For the Lesa Pilot, the EVO Master Hardware system was provided with a customized firmware, software and in general system solutions, is depicted in the following basic figures.

Figure 3-1: box hosting only the EVO Master unit

Figure 3-2: EVO Master Module with I/O and other connections



To make simpler the installation, but standardized, of the DOKI BEMS in the other Pilots it was decided to develop a pre-wired control box instead of providing discrete components to be installed on site. This solution allowed to perform, in the SCE/DOKI laboratories, the necessary safety tests, electromagnetic compatibility and inspections of thermal stress for the equipment and, above all, the customization of the control unit to the specific room to be controlled and monitored. This development introduced a common architecture of the control network, and independent by wired or wireless configurations [3], and a standardisation and the firmware even in presence of room customisation needs.

Thereby a considerable increase of the commitment in the project, and increasing assembly and testing phases in the production, was reached although the choice led to an increase of budgeted costs for the partner SCE/DOKI.

The Pilots that adopted this new solution, Plovdiv, Genoa and Lisbon, have been greatly simplified the BEMS installation. In the following some images of the new control unit are shown.

[3] Lesa, Plovdiv and Genoa have installed a wired control network; Lisbon has a wireless control network.

Figure 3-3: EVO boxes for Standard Rooms, for Energy Measurements and Wireless EVO Unit

This solution has been extended also to the energy monitoring units, which include electrical thermal measurement, in the Pilot and in the School and in renewable plants where they exist.

The following figure is reporting the type and number of units installed in each Pilot. Further details are documented in the Annex of each Pilot.

Figure 3-4: Number of EVO modules in the 4 Pilots

Type and number of installed EVO Master Modules					
	Nr. Of Control Boxes	**Lesa**	**Plovdiv**	**Lisbon**	**Genoa**
1	Room Units	**13**	**18**	**16**	**20**
2	Energy Units	**3**	**3**	**2**	**3**

The wireless solution of the control network, chosen in the Lisbon Pilot, has been developed both for demonstrating the same functionality with another communication protocol [4] and for solving some practical connection problems in specific areas of the Pilots.

For the remaining BEMS equipment, an accurate selection was carried out following the needs and opportunities of the applications in the different Pilots:

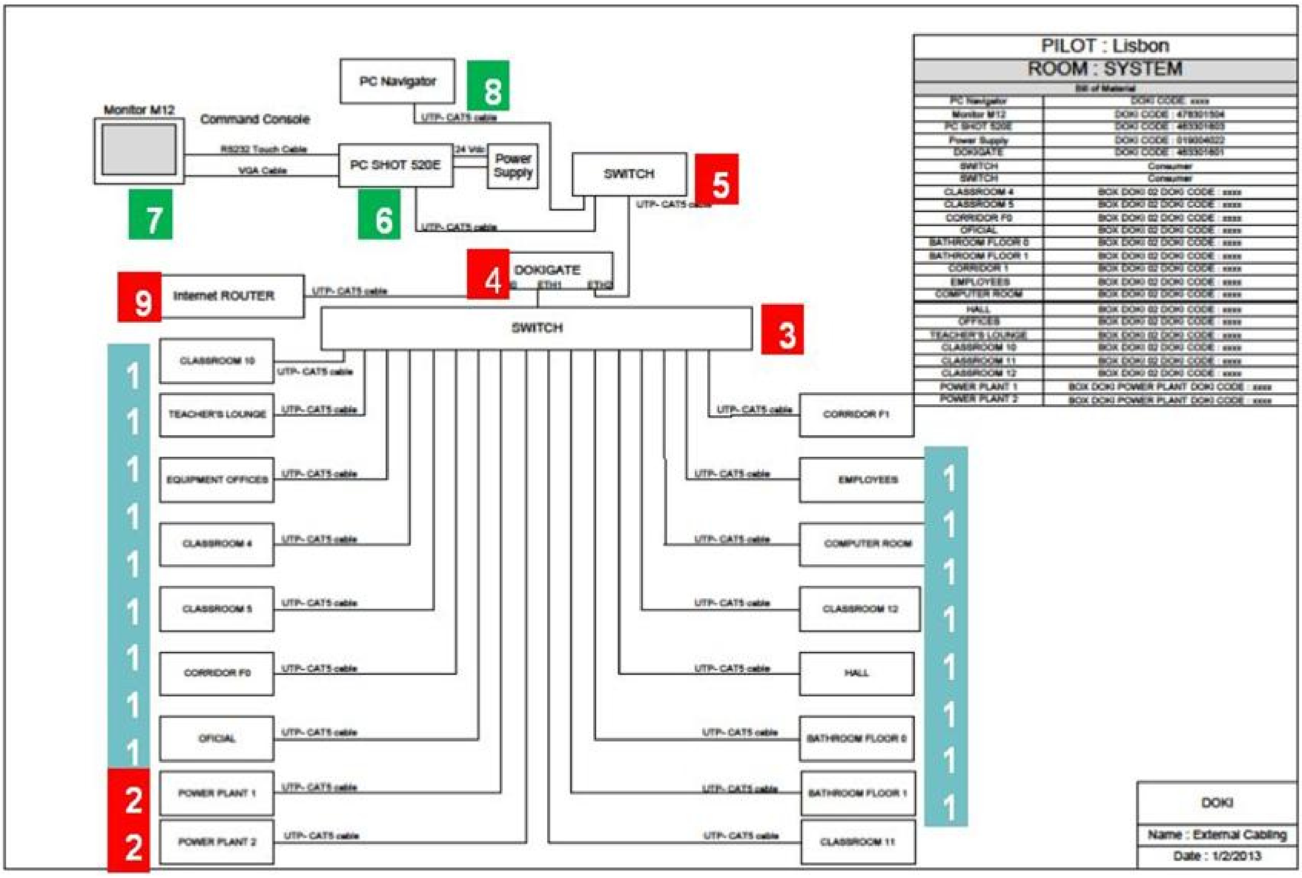
- temperature is measured with PT1000 sensors, unified for both for internal and external allocations,
- presence is detected with Presence sensor, i.e. Finder 182182300300,
- light and presence are detected with Integrated Light and Presence sensor, i.e. ThebenHTS201-4-001,
- windows opening is detected by VIMO CTE020 sensors,
- heating is controlled by electric valves, purchased by IVAR, of different models to fit with the existing radiators,
- electricity consumption or generation (for schools with photovoltaic plants) is measured with ALGODUE UEC80-4A and TS232 adapter devices,
- thermal energy consumption is measured by Smart Calorie meters IVAR G04/2150 + adapter in Genoa, while for plant reasons Plovdiv has been equipped with Sonometer 1100+Pulse generator + adapter.

[4] this was a recommendation of the EC PO and the Reviewers with the outcome letter of the first project review meeting.

3.1.1 *Example of data wiring for a complete Pilot*

The drawing of the overall control network, i.e. with connections of all control boxes, fits perfectly to the need of having an exhaustive documentation of the "local" wiring for all the individual classrooms/premises. The drawing is part of the complete Pilot plant. The figure below shows an example for one Pilot [5].

Figure 3-5: example of data wiring for a complete Pilot



The meaning of the reported number is as follows: 1-EVO Module room A/B; 2 -EVO Module energy meter; 3&5 - Internet Switches; 4 – DOKI Gate Switch; 6 – PC SHOT Supervisor; 7 – Touch Screen Display; 8 - PC Navigator to HLS.

The overall solution involves the use of two separated PC: the first one to run the user interface either locally (via touch-screen display) and remotely (via a standard internet connection); the second one is devoted to the data communication with the HLS [6].

The solution to use two PC was adopted by requirement of maintaining the two performance as much as possible separated and independent each other.

A dedicated device manufactured by SCE/DOKI, the DOKI GATE, is responsible for managing all data and communication conflicts at a high level, including the single connection via the Internet.

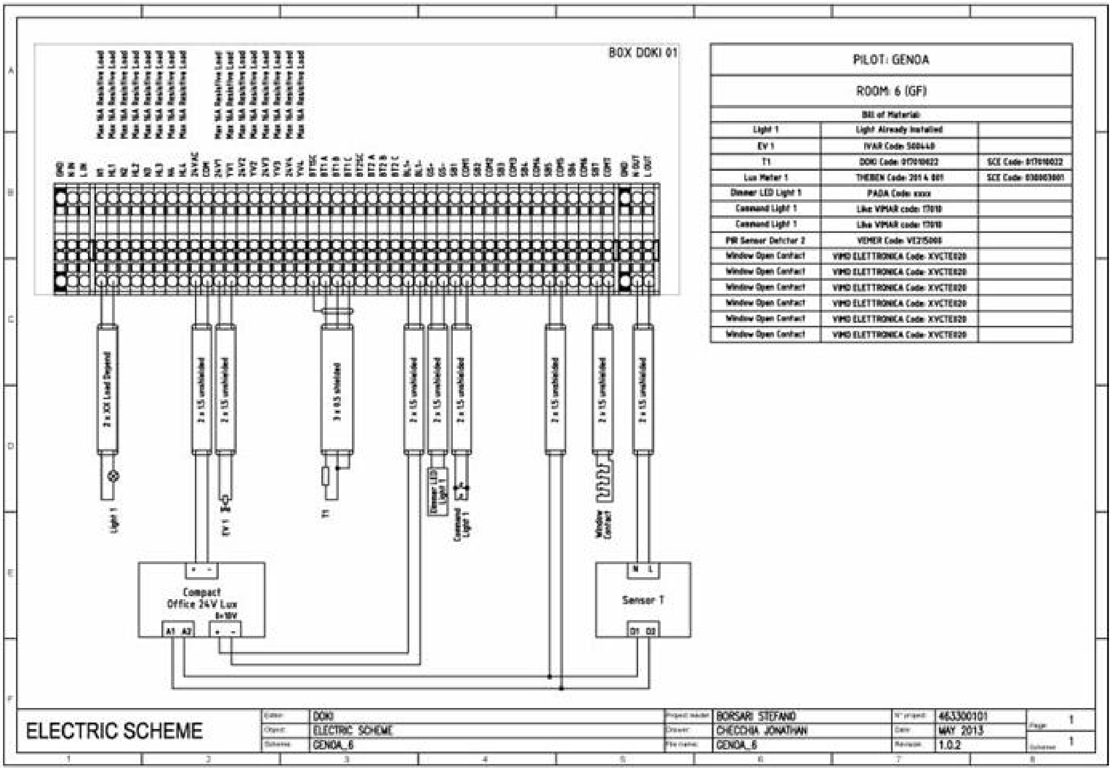
3.2 Example of wiring for a typical Classroom/Premise

Even if Hardware, Firmware and Software of the Control Module unit are pre-configured and standardized for each classrooms/premises, every control unit is interfacing a different room and consequently a different wiring has to be put in action.

[5] In this example, control boxes are wireless communicating.
[6] Data are transmitted from the Pilot BEMS to VSNavigator each 5 minutes.

The following is a typical schema of a classroom configuration, with sensors, actuators and general wiring connection specifications.

Figure 3-6: example of wiring for a classroom with 1 temp probe, 1 light measurer, LED lights, etc.



The BEMS drawings of each Pilot are detailed into the related Annex, external to this document.

3.3 Adaptation of the selected solutions to the peculiarities of the four installations

A great effort to develop as much as possible “standard solutions” for sensors, actuators, control units, measuring instruments, networking devices, communication and interfacing tools. Nevertheless, local constrains and boundaries of existing buildings and plants, in some cases compelled to customize the solutions to the specific needs of the single pilot.

The specific adopted solution for every Pilot can be found in the four Annexes (external to this document) devoted to the Pilots themselves, but just to supply some basic information hereafter a summary of the solutions adopted to overcome specific problems is included.

1. *Sensors*: temperature sensors have been standardized in PT 1000 thermo resistors; the sensors have been chosen in a basic 3 wires solution with IP67 protection. To comply with internal and external application a plastic fit has been adopted.
2. *Actuators*: the only actuators are the ON/OFF valves. SCE/DOKI selected the products of IVAR, a well known producer of thermostatic valves and other devices connected to heating and piping. In the Plovdiv plant valves have been supplied a by a Bulgarian reseller of Dunfoss, to maintain uniformity in the devices already installed in the School.
3. *Control units*: all rooms/premises and power control units have been identically shaped in only two models, one for the rooms and one for the power measurements. Also if electronic units are identical, the drawings for the single boxes have been customized to help as much as possible the local installer in the understanding of the work and to create a professional documentation for the work to be done. This also extended to the drawings showing all the connections between modules and other devices for each pilot. For technical documentation please see the Annexes of the four Pilots.

4. *Electrical smart meters*: devices have been chosen from a family of instruments which may handle 1 or 3 phases signals and a large variety of current. For this reasons every pilot's instrumentation has been customized to its specific need, so to fit at best and with the maximum resolution of every application.
5. *Thermal smart meters*: the basic selection was that of adopting the IVAR smart meter equipped with integrators to supply a pulse every kWh of measured energy consumption, through the plant pipes. Nevertheless, to comply with existing devices and instruments service company of Plovdiv, a Dunfoss no-contact flow meter was adopted for this specific pilot.
6. *Basic networking devices and types of networks* are the same for all pilots, being constituted by a couple of industrial PC's and some customized switch. Nevertheless, every PC DOME, physical interfacing unit, has been charged with a customized interface to take into account the local configuration of every pilot on the basis of number of classrooms/premises and energy measurer layout. Moreover, wireless interconnection instead of the wired one has been used in all rooms of the Lisbon Pilot; indeed, for Genoa a wireless point to point connection has been set up for connecting the remote thermal smart meter with the general control system.

3.4 Heating/cooling equipment

A great challenge for the Pilots is the need of maintaining an optimal thermal comfort in each classroom and indoor space together with the objective of achieving important savings in energy consumptions, and related costs, mostly spent for heating.

The preparation of the Pilots in view of the DOKI BEMS installation had obviously taken into account the existing heating and/or cooling plants. A completely different situations were found among the four schools, mostly for:

- the type of heat generation,
- the choices of radiators, and
- the systems of temperature control.

Moreover, most part of the inspected plants (excluding the Genoa Pilot) are obsolete and with:

- very old and low efficiency heating boilers,
- systems for throttling the flow of hot water with manual control only,
- ancient radiators and poorly positioned,
- temperature control systems that operate only thanks to a single internal temperature sensor for the whole building,
- management of the cycles of heating and temperature based, in the best of cases, on the experience, with no feedback procedures.

A small selection of photos documenting some aspects of the original heating systems in the four Pilots is included hereafter.

Figure 3-7: Heating plants and radiators in Plovdiv

Figure 3-8: Heating plants and radiators in Lesa, Lisbon and Genoa

In one case (the Lisbon Pilot) heating is not a primary need, so heating is provided with mobile electric oil radiators or splits mounted on wheels and positioned in the rooms, to satisfy the thermal comfort needs of the moment.

The solution of studying a unique BEMS control unit was also rather complicated because of the district heating supply in one of the Pilots (Plovdiv). This fact introduced a further rigidity in the management of any interventions on the pipes for the insertion of the flow meters and the temperature sensors for the hot water. The problem was solved selecting a heat measurer which may be inserted outside the pipes, solution which could require a periodic calibration to ensure the best precision.

To obtain a “granular” temperature control, i.e. in each classroom and indoor space, the adopted solution was to install at least one temperature sensor for each room (coupled with the presence sensor used also for the lighting control) and ON/OFF thermostatic valves for every radiator. Depending on the room/space configurations, radiators are controlled individually or as “group” of maximum 4 unit.

Figures below shown some typical installations.

Figure 3-9: Temperature sensors and ON/OFF valve on radiators.

Most of the installation did not have an external temperature sensor, so only the internal temperature in a single fixed point is used to control the heating of all the building. The four Pilots are now equipped with one external temperature sensor.

With the exception of the Lisbon Pilot, cooling is not considered in the schools. Lisbon has some cooling installation, but air units were very old and the BEMS application of specific controls was found very difficult. Anyhow, in view of activation of new cooling devices, the BEMS supplies in each room a ON/OFF temperature signal to be managed according to the further specific model of air conditioner.

3.4.1 Temperature Sensors

Temperature sensors are the basic tool to pick up the temperature in a specific environment, so to be able to interface the physical dimension and transform it in a electric variable able to be managed by control unit.

In the VERY School Project, temperature management of the single room/premise is one of the fundamental tools to manage comfort conditions and energy consumption. The EVO Master Room units handle a FW PID procedure which, starting from the temperature measured by the local sensors, may control on-off or continuous regulation of temperature, acting on valves of the correct type.

In the VERY School project all valves actuators are of the on-off type.

To obtain better results in the regulation, all EVO Modules, through the local LAN, receive also the external temperature picked up by an unique external sensor.

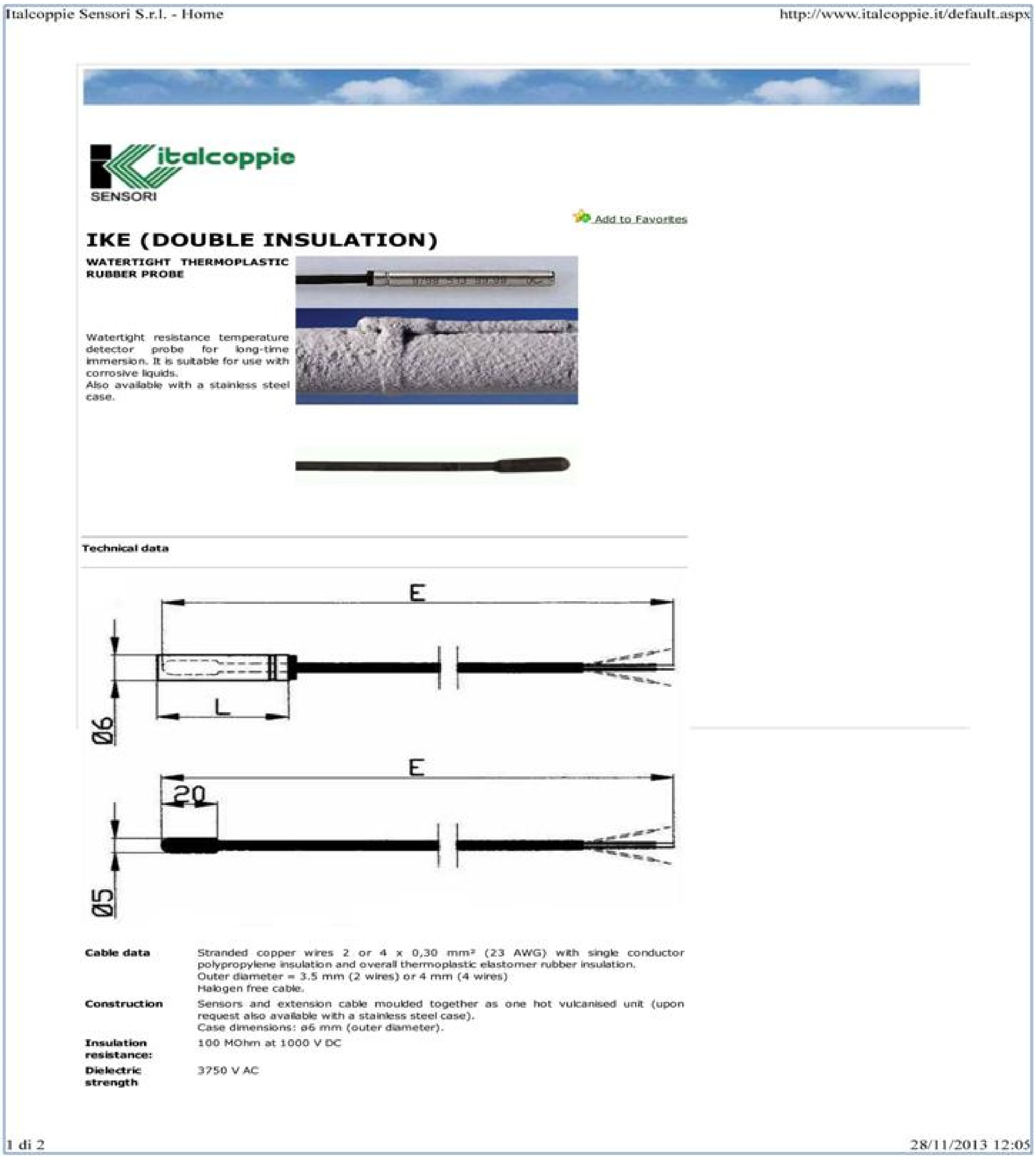
The selected brand is Italcoppie, a well established manufacturer which controls all the phases of research and production of these devices.

This device was selected for (i) the adherence to the needs of the applications, (ii) the reputation of the manufacturer, (iii) the presence of resellers and service centres, (iv) the cost in line with the budget of the project and (v) the number of available certifications.

Figure 3-10: Italcoppie Certifications

The following figures shows data sheet of the internal and external selected sensors.

Figure 3-11: Italcoppie Internal use temperature probe



Italcoppie Sensori S.r.l. - Home

http://www.italcoppie.it/default.aspx

italcoppie SENSORI

Add to Favorites

IKE (DOUBLE INSULATION)

WATERTIGHT THERMOPLASTIC RUBBER PROBE

Watertight resistance temperature detector probe for long-time immersion. It is suitable for use with corrosive liquids.
Also available with a stainless steel case.

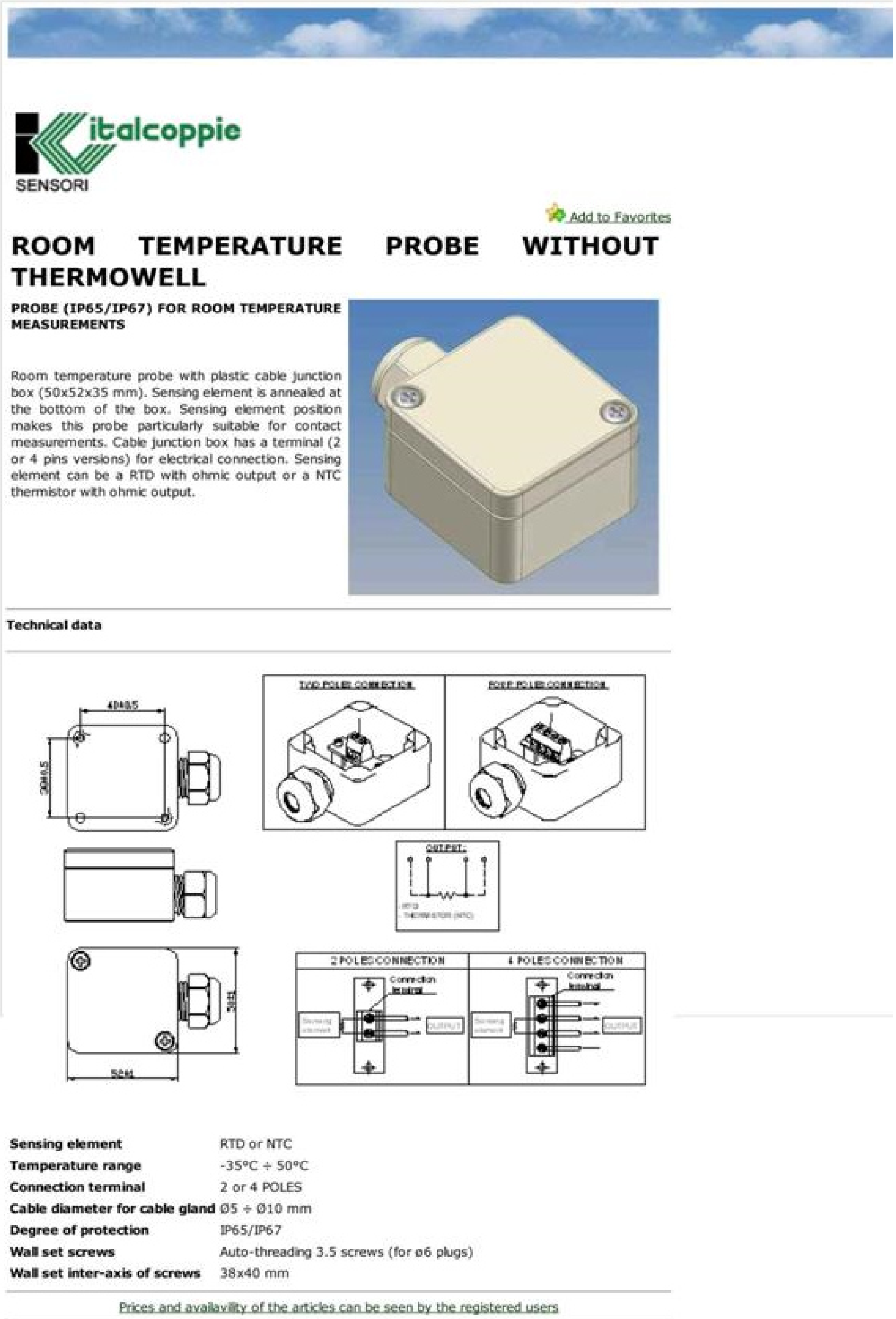
Technical data

Cable data	Stranded copper wires 2 or 4 x 0,30 mm² (23 AWG) with single conductor polypropylene insulation and overall thermoplastic elastomer rubber insulation. Outer diameter = 3.5 mm (2 wires) or 4 mm (4 wires) Halogen free cable.
Construction	Sensors and extension cable moulded together as one hot vulcanised unit (upon request also available with a stainless steel case). Case dimensions: ø6 mm (outer diameter).
Insulation resistance:	100 MOhm at 1000 V DC
Dielectric strength	3750 V AC

1 di 2

28/11/2013 12:05

Figure 3-12: Italcoppie IP67 External use temperature probe



italcoppie
SENSORI

Add to Favorites

ROOM TEMPERATURE PROBE WITHOUT THERMOWELL

PROBE (IP65/IP67) FOR ROOM TEMPERATURE MEASUREMENTS

Room temperature probe with plastic cable junction box (50x52x35 mm). Sensing element is annealed at the bottom of the box. Sensing element position makes this probe particularly suitable for contact measurements. Cable junction box has a terminal (2 or 4 pins versions) for electrical connection. Sensing element can be a RTD with ohmic output or a NTC thermistor with ohmic output.

Technical data

Sensing element	RTD or NTC
Temperature range	-35°C ÷ 50°C
Connection terminal	2 or 4 POLES
Cable diameter for cable gland	Ø5 ÷ Ø10 mm
Degree of protection	IP65/IP67
Wall set screws	Auto-threading 3.5 screws (for ø6 plugs)
Wall set inter-axis of screws	38x40 mm

Prices and availability of the articles can be seen by the registered users

The following figure summarizes the amount of temperature sensors installed in each Pilot.

Figure 3-13: installed temperature sensors in all Pilots

Temperature sensors					
	Type	**Lesa**	**Genoa**	**Plovdiv**	**Lisbon**
1	indoor	14	23	18	13
2	external	1	1	1	1

3.4.2 Windows Contacts

Windows contacts are typically used as components of a security systems, so the market offers a large variety of technical solutions with an open range of prices.

The DOKI BEMS uses the windows contacts (and in particular magnet and reed relays solutions) as a fundamental component of the heating/cooling room temperature control. Every window with the possibility of being opened is equipped with a contact sensor.

Where in a room there were more than one window all contact sensors are connected in series to obtain a unique circuit. The unique or window contacts circuit is then connected to a specific input of the EVO DOKI Room Module. This means that the number of installed sensors may vary for every window, depending on the specific shapes of every windows : it is more correct to speak of "group of contacts" for every window.

Basically the monitoring performance of this component will facilitate the behavioural assessment of providing heating/cooling with windows opened in the room. The DOKI BEMS has been delivered to the Pilots with this control function disabled to allow VSNavigator to discover the anomalous behaviour and to suggest the "optimized scenarios" of closing the heating/cooling (thermostatic valve) when at least one window is opened, so to avoid useless waste of energy.

From the official VIMO Brochure: CTE020 - Magnetic contact for surface mounting with ABS housing

Figure 3-14: Magnetic contacts and detectors for Surface

CTE020: Magnetic contact for surface mounting, ideal for aluminium and wooden surfaces with cover to protect screw terminals. Also available with changeover reed(NA/NC). Spacers also available (on request) for installation on iron doors.

Technical information	**REED CHARACTERISTICS**
Minimum gap 15 mm	*Maximum voltage 200V dc*
Housing Plastic	*Maximum current 500mA*
Approval - Standards CE	*Maximum power 10VA*
Connection 2 terminal block for NC contact	*Initial contact resistance R=0,1Ω*
Reed dimensions 60x13x13 mm	*Insulation resistance $R=10^{12}\Omega$*
Magnet dimensions 60x13x13 mm	*Operating temperature -40°C/+125°C*
Colour White	*MTBF Number of operations 10^8*

The following figure summarizes the amount of windows contact sensors delivered to all Pilots.

Figure 3-15: Delivered or installed windows contact sensors for all Pilots

Windows sensors					
	Type	**Lesa**	**Genoa**	**Plovdiv**	**Lisbon**
1	Windows sensors	45	56	52	45

3.4.3 *Thermostatic Valves*

Valves are the actuators used in the control of heat radiators through the outputs of the EVO Master controls applied in every rooms. Due to the characteristics of plant to renew, the on-off valves allow to manage all different plants with the same FW. Valves go in substitution of the old manual components already existing on every radiator.

The thermostatic valves were selected taking into account:

- the adherence to the needs of the applications,
- the reputation of the manufacturer,
- the presence of resellers and service centres all over Europe,
- the cost in line with the budget of the project and (v) the number of available certifications.

The selection of the specific valve manufacturer was made after the SCE-DOKI technical visit at every site. Basic components selected by SCE/DOKI, to maintain compatibility with existing devices, are products of the IVAR [7] commercial catalogue. As unique alternative in Plovdiv Pilot valves from Dunfoss [8] were purchased and installed.

To give an idea of the need of customisation for this component, below a short table of the Valves used in Genoa Pilot is included.

Figure 3-16: example of Genoa valves selection

Code	Description	N°
500500	Corner valve G 3/8 iron pipe	18
500656	Corner valve holder G3/8 iron pipe	18
500501	Corner valve G 1/2 iron pipe	9
500652	Corner valve holder G 1/2 iron pipe	9
501524F	Electric head 24 VAC	27

Figure 3-17: Example of Ivar valves

Figure 3-18: example of Dunfoss valves

The following figure summarizes the amount of valves units installed in all Pilots.

Figure 3-19: Installed valves in the Pilots

Installed valves					
	Type	**Lesa**	**Genoa**	**Plovdiv**	**Lisbon**
1	ON/OFF valves	25	24	43	0

[7] See http://www.ivar-group.com/.
[8] See http://www.danfoss.com/

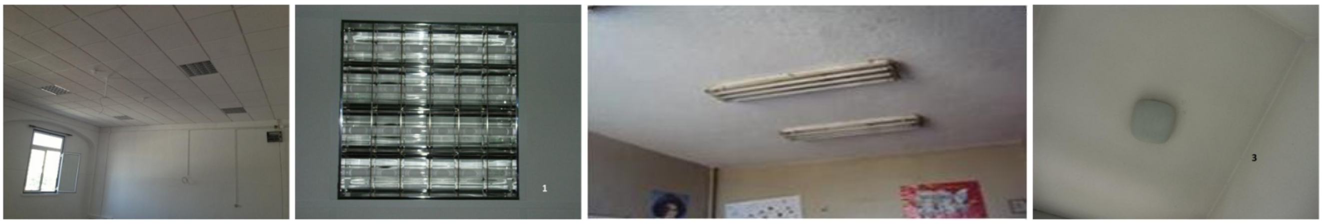
3.5 Lighting equipment

The preparation of the Pilots in view of the installation of the BEMS systems had also to take into account the existing lighting equipment. Lighting equipment in the different Pilots showed different characteristics, both:

- in kind of used lamps,
- in light intensity adopted, and
- in different areas of the same schools.

Figures below shown some existing lighting installations.

Figure 3-20: existing lighting in the four Pilots.

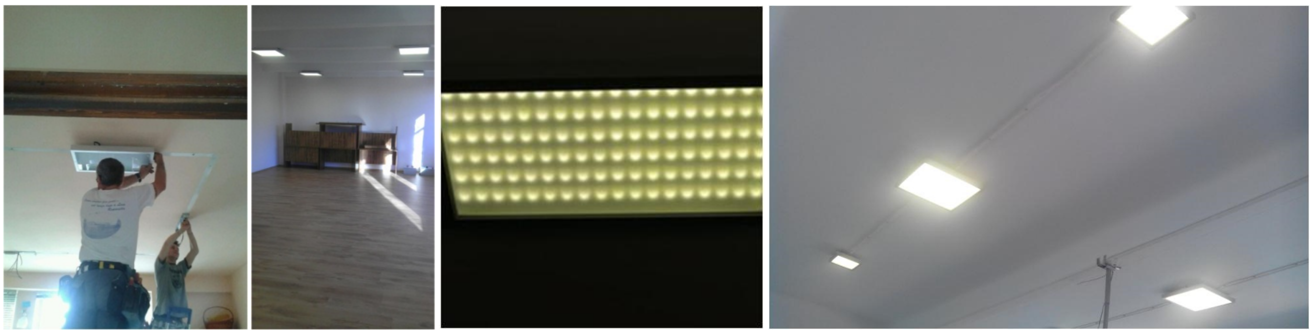


For energy saving reasons, and according to the DoW, LED technology is considered in the VERYSchool project, with the objectives of:

- using lamps requiring less electrical power while maintaining the same, or better, luminance levels,
- using lamps with a longer life than those normally used in the schools, so to reduce maintenance costs and reduce the hourly cost of the used lamps,
- introducing the possibility of modulating the light intensity, so to be able to give a subsidiary lighting and maintain a prefixed minimum illumination intensity without wasting energy as it happens with on-off lighting systems,
- choosing a light temperature of colour, and keep it constant during the years instead of being subject to the progressive loss of intensity and to the reduction of the colour of light typical of fluorescent and filament lights, and
- sparing energy thanks to the efficiency of LED lamps.

Figures below shown some LED installations which replaced the existing lighting.

Figure 3-21: LED replacing existing lighting in the four Pilots.



The selected temperature of colour of the LED lamps was 4000 [°K], which is normally identified with Plain White, or in practice, the average colour of the sunlight. As some Schools in the past made a different choice of colour for the lamps, a fast investigation approved the choice of 4000 [°K] for the colour of the light of the new LED lamps to be installed in all pilots.

The selection of the LED lamps supplier was made considering:

- the possibility of having a product at least certified following the CE standards,
- the need of selecting a supplier able to make a documented choice of power and colour of the light
- the possibility of having a standardized product with a warranty valid in all the EU Countries.

Figure 3-22: LED lights certifications

MADE IN ITALY RoHS Compliant CE

The choice of the electrical power of the LED lamps was based on a comparison table with the existing "traditional" lighting system existing in the Pilots and with requirements imposed by the national regulations; the experience of the LED lamp supplier was also considered.

A fast survey showed that most of the cheap products on the market are produced in the Asia Continent and that most of suppliers do not comply with the previous points. For cost and geographical reasons the well known PADA s.r.l. Italian a company [[9]] was selected as LED supplier. The list of the existing lamps in each room of the four Pilots was provided to the lamps manufacturer, which on the basis of the existing configuration and of the heights of the rooms proposed a substitution schema. For security reasons, a margin of about 10% on the power of the lamps was requested to the LED lamps supplier. The final choice, also approved by the Pilot Leaders, was that 60W, 30W and 16W LED electrical power were enough to comply with the needs of the selected classrooms.

Some LED rooms have been equipped with dimming devices driven by light intensity measurers, while others LED lamps have been installed using fixed power to compare in practice the behaviour of the two solutions.

Due to the presence of very large windows, Plovdiv Pilot required the use of 10 supplementary light intensity measurers to obtain a good behaviour of the lighting systems of rooms equipped with or without LED lamps.

[[9]] See https://it-it.facebook.com/switchonled.it and http://www.switchonled.it/index.php?sl=EN, with a large catalogue of products, mainly for industrial use.

Figure below shows the number and the electrical power of the LED lights installed in each Pilot.

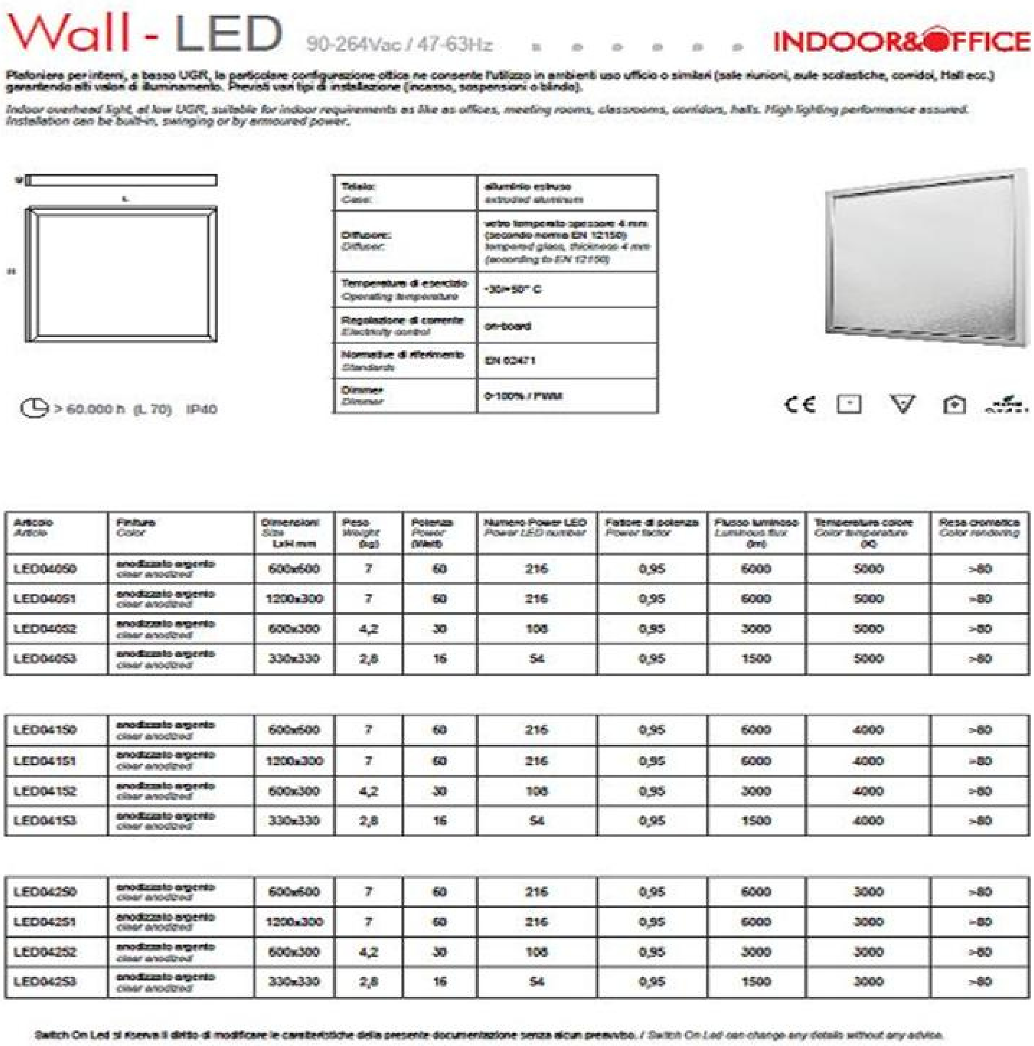
Figure 3-23: fluorescent and LED lamps comparison schema

		Existing Lighting				New LED Lamps					
Pilot	**ROOM ID**	**Nr. Luminaries**	**Type**	**Unit Power [W]**	**Total Power [W]**	**Nr. Luminaries**	**Type**	**Size [mm]**	**Unit Power [W]**	**Total Power [W]**	**Dimming**
LESA	6	7	Zumtobeln 1x58 W	58	406	7	LED 04152	600x300	30	210	yes
	7	7	Zumtobeln 1x58 W	58	406	7	LED 04152	600x300	30	210	yes
	8	7	Zumtobeln 1x58 W	58	406	7	LED 04152	600x300	30	210	no
	10	7	Zumtobeln 1x58 W	58	406	7	LED 04152	600x300	30	210	yes
GENOA	4A WC + 6A	1 4	Ceiling Light CW 2x58W Ceiling Light CW 2x36W	116 72	116+288=404	1 4	LED 04150 LED 04152	600x600 600x300	60 30	60+120=180	no
	6	6	Ceiling Light CW 2x36W	72	432	6	LED 04152	600x300	30	180	yes
	19	2	Ceiling Light CW 2x58W	116	232	2	LED 04150	600x600	60	120	no
	22	10	Ceiling Light CW 2x36W	72	720	10	LED 04152	600x300	30	300	no
PLOVDIV	1309	9	3 x40W	120	1080	9	LED 04150	600x600	60	540	yes
	1307	8	3 x40W	120	960	8	LED 04150	600x600	60	480	yes
LISBON	4	2 1	CW/T8 2x58W CW/T8 1x36W	116 36	232+36=268	6	LED 04152	600x300	30	180	yes
	5	2 1	CW/T8 2x36W CW/T8 1x36W	72 36	144+36=180	4 2	LED 04153 LED 04150	330x330 600x600	16 60	64+120=184	yes

As each LED laps needed his own Power Supply, for standardisation reasons it was decided to use only power units with included the dimming feature, so to avoid problems and errors during the installation. The power supply were unified and they were reduced to only two models, one for 60W and 30W and one for 18W.

In the following the data sheet of the adopted and supplied LED lamps is attached. The 16 W unit has been improved to 18W changing type of LED used in the lamp.

Figure 3-24: fluorescent and LED lamps comparison schema



Wall - LED 90-264Vac / 47-63Hz INDOOR&OFFICE

Plafoniera per interni, a basso UGR, la particolare configurazione ottica ne consente l'utilizzo in ambienti uso ufficio o simili (sale riunioni, aule scolastiche, corridoi, Hall ecc.) garantendo alti valori di illuminamento. Previsti vari tipi di installazione (incasso, sospensioni o blindo).

Indoor overhead light, at low UGR, suitable for indoor requirements as like as offices, meeting rooms, classrooms, corridors, halls. High lighting performance assured. Installation can be built-in, swinging or by armoured power.

Telaio: *Case:*	alluminio estruso *extruded aluminium*
Diffusore: *Diffuser:*	vetro temperato spessore 4 mm (secondo norma EN 12150) *tempered glass, thickness 4 mm (according to EN 12150)*
Temperatura di esercizio *Operating temperature*	-30÷50° C
Regolazione di corrente *Electricity control*	on-board
Normative di riferimento *Standards*	EN 62471
Dimmer *Dimmer*	0-100% / PWM

> 60.000 h (L 70) IP40

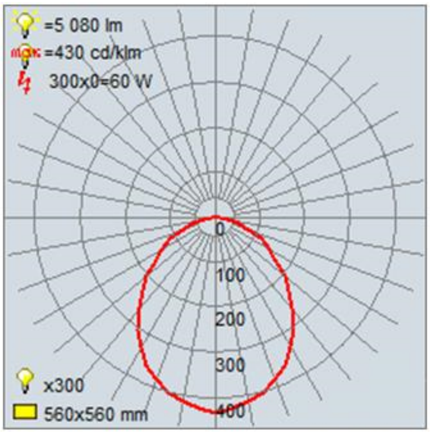
Articolo *Article*	Finitura *Color*	Dimensioni *Size* LxH mm	Peso *Weight* (kg)	Potenza *Power* (Watt)	Numero Power LED *Power LED number*	Fattore di potenza *Power factor*	Flusso luminoso *Luminous flux* (lm)	Temperatura colore *Color temperature* (K)	Resa cromatica *Color rendering*
LED04050	anodizzato argento *clear anodized*	600x600	7	60	216	0,95	6000	5000	>80
LED04051	anodizzato argento *clear anodized*	1200x300	7	60	216	0,95	6000	5000	>80
LED04052	anodizzato argento *clear anodized*	600x300	4,2	30	108	0,95	3000	5000	>80
LED04053	anodizzato argento *clear anodized*	330x330	2,8	16	54	0,95	1500	5000	>80
LED04150	anodizzato argento *clear anodized*	600x600	7	60	216	0,95	6000	4000	>80
LED04151	anodizzato argento *clear anodized*	1200x300	7	60	216	0,95	6000	4000	>80
LED04152	anodizzato argento *clear anodized*	600x300	4,2	30	108	0,95	3000	4000	>80
LED04153	anodizzato argento *clear anodized*	330x330	2,8	16	54	0,95	1500	4000	>80
LED04250	anodizzato argento *clear anodized*	600x600	7	60	216	0,95	6000	3000	>80
LED04251	anodizzato argento *clear anodized*	1200x300	7	60	216	0,95	6000	3000	>80
LED04252	anodizzato argento *clear anodized*	600x300	4,2	30	108	0,95	3000	3000	>80
LED04253	anodizzato argento *clear anodized*	330x330	2,8	16	54	0,95	1500	3000	>80

Switch On Led si riserva il diritto di modificare le caratteristiche della presente documentazione senza alcun preavviso. / *Switch On Led can change any details without any advice.*

Indeed, the image on the right shows the radiating diagram of the 60 W LED lamp.

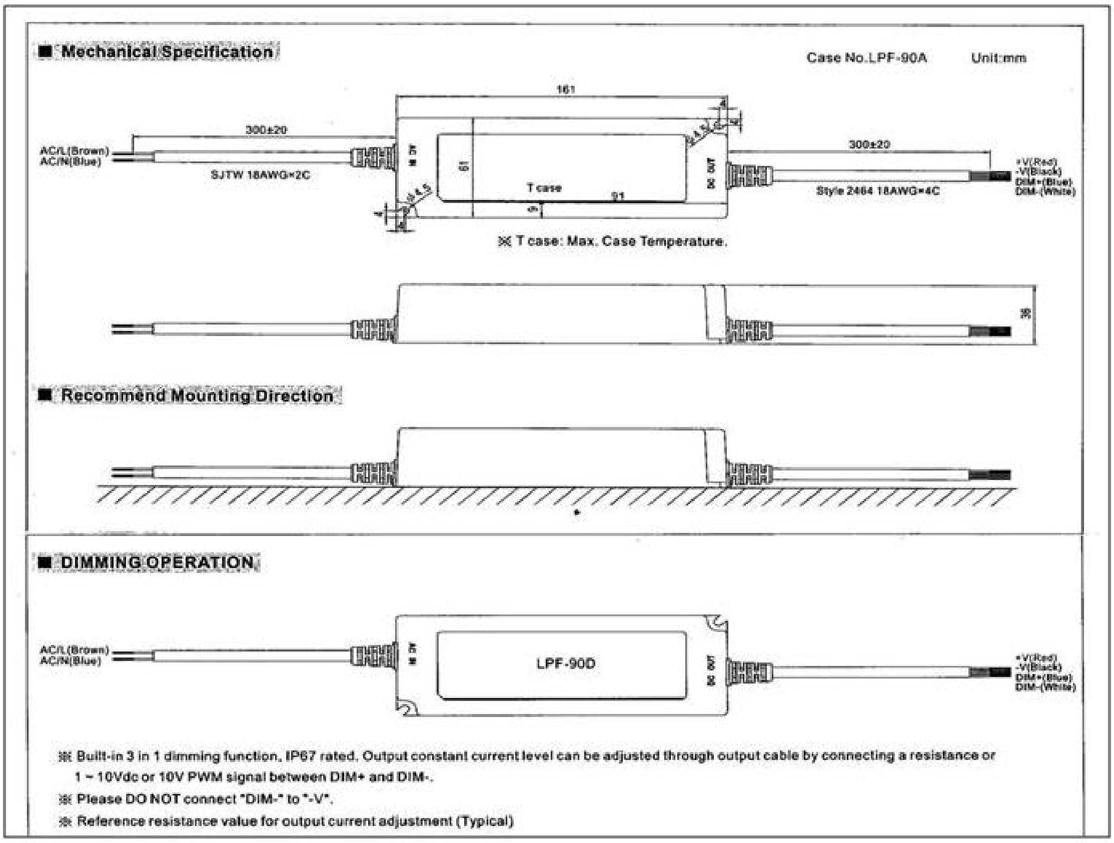
The other lamps have similar diagrams with obvious changes on the parameters according to the different electrical power.

Figure 3-25: Example of 60w lamp diagram



The next image shows one of the power and dimming modules used to feed and to control the LED lights.

Figure 3-26: Example of 60w lamp power supply and dimmer



Another important and considered aspect was the need to calculate the electricity consumptions of fluorescent and LED lamps, and comparing them, while evaluating the visual comfort conditions maintained with both traditional and LED lightings. This very important aspect is part of the experimental activity and it has been considered in the HQDS calculations of VSNavigator; DOKI BEMS has been designed to provide the experimental data and to apply the most convenient set-point strategy for visual comfort.

3.5.1 Presence Sensors

For the management of lights, one key component is the presence sensor, crucial for switching on lights only when there is the presence of people in the room/premise. In other cases the lights management is better performed using the Presence and Light Measurement sensors, whose characteristics may be found in the next point: this application is recommended for places where natural light is strong or which are illuminated by sunlight. The selection considered as much as possible the height of the ceiling of the rooms.

The adopted model was Finder 18.21.82300300, as it was needed a no voltage metal output contact. The producer is the well known Finder Spa.

This device was selected for (i) the adherence to the needs of the applications, (ii) the reputation of the manufacturer, (iii) the presence of resellers and service centres all over Europe, (iv) the cost in line with the budget of the project and (v) the number of available certifications.

Figure 3-27: Finder certifications

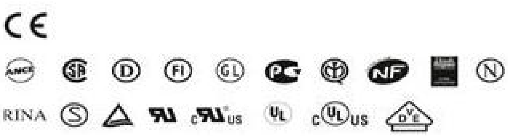
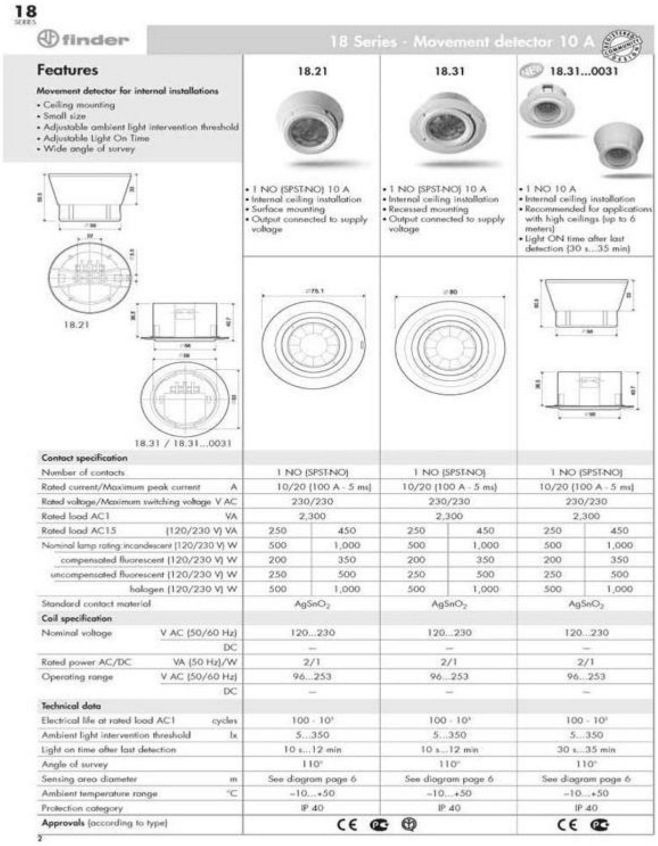


Figure 3-28: Presence sensors datasheet



18 SERIES

finder — 18 Series - Movement detector 10 A

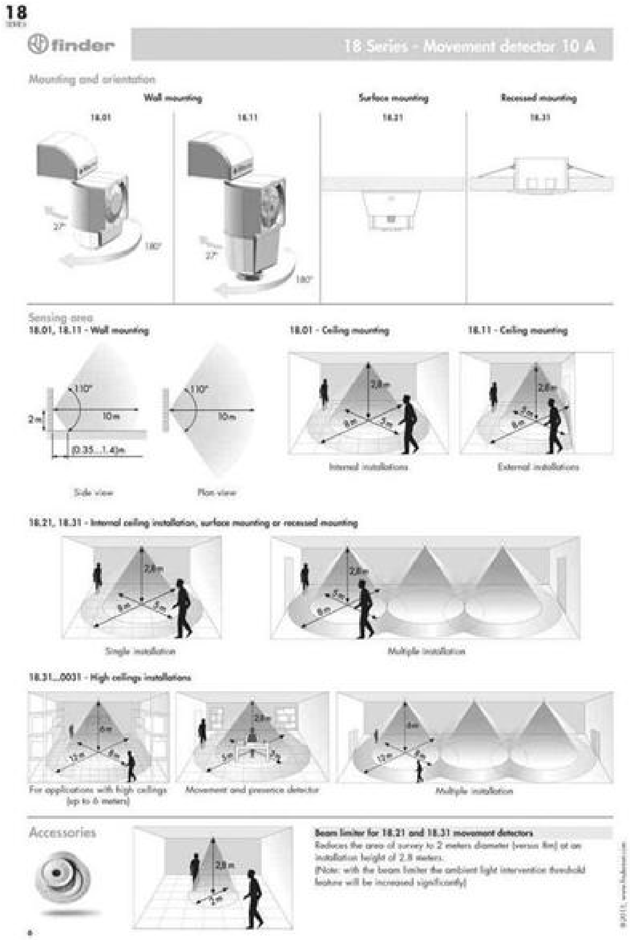
Features

Movement detector for internal installations
- Ceiling mounting
- Small size
- Adjustable ambient light intervention threshold
- Adjustable Light On Time
- Wide angle of survey

	18.21		18.31		18.31...0031	
	• 1 NO (SPST-NO) 10 A • Internal ceiling installation • Surface mounting • Output connected to supply voltage		• 1 NO (SPST-NO) 10 A • Internal ceiling installation • Recessed mounting • Output connected to supply voltage		• 1 NO 10 A • Internal ceiling installation • Recommended for applications with high ceilings (up to 6 meters) • Light ON time after last detection (30 s...35 min)	
Contact specification						
Number of contacts	1 NO (SPST-NO)		1 NO (SPST-NO)		1 NO (SPST-NO)	
Rated current/Maximum peak current A	10/20 (100 A - 5 ms)		10/20 (100 A - 5 ms)		10/20 (100 A - 5 ms)	
Rated voltage/Maximum switching voltage V AC	230/230		230/230		230/230	
Rated load AC1 VA	2,300		2,300		2,300	
Rated load AC15 (120/230 V) VA	250	450	250	450	250	450
Nominal lamp rating: incandescent (120/230 V) W	500	1,000	500	1,000	500	1,000
compensated fluorescent (120/230 V) W	200	350	200	350	200	350
uncompensated fluorescent (120/230 V) W	250	500	250	500	250	500
halogen (120/230 V) W	500	1,000	500	1,000	500	1,000
Standard contact material	$AgSnO_2$		$AgSnO_2$		$AgSnO_2$	
Coil specification						
Nominal voltage V AC (50/60 Hz)	120...230		120...230		120...230	
DC	—		—		—	
Rated power AC/DC VA (50 Hz)/W	2/1		2/1		2/1	
Operating range V AC (50/60 Hz)	96...253		96...253		96...253	
DC	—		—		—	
Technical data						
Electrical life at rated load AC1 cycles	$100 \cdot 10^3$		$100 \cdot 10^3$		$100 \cdot 10^3$	
Ambient light intervention threshold lx	5...350		5...350		5...350	
Light on time after last detection	10 s...12 min		10 s...12 min		30 s...35 min	
Angle of survey	110°		110°		110°	
Sensing area diameter m	See diagram page 6		See diagram page 6		See diagram page 6	
Ambient temperature range °C	–10...+50		–10...+50		–10...+50	
Protection category	IP 40		IP 40		IP 40	
Approvals (according to type)	CE				CE	

2

Figure 3-29: Presence sensor datasheet



3.5.2 *Integrated Light and Presence sensors*

For the management of lights in condition of high lights coming from the windows , one key component is the Presence and Light Measurement sensors, crucial for switching on lights only when there is the presence of people in the room/premise and the natural light may be strong.

In other cases the lights management is better performed using the Presence and Light Measurement sensors, whose characteristics are reported here: this application is recommended for places where natural light is strong or which are illuminated by sunlight. Nevertheless, one specific and very important point is the choice of the installation position, which could significantly affect the performance of the system, as the sensor must be out from the reach of the direct sunlight to avoid incorrect and unpredictable behaviour of the whole lighting system in the room. Also direct lighting by part of the controlled lamps may determine a poor performance of the installation.

The adopted model is Theben HTS 201 4 001, as the characteristics fits well with the Pilots needs. The producer is the well known Theben AG, with a long tradition in the sector.

This device was selected for (i) the adherence to the needs of the applications, (ii) the reputation of the manufacturer, (iii) the presence of resellers and service centres all over Europe, (iv) the cost in line with the budget of the project and (v) the number of available certifications.

Figure 3-30: Theben selection of Certifications

Figure 3-31: Light & Presence sensor: basic datasheet

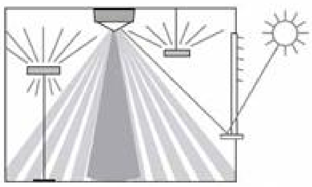
8. Technical specifications

Sensor module	compact office 24V
Detection range: horizontal / vertical	360° / 120°
Recommended mounting height (Mh)	2,0 - 3,0m
Maximum range	6 x 6 m (Mh. 2.5m) / 8 x 8 m (Mh 3.5m)
Mixed light control / Light measurement deactivated	ca. 10 - 1500Lux / „on"
Switch off delay for light / Short pulse	10sec. - 20min. / 0.5sec. „on"/ 10sec. „off"
Switch off delay for presence	10sec. - 120min.
Switch on delay for presence / Room surveillance	0sec. - 10min.
Power modules	**compact power 24V / compact power 24V Lux**
Nominal voltage	24V AC/DC ± 20%
Relay output A1, A2 for „light"	**Relais, potential free**
Type of contact / potential-free micro-contact	24V ≅ AC/DC ±20%
Switching capacity: minimal / maximal	1V / 1mA *) / 50W / 460VA

*) A load of more than 60V or 100mA on the switching contact (max. 1.5W) changes its characteristics permanently; the minimum load specification of 1V/1mA can no longer be guaranteed.

3.2 Light measurement

The detector measures artificial light and daylight reflected directly beneath the detector (beam width approx. ± 30°).



The mounting location is used as the reference for the lighting levels.

With indirect lighting, the artificial light at the detector's mounting location should not exceed 2000 Lux (Brightness value > 2000 Lux).

3.3 Connection

A concealed housing should be used for flush-mounted fitting of the presence detector. A surface frame is available for surface mounting.

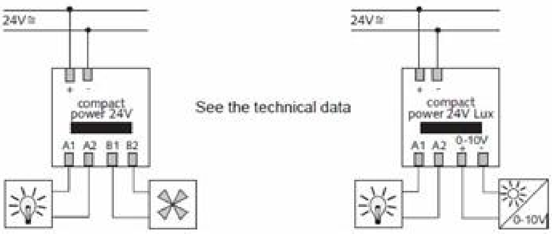
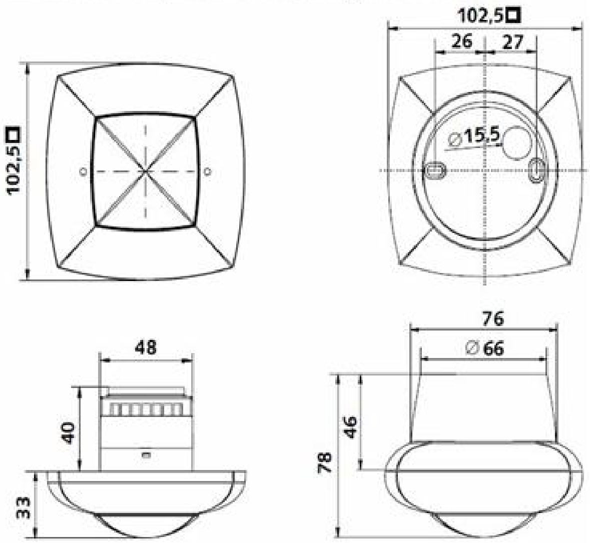


Figure 3-32: Light & Presence sensor: dimensions datasheet

Relay output B1, B2 for „presence" (compact power 24V only)	Relay potential-free
Type of contact / potential-free micro-contact	24V ≅ 2Aμ, 230V~2Aμ
Switching capacity: minimum / maximum	1V / 1mA *) / 50W / 460VA
Analog output 0-10V (compact power 24V Lux only)	**0-10V**
Output voltage	0-10V DC
Load resistor	> 10kΩ
Mixed light measurement linear / logarithmic	approx. 10 - 1500 Lux / approx. 10 - 5000 Lux
Depth / Diameter / Mounting plate	40mm / 48mm / 70 x 70mm
Screw terminals	max. 2x 2.5mm2
Size of concealed housing (for flush-mounting)	Dim. 1, (NIS,PMI)
Ambient temperature	0° - 50°C
Degree of protection	IP 40
Article numbers	
compact office 24V	201 4 000
compact office 24V Lux	201 4 001
Surface frame for compact	907 0 514
Service remote control QuickSet plus	907 0 532
User remote control clic	907 0 515

56

Dimensions compact office 24V, compact office 24V Lux



Subject to change without prior notice. Errors and omissions excepted.

The following figure summarizes the amount of presence and light sensors install in all Pilots.

Figure 3-33: Installed presence and light sensors in all Pilots

	Type	Lesa	Genoa	Plovdiv	Lisbon
1	Presence sensors	17	21	21	12
3	Integrated presence and light sensors	3	1	12	2
4	Nr. of individual light circuits with ON/OFF control	29	23	22	10
5	Nr. Of individual light circuits with dimming control	3	1	2	2

3.6 Smart meters

3.6.1 Electricity Measurement devices

Measuring the consumption of electric energy is one of the fundamental tasks of DOKI BEMS, as the collected information's if correctly managed allows both to manage the energy use and the optimisation of the energy itself.

The VERYSchool project has established as one of his most important objectives:

- the ability to control the consumption of electricity, and
- the identification of the actions to be taken to reduce its value while complying with regulations and assuring the necessary comfort to the users of the sites.

The selected measurer must fit with different voltages, number of phases and number of wires. Moreover it is necessary that the selected devices comply with the characteristic of offering a number of communication interfaces to fit with the networking and communication need.

The adopted models makes part of the AlgoDue serie UEC80-XX, as the characteristics fits well with the Pilots needs. The producer is the well known AlgoDue Elettronica srl, with a long tradition in the sector.

This device was selected taking account of:

- the adherence to the needs of the applications,
- the reputation of the manufacturer,
- the presence of resellers and service centres all over Europe,
- the cost in line with the budget of the project, and
- the number of available certifications.

Figure 3-34: Algodue Certifications

In the following page is reported a basic datasheet of the selected family of products.

Figure 3-35: Electric Energy Measurer datasheet

MID Energy Counters

UEC80-3X, UEC80-4X

80A three phase 3 or 4 wires energy counter

- Direct connection up to 80 A
- Fully bi-directional four quadrants measurements for all energies and powers
- For 3 or 4 wire networks with balanced or unbalanced load
- Class B according to EN50470-3
- Tariff input
- 2 S0 outputs for energy pulse emission
- LCD display with 8 main digits
- Optical port for communication
- Available with MID certification

MID Energy Counters

» General features

4 DIN modules energy counter for the energy measurement in industrial and civilian application, available with MID certification suitable for billing.
Combined with different external modules, the counter can communicate with other systems. COM modules are available for the most common field protocols.
Besides the energy, the counter can measure the main electrical parameters and makes them available on the COM port.
The LCD display shows the energies and the instantaneous powers.
The counter is built according EN50470-3 standard. The accuracy of the active energy fulfills class B requirements. The accuracy of the reactive energy is compliant to EN62053-23 class 2.
Wide backlighted LCD display with clear graphic symbols comprehensible at a glance.
Metrological LED on front panel and sealable terminal covers.
Available versions with different voltage working range for the connection on 3 or 4 wire network, suitable for balanced or unbalanced loads. The analysis of the MTBF values, the accurate selection of components and the reduction of the internal working temperatures together with strict production and control standards guarantee a product with an excellent quality and a long lasting reliability.

» Applications

- Totalization of the electric energy in the industry for each single line or machine.
- Measurement of energy generated by renewable sources such as solar, eolic, etc.
- Accounting and billing of consumptions in camp sites, malls, residential areas, naval ports, etc.
- Totalization of the electric consumption in hotels, congress centers, exhibition fairs.
- Accounting of the consumptions in buildings with executive office services.
- Internal allocation of the consumptions in timeshare civilian and industrial buildings.
- Realization of energy monitoring systems.
- Remote survey of the consumptions and compute of the costs.

» Benefits

- Up to 30 instantaneous measurements, complete set of energy counters with 2 tariffs total and partial counters. Moreover partial counters can be started, stopped or reset.
- The counter provides phase sequence and a diagnostic function for error signalling in case of wrong polarity connection.

» Related Products

- Communication modules (RS485 Modbus, M-Bus, Lan gateway)

1

algodue ELETTRONICA

3.6.2 Heating Measurement devices

IVAR G04/2150 and Sonometer 1100

One of the basic selected heat measurer was from the brand IVAR, the one which also supplied the standard valves used in Lesa and Genoa. The selected flow meter is belonging to the family IVAR G04/2150; the measurer must be inserted in series into the hot water pipe which feeds the radiators in the Pilot, and is completed by an integration module able to send a contact every equivalent of 1 kWh measured by the system. In practice, the device has been supplied to Genoa, but only the latter is completely working as in Lesa the existing plant for heating is under discussion, as it could be substituted in the next future.

Plovdiv School, which already used some Dunfoss devices, has been equipped with the contactless measurer Dunfoss Sonometer 1100, together with an integrating module behaving like the IVAR integrator. The solution was adopted to keep uniform the supplier solution previously adopted by the Plovdiv school and to experiment in practice two different technologies for measuring the flow of the hot water.

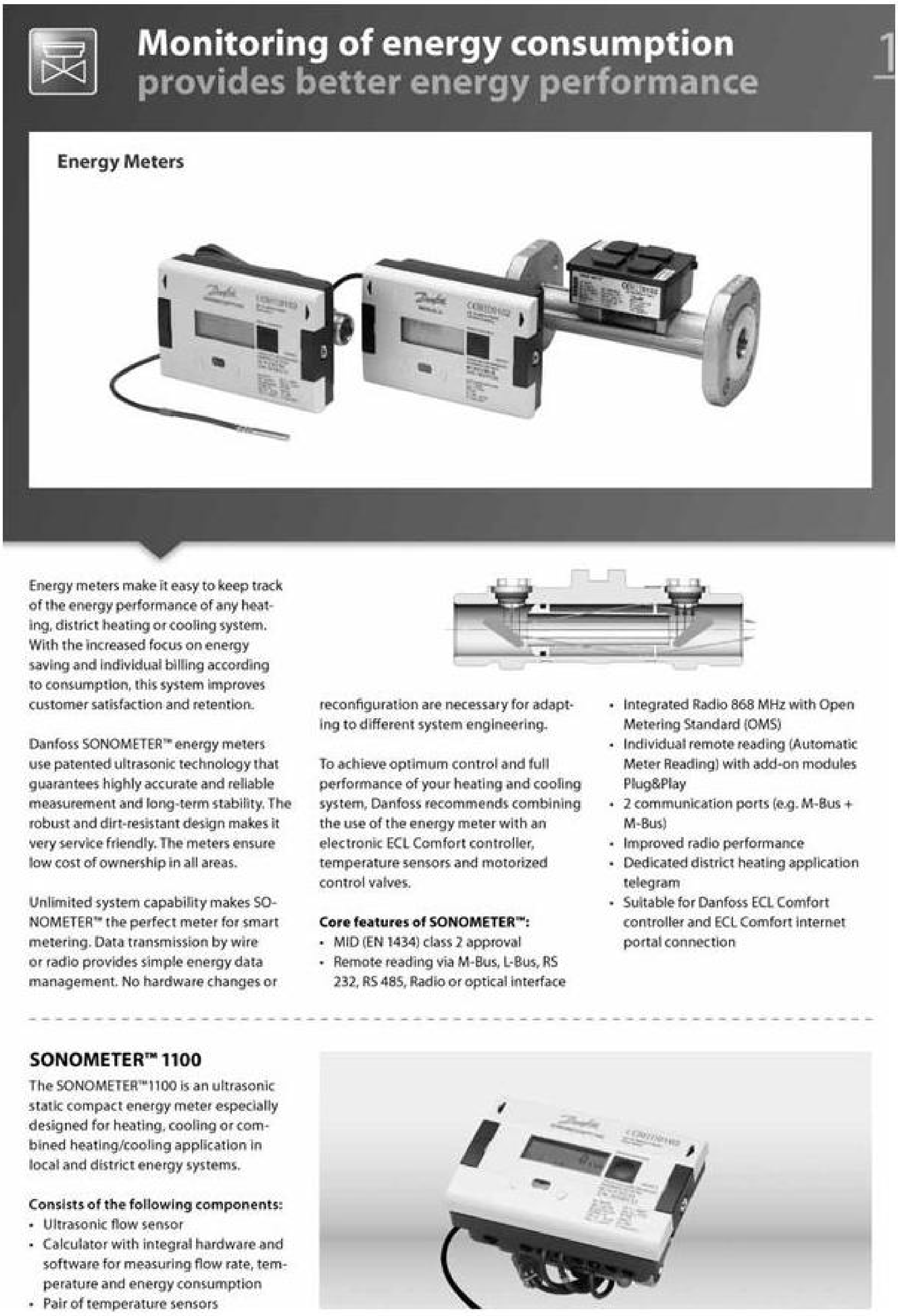
In the following figures, a selection of photos and data sheet is reported for both instruments.

Figure 3-36: Ivar heat measurer, integrator and temperature probes

Figure 3-37: Dunfoss heat measurer, control unit

In the following page, a short form technical sheet shows the basic principle and reference data for the Dunfoss Sonometer 1100. This device may be useful for applications were is desired a solution without moving parts; installation must be made paying special attention in avoiding the presence of air in the pipes.

Figure 3-38: Dunfoss heat measurer, basic data sheet



Monitoring of energy consumption
provides better energy performance

Energy Meters

Energy meters make it easy to keep track of the energy performance of any heating, district heating or cooling system. With the increased focus on energy saving and individual billing according to consumption, this system improves customer satisfaction and retention.

Danfoss SONOMETER™ energy meters use patented ultrasonic technology that guarantees highly accurate and reliable measurement and long-term stability. The robust and dirt-resistant design makes it very service friendly. The meters ensure low cost of ownership in all areas.

Unlimited system capability makes SONOMETER™ the perfect meter for smart metering. Data transmission by wire or radio provides simple energy data management. No hardware changes or reconfiguration are necessary for adapting to different system engineering.

To achieve optimum control and full performance of your heating and cooling system, Danfoss recommends combining the use of the energy meter with an electronic ECL Comfort controller, temperature sensors and motorized control valves.

Core features of SONOMETER™:

- MID (EN 1434) class 2 approval
- Remote reading via M-Bus, L-Bus, RS 232, RS 485, Radio or optical interface
- Integrated Radio 868 MHz with Open Metering Standard (OMS)
- Individual remote reading (Automatic Meter Reading) with add-on modules Plug&Play
- 2 communication ports (e.g. M-Bus + M-Bus)
- Improved radio performance
- Dedicated district heating application telegram
- Suitable for Danfoss ECL Comfort controller and ECL Comfort internet portal connection

SONOMETER™ 1100

The SONOMETER™ 1100 is an ultrasonic static compact energy meter especially designed for heating, cooling or combined heating/cooling application in local and district energy systems.

Consists of the following components:

- Ultrasonic flow sensor
- Calculator with integral hardware and software for measuring flow rate, temperature and energy consumption
- Pair of temperature sensors

The following figure summarizes the amount of smart meters install in all Pilots.

Figure 3-39: installed smart meters in all Pilots

Temperature sensors					
	Type	Lesa	Genoa	Plovdiv	Lisbon
1	Electrical measurement in the Pilot area	1	1	2	2
2	Electrical measurement for the School	1	1	1	-
3	Renewable Energy Plants	1	1 (not active)		
4	Thermal Energy	-	1	1	-

3.7 Summary of delivered BEMS equipment to all Pilots

Figure 3-40: Type and number of sensors, actuators, instruments in the four Pilots

	Item	Code	Lesa delivered 2012/13	Genoa delivered 2013	Lisbon delivered 2013	Plovdiv delivered 2013	Total
Communication and supervision							
1	PC SHOT 520E DHOMO with SCE520 V.1.2 E WIN CE – VS	463301606	1	1	1	1	4
2	MONITOR ROSSO MARANELLO METAL 12T ROSSO TOUCH for WIN.CE DOKI – VS	478301609	1	1	1	1	4
3	Arm basic for Monitor Maranello	003014021	1	1	1	1	4
4	Power supply 2,5A	019004022	1	1	1	1	4
5	X Navigator NETTOP PC ATOM A3550 BLACK (NTA3550-D2550-R2-S60)	026020052	1	1	1	1	4
6	SW WinXP Pro Sp.3 OEM for PC ATOM	27001015	1	1	1	1	4
6A	LogMeIn Pro Control SW	WEB installation	1	1	1	1	4
7	Ethernet Switch for Navigator LEVELONE GSW-0807 (per PC)	026030004	1	1	1	1	4
8	Ethernet Switch for Navigator LEVELONE GSW-0807 (per schede)	026030004	1	1	2	5	9
9	Ethernet Switch for Navigator LEVELONE FEU-1610 (per schede)	026030006		3			3
10	DOKI gate	463301601	1	1	1	1	4
11	WIFI Point to point devices TL-WA5210G Access Point 2.4GHz	026031002		2			2
12	WIFI access point Buffalo WZR-HP-G450H	026031003			1		1
Local control							
13	MASTER EVO 512k - UNITA MASTER 4 PT1000 – VS (Energy) LESA only	463301203 /204	4				4
14	MASTER EVO - UNITA MASTER 4 PT1000 2Mb – VS (Rooms) LESA only	463301103	13				13
15	4 RELAIS for POWER MODULE EVO, Lesa only	463416011	32				32
16	Power supply (Lesa only)	019004032	12				12
17	Preassembled EVO BOX for Rooms	463300101		20		18	38
18	Preassembled EVO BOX for Rooms Wireless	463300104			16		16
19	Preassembled EVO BOX Energy Measurement	463300103		3		4	7
20	Preassembled EVO BOX Energy Measurement Wireless	463300105			2		2
Heating and cooling							
21	Room temperature sensor PT1000 with holder	463302701 017010022	13	30	20	25	88
22	Pipe contact temp. sensor PT1000	017010021	4	2	2	2	10
23	External temperature sensor PT1000 with case	017010017	1	1	1	1	4
24	Smart Calory meters Dunfoss Sonometer 1100 + Pulse generator + Adapter	Bought and delivered in Bulgaria				1	1
25	Smart Calory meters IVAR G04/2150-02 0 0000 + output module	IVAR 330.908/00		1			1
26	Valves complete Dunfoss	Bought and delivered in Bulgaria				46	46

	Item	Code	Lesa delivered 2012/13	Genoa delivered 2013	Lisbon delivered 2013	Plovdiv delivered 2013	Total
27	Valves complete IVAR	Variuos codes	**25**	**27**			**52**
28	Window sensors VIMO CTE020	0170013001	**46**		**45**	**50**	**95**
Lighting Equipments							
29	Integrated Light and Presence sensor ThebenHTS 201 4 001 for Lesa	030003001	**3**	**1**	**2**	**2**	**8**
30	Presence sensor Finder 182182300300	017012001	**15**	**40**	**24**	**35**	**114**
31	PADA LED lamp module 60W (dimmerable)	015023010		**3**	**2**	**17**	**22**
32	PADA LED lamp module 30W (dimmerable)	015023011	**28**	**20**	**6**		**54**
33	PADA LED lamp module 16W (dimmerable)	015023012			**4**		**4**
34	PADA FIX for 60W & 30W LED lamp	015023013	**28**	**23**	**8**	**17**	**76**
35	PADA FIX for 16W LED lamp	015023014			**4**		**4**
Electric Measuring Instruments							
36	Smart Electric Meters UEC 80 XX+ interface RS485+Current transformers	Various codes	**3**	**2**	**2**	**4**	**11**

3.8 Summary of complementary or spare BEMS equipment delivered to Pilots in 2013-2014

Figure 3-41a: Type and number of additional sensors, actuators, instruments in the four Pilots

	Item	Code	Lesa delivered 2014	Genoa delivered	Lisbon delivered	Plovdiv delivered 2014	Total
10	DOKI gate	463301601	**2**				**2**
29	Integrated Light and Presence sensor ThebenHTS 201 4 001 for Plovdiv	030003001				**10**	**10**

4 DOKI BEMS: Technical manual

DOMOTICS & ENERGY CONTROL

www.do-ki.it

The system is based on the use of a Master EVO board for the management of the preloaded systems.

In the specific case of the VERYSchool project, 3 kind of firmware are used:

- large classroom
- traditional classroom
- bathroom

The Master EVO VERYSchool board comes out already with a set of preloaded and configured programs for the school management. To select a program rather than another it is necessary to change the DIP switch 2 setting.

4.1 Lighting Management

4.1.1 Generalities

In each room there may be two types of sensors, only one of them or none. The two types of sensors are:

1. Brightness sensor
2. Presence sensor

Both sensors will be present in the room that are controlled, but is some case there is only the brightness or just the presence sensor. Therefore, the board will have a different function depending on how many and what type of sensors will be present. The logic then will be split into 4 parts:

1. Both sensors
2. Presence sensor only
3. Brightness sensor only
4. No sensors

Buttons for lights adjusting will always be present in the room/premise and it will be possible to use the auto or manual mode that will be described afterwards for each section.

<u>“Not Overlap” Function</u>

As a general feature, a function called "Not Overlap" has been developed and introduced: this function doesn’t allow the reset of the timer in case of recurrence of a presence signal by the sensor used. Or if such sensor is excited again after a loss-of-excitation, perhaps due to a forgetfulness of an object in the room, the timer is not reset. Of course, if the timer runs out and the sensor detects a presence, the light will not be turned off and the timer will start again when the sensor doesn’t detect its presence.

4.1.2 Brightness Sensor and Presence Sensor, general features

In case both sensors are positioned within the classroom there will be a fine control, therefore the management logic will be more complex.

Generalities

When the Presence sensor closes the contact, the Master Evo VS board is informed that the room is occupied. According to the information's received by the Brightness sensor, the Master Evo VS board will decided how many lights (in case of digital lights) or how intensely adjust them (in case of presence of a 0-10 V dimmer). The firmware will adjust the light groups of analogue and digital parts at the same time, therefore it isn't required to provide the information to the board during his initial configuration. In the small classrooms will have 2 light groups, while in the large ones 4 light groups are installed.

The lights will be adjusted as shown in the following graph according to a PID control where, by choosing the parameters correctly, you can get a more immediate adjustment or sweeter, in function of the variation of brightness. Such action will be more appreciable in case of dimmable lights rather than in case of digital lights.

The management of the PID type will allow to manage the lights output in order to compensate the trend of the brightness inside the room according to a desired set point, finding the compromise between comfort bright and then maintaining the same level of brightness and variation of intensity.

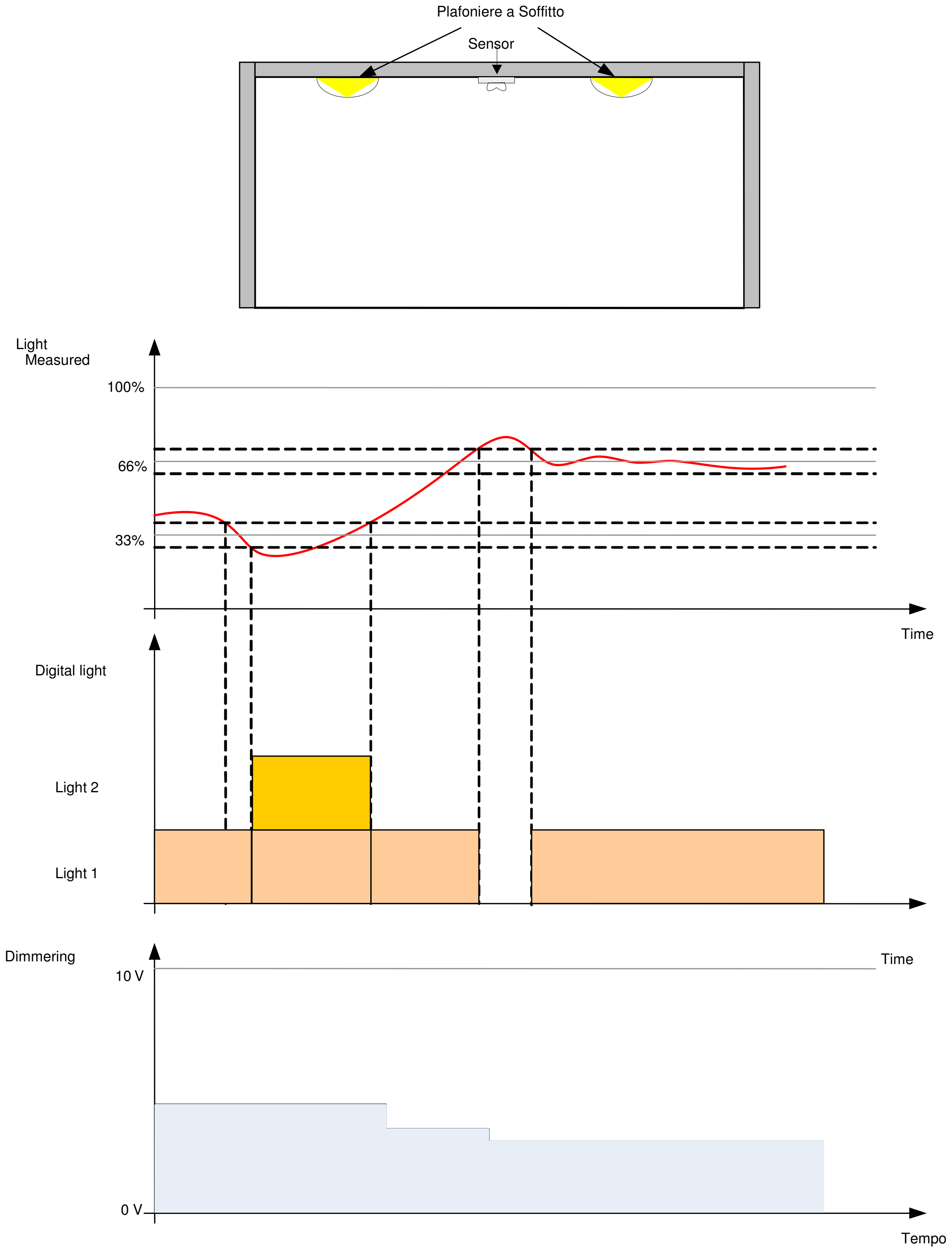
Example:

In case of days with a particular unstable weather, it may have a continuous variation of light inside the room, due to the passage of the clouds. A sudden adjustment may cause a continuous variation of the state of brightness, creating a perception of discomfort. With the PID parameters selected wisely, the variation of the light intensity will be pursued in a milder way without too abrupt changes of lights.

The parameters can be changed manually or follow preloaded configurations for a milder or faster adjustment.

When the Presence sensor opens the contact, the Master Evo VS board is informed that the room is empty. At this point a configurable timer is activated to maintain the brightness of the room, from a minute to an hour. At the end of this timer, the light will be switched off.

Figure 4-1: Lighting management graphic



In the following pages the basic logical behaviour is illustrated.

Pushbuttons

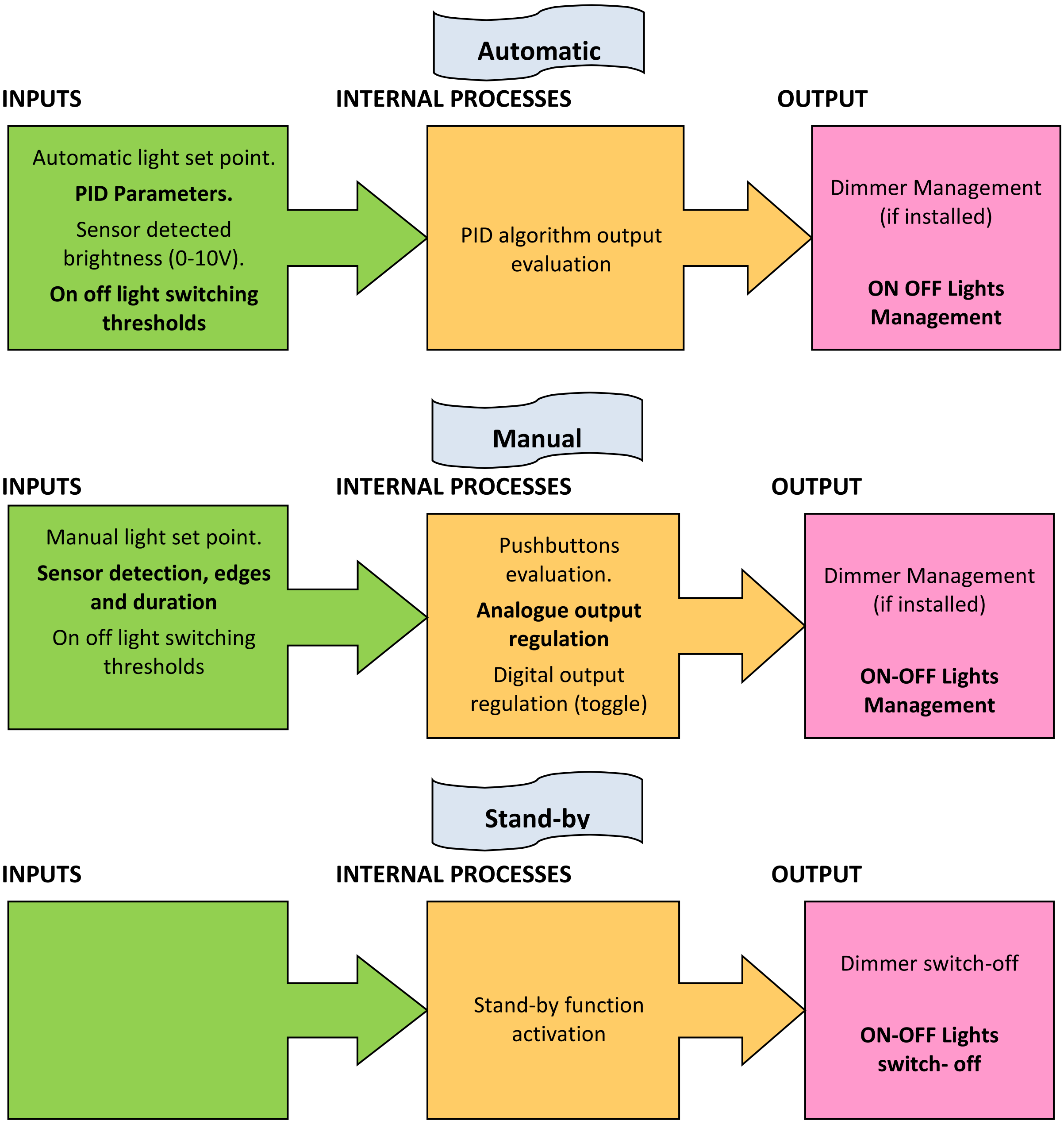
The pushbuttons allow to select the way of use:

A. Automatic

B. **Manual**
C. **Stand-by**

At the beginning of the lighting cycle of the room, i.e. at the first closure of the sensor (not in "Not Overlap Function"), the room lighting starts in **automatic** operation. This option is called Auto Automatic.

Figure 4-2: Lighting management processes



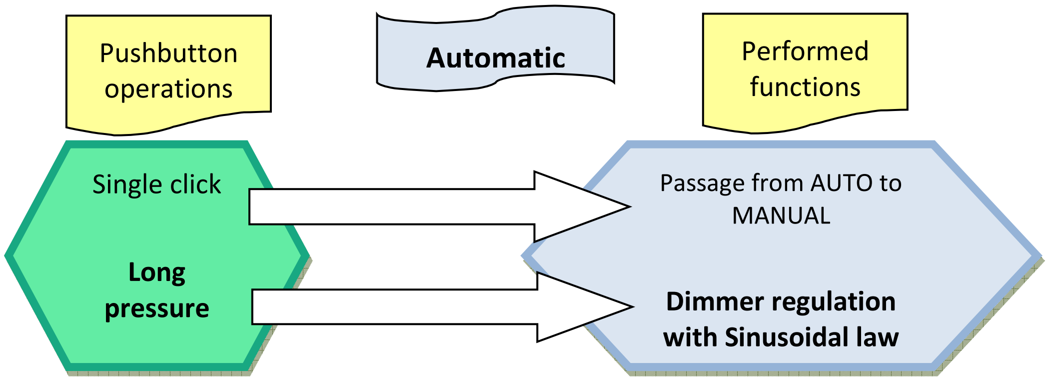
The functions are activated automatically with subsequent pressing of the button, as described in the following graphs

<u>A. Automatic operation</u>:

a. Single short pressure: activates manual mode and performs the toggle (i) of the digital light activated by the specific button or (ii) of the analogue output (from 0 to 10 or vice versa) of the classroom to which the pushbutton refers.

b. Long pressure (more than 3 seconds): activates the manual mode and start adjusting the dimmer, if any, of the analogue output of the room where the button is pressed.

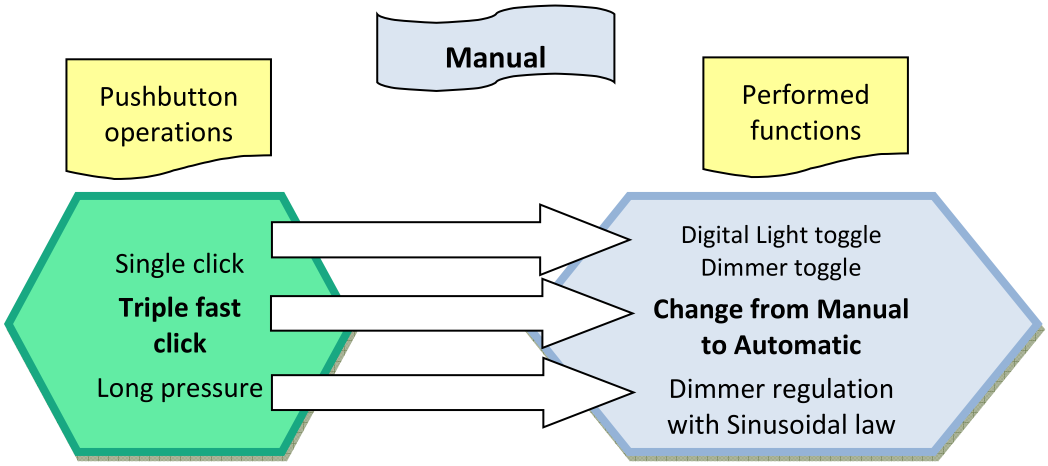
Figure 4-3: Automatic lighting management processes



B. Manual operation:

a. Every single press run the digital and analogue toggle of the lights referred to by the button (from 0 to the maximum value).
b. Three close-ups pressures allow to reactivate the automatic function.
c. A long press allows adjustment of the dimmer, if any.

Figure 4-4: Manual lighting management processes



The manual management is the more complicated of the 3 ways of controls: for a better understanding, a **Manual** behaviour flow-chart is reported.

For the **manual** operation there is a sequence for each key in association with a light. The sequence is:

1. Digital associated light forced on, and analogue associated light switched on at 100%
2. Digital associated light forced off, and analogue associated light switched off at 0%
3. Re-entry automatic operation

In case the pushbutton is pressed for more than 3 seconds, it will start an operation of fine adjustment of the analogue light. Substantially it will start a regulation operation between 0 and 10 V in output in order that the user can adjust the light as he prefers, and in the moment when it is reached the desired intensity, releasing the button, the value will remain set.

From the software management there will be a slightly different behaviour. One can choose between automatic and manual mode, where he can adjust the light intensity or the lights to switch on and off as he prefers. In any case, the state of the lights will be determined by the last object that will set the command, no matter the pushbutton or the software.
A flow chart is reported below with a functional logic and its relative trend of manual voltage regulation, in case it is managed by pressing the pushbutton.

Figure 4-5: Flow Chart for push bottoms management

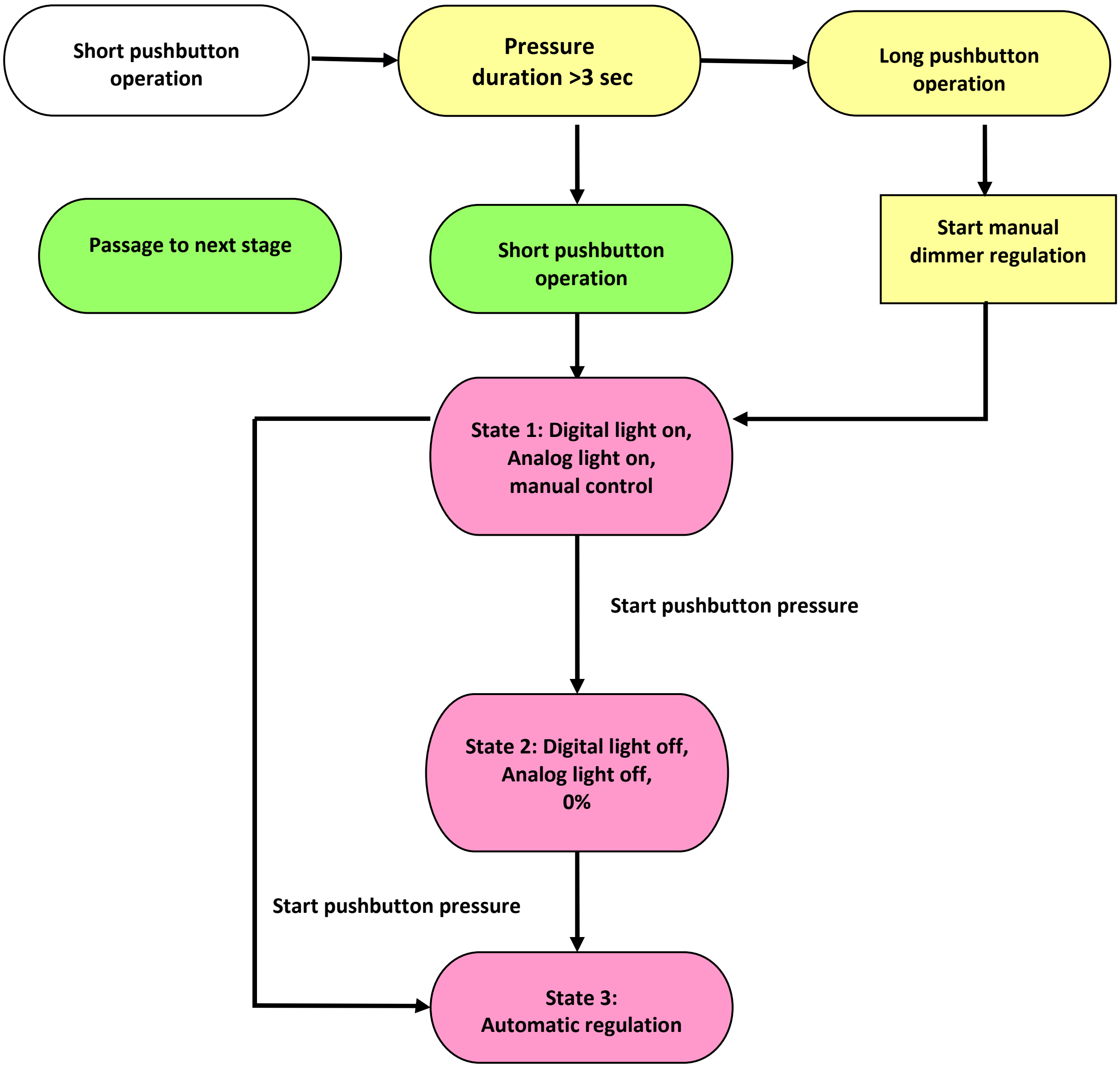
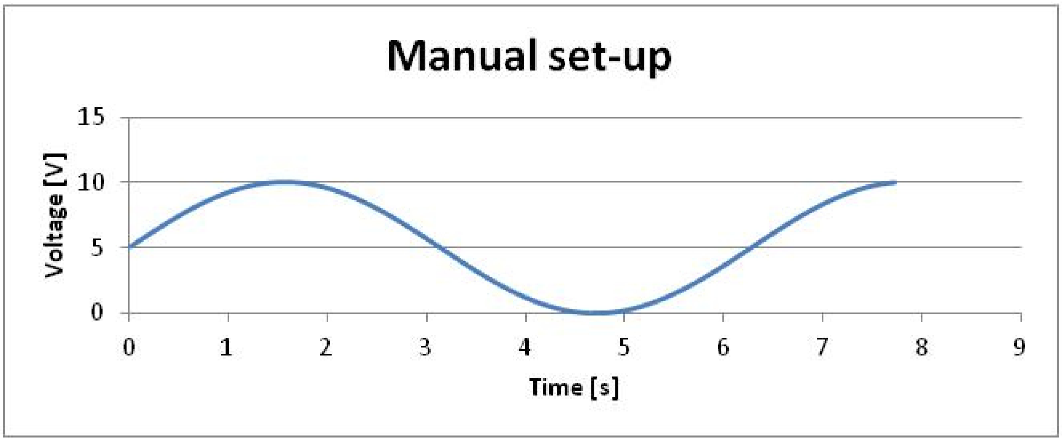


Figure 4-6: Function of light intensity with manual regulation



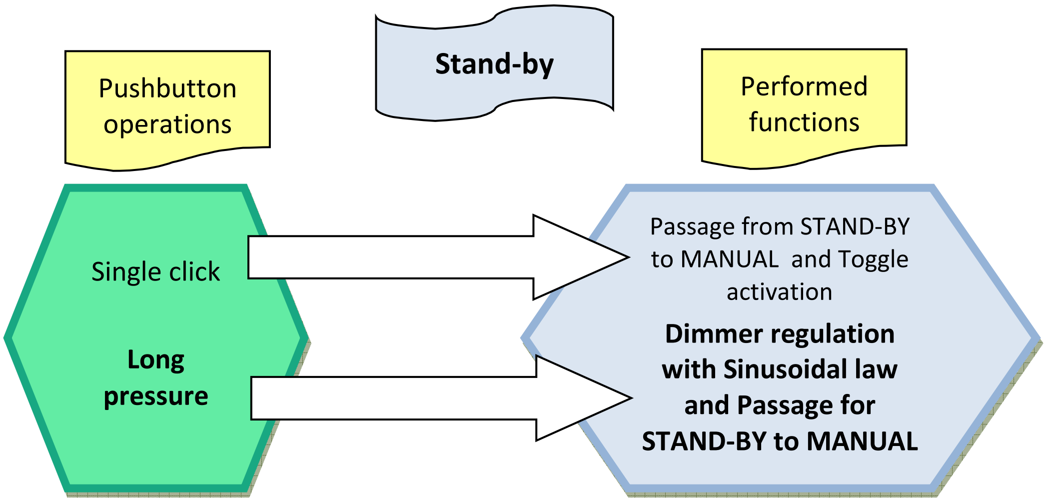
The operation is cyclical, two pushbuttons are set in the electrical scheme. From the software side there will be a slightly different behaviour. One can choose between automatic and manual mode, where he can adjust the light intensity or the lights to switch on and off as he prefers. In any case, the state of the lights will be determined by the last object that will set the command, no matter the pushbutton or the software.

B. Stand-by operation:

a. Single pushbutton pressure: activates the manual mode and performs the toggle light digital referred to by the pushbutton (0 to 10 or vice versa) of the classroom where it is installed.

b. Long pushbutton pressure (more than 3 seconds): turn-on the manual mode and start adjusting the dimmer, if any, of the room where the button is pressed.

Figure 4-7: Stand-by lights operation



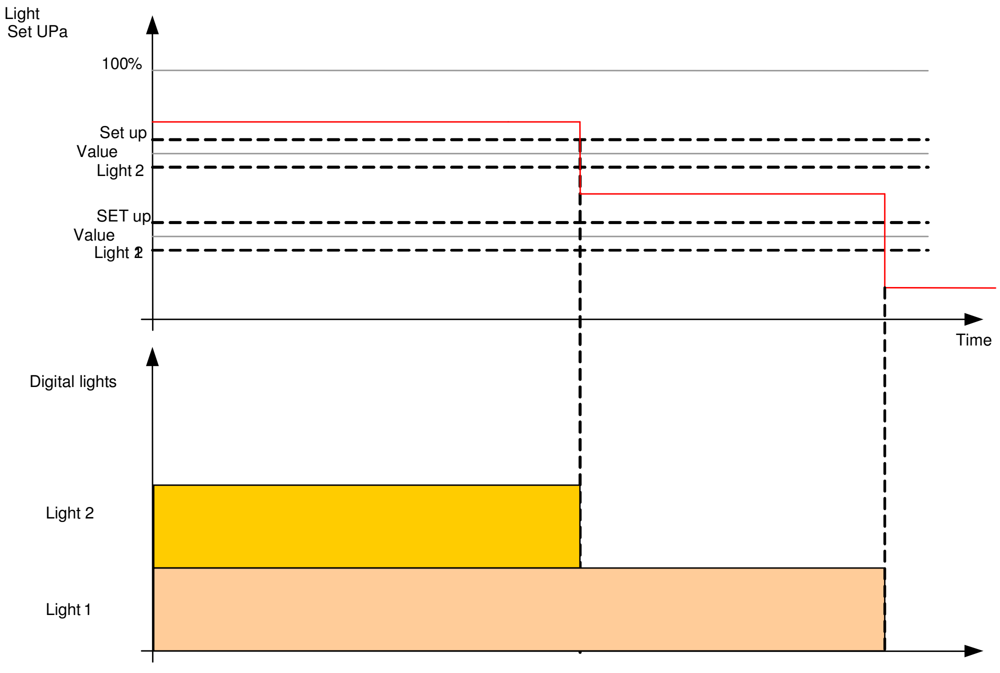
4.1.3 Operation with Presence Sensors

In case of a the classroom with only a presence sensor, there will be a digital control; even in case of dimmer presence, it will be driven in automatic mode from 0 to 10 V according to the logic described below.

Automatic

When the presence sensor closes the contact and informs the EVO Master BOX that the classroom is occupied, all the available lights will switch on. At the same time the output for the dimmer will be driven at 10V. Also in this logic, the "Not Overlap" function is activated, as previously described.

Figure 4-8: Lights operation with Presence sensors



Pushbuttons

Manual - Automatic functioning is included also in this version, as previously described. When the pushbuttons are pressed, the functioning will be the same one previously described with both sensors which activates the automatic and manual functioning as indicated below:

1. Digital light associated forced on, and analogue light associated switched on at 100%
2. Digital light associated forced off , and analogue light associated switched off at 0%
3. Re-entry automatic operation

The pushbuttons allow to select the way of use:

A. Automatic
B. Manual
C. Stand-by

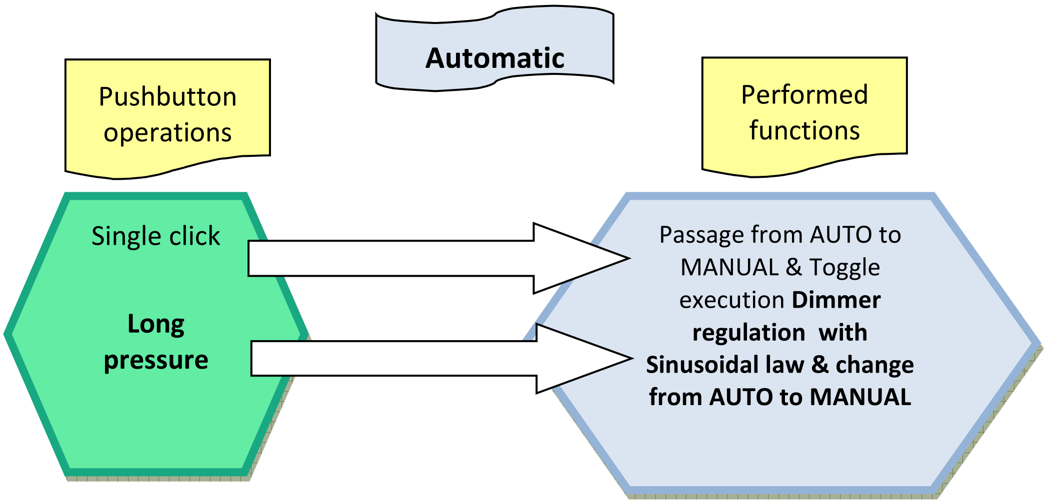
At the beginning of the lighting cycle of the room, i.e. at the first closure of the sensor (not in "Not Overlap Function"), the room lighting starts in **automatic** operation. This option is called Auto Automatic.

The functions are activated automatically with subsequent pressing of the button, as described in the following graphs.

A. Automatic operation:

a. Single short pressure: activates manual mode and performs the toggle (i) of the digital light activated by the specific button or (ii) of the analogue output (from 0 to 10 or vice versa) of the classroom to which the pushbutton refers.
b. Long pressure (more than 3 seconds): activates the manual mode and start adjusting the dimmer, if any, of the analogue output of the room where the button is pressed.

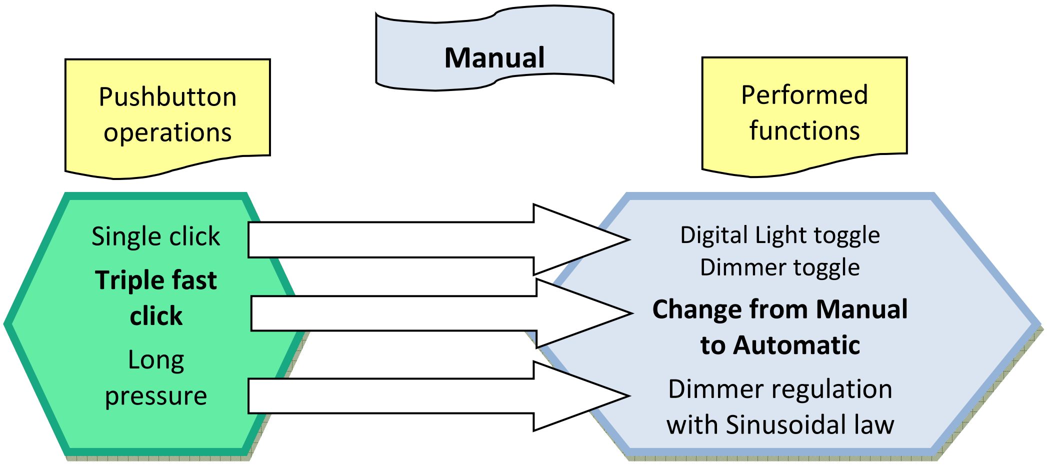
Figure 4-9: Automatic lighting management processes with presence sensors



B. Manual operation

a. Every single press run the digital and analogue toggle of the lights referred to by the button (from 0 to the maximum value).
b. Three close-ups pressures allow to reactivate the automatic function.
c. A long press allows adjustment of the dimmer, if any.

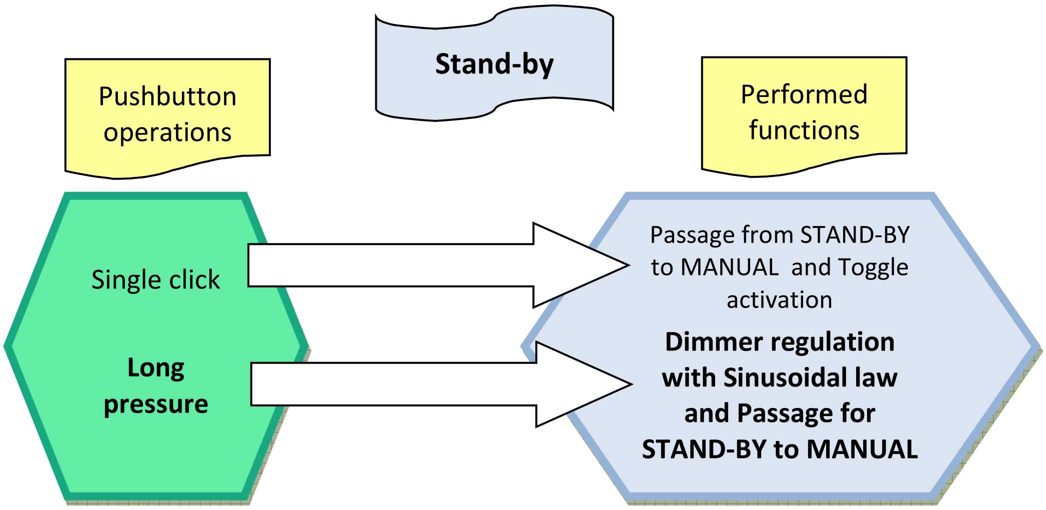
Figure 4-10: Manual lighting management processes with presence sensors



B. Stand-by operation

a. Single pushbutton pressure: activates the manual mode and performs the toggle light digital referred to by the pushbutton (0 to 10 or vice versa) of the classroom where the pushbutton is inserted.
b. Long pushbutton pressure (more than 3 seconds): turn-on the manual mode and start adjusting the dimmer, if any, of the room where the button is pressed.

Figure 4-11: Stand-by lights operation with presence sensors



4.1.3.1 Operation with Brightness Sensor

This situation, when needed, will be handled by the firmware, which is already settled up for this function. In this situation there will be a continuous control on the brightness.

Automatic functioning

The light will be adjusted according to the brightness detected in the same way illustrated in past paragraphs and described in the drawings.

<u>Pushbuttons functions</u>

The pushbuttons allow to select the way of use:

A. Automatic
B. Manual
C. Stand-by

When entering the room, light must be switched on manually. The starting situation of the room will be Manual. The functions of the pushbuttons are the same of the previous chapters, and will be described in the following pages.

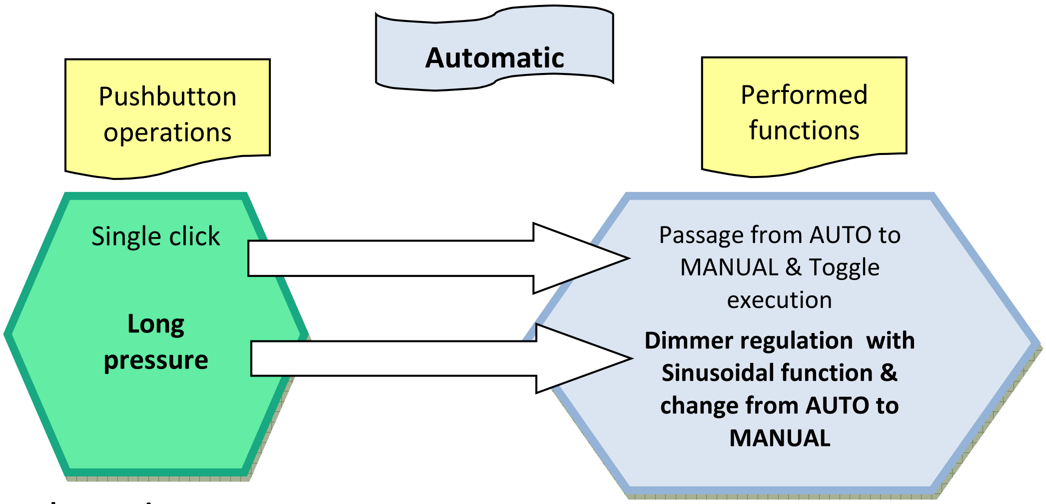
The functions are activated automatically with subsequent pressing of the button, as described in the following graphs.

<u>A. Automatic operation</u>:

Single short pressure: activates the manual mode and performs the toggle (i) of the digital light activated by the specific button or (ii) of the analogue output (from 0 to 10 or vice versa) of the classroom to which the pushbutton refers.

Long pressure (more than 3 seconds): activates the manual mode and start adjusting the dimmer of the analogue output of the room where the button is pressed.

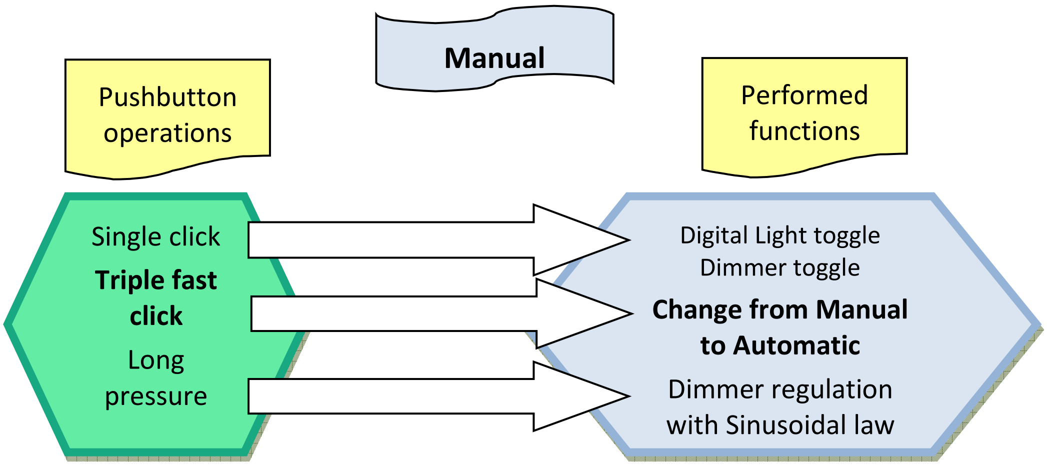
Figure 4-12: Automatic lighting management processes with light sensors



B. Manual operation

a. Every single press run the digital and analogue toggle of the lights referred to by the button (from 0 to the maximum value).
b. Three close-ups pressures allow to reactivate the automatic function.
c. A long pushbutton press allows adjustment of the dimmer.

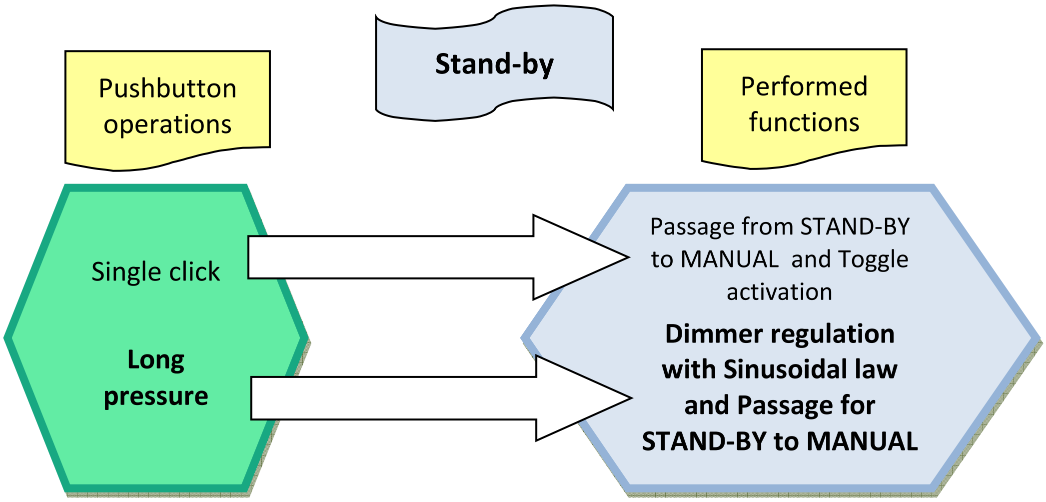
Figure 4-13: Manual lighting management processes with light sensors



B. Stand-by operation

a. Single pushbutton pressure: activates the manual mode and performs the toggle light digital referred to by the pushbutton or of the control (from 0 to 10 or vice versa) of the classroom where the pushbutton is inserted.
b. Long pushbutton pressure (more than 3 seconds): turn-on the manual mode and start adjusting the dimmer of the room where the button is pressed.

Figure 4-14: Stand-by lights operation with light sensors



4.1.4 Operation with no sensor

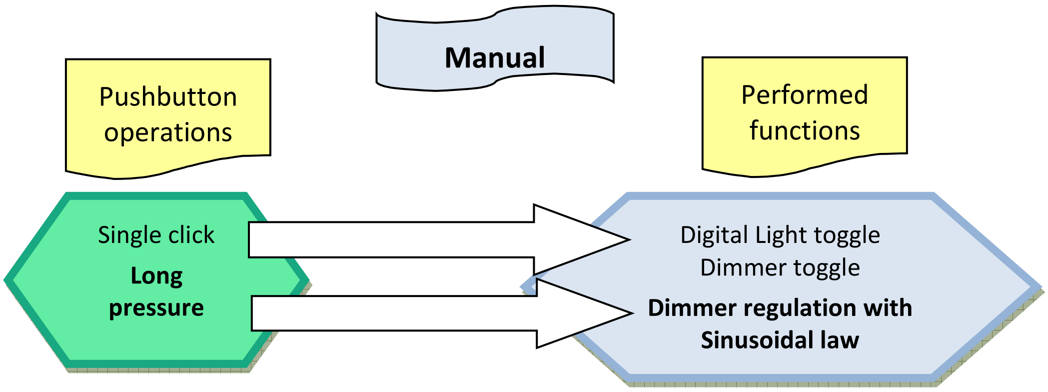
In this case there is no type of automatic management, therefore the use of lights is the classic one with the possibility to perform the toggle of controlled lights but also with the possibility to perform a manual adjustment of any dimming. In essence, the only possibilities are those described by the manual mode, the operation of which is shown in the following section. This function is used to exclude the light management by EVO Master unit, so to be able to make comparisons between the use with or without control unit.

Pushbuttons

A. Manual

a. Every single press run the digital and analogue toggle of the lights referred to by the pushbutton (from 0 to the maximum value).
b. A long pushbutton press allows adjustment of the dimmer.

Figure 4-15: Manual lighting management processes with no sensors



4.2 Temperature Control

The Firmware for the DOKI boxes has been developed for managing with a single unit:

- 2 rooms with maximum of 2 temperature sensors and 2 groups of radiators each;
- 1 room with maximum of 4 temperature sensors and 4 groups of radiators each.

Nevertheless, to simplify project management, only “single room and 4 sensors and actuators DOKI boxes” have been used in the VS Project, to reduce problems of installation, set up and management in 4 pilots and 3 different countries.

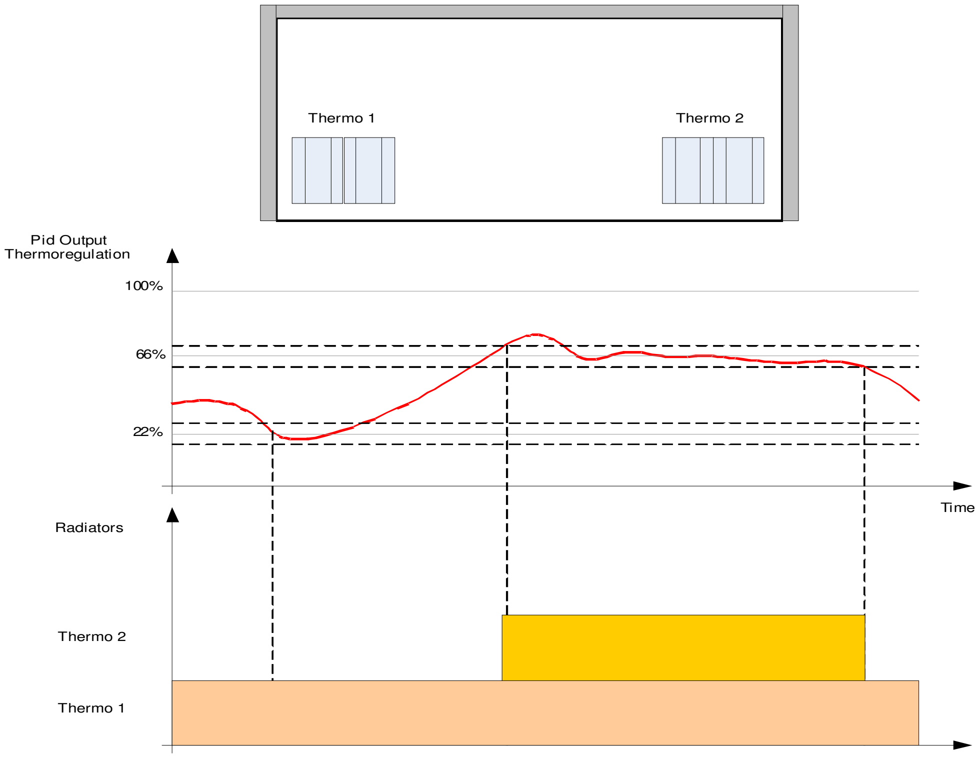
For completeness purposes, both 2 rooms and 1 room solution are illustrated in following pages.

4.2.1 Thermoregulation in 2 rooms

Thermoregulation Management is carried out with a Crono-thermostat 7/24 and a control of the PID type; the parameters are different compared to the PID that manages the brightness because the answer must be different, with inertia completely different. Input parameters are Set Point temperature, set by chronostat Software and the temperature probe placed in the environment.

Based on the output value is only activated a thermo or both as illustrated in the following graph:

Figure 4-16: Thermoregulation in 2 rooms with max 2 radiators groups each



If the switch-on of a radiator is enough to meet the needs of the classroom the second valve head will not be activated, while otherwise it will trigger both. This management is carried out in order to ensure maximum comfort (response time must not be too long) combined with the best possible energy savings.

The best parameters depend on several factors. In this phase will be necessary make on-site tests, but with the help of a “building modelling” will be possible to know the response time of the building, based on energy input and to adjust more precisely the opening of the heads through a calculation of energy balance. In addition with the parameters that manage PID, it’s possible to adjust also the intervention thresholds of the 2 heads.

<u>Thermoregulation in 2 rooms with maximum two groups of radiators each</u>

The part of the setting of set-point software is provided by using the Chronothermostat 7/7-24/24.

If the heads are of ON/OFF type it's necessary to adjust the percentage of intervention of the heads themselves and inform the system of how many heads are available. The trigger threshold has the same notion of lights. Through a PID, which is informed of both the temperature set point and the detected temperature, the need of heat is adjusted in analogue mode. If you have "modulating heads" the regulation will be more specific, if you use the classic on/off valves you will have the opportunity to select the thresholds above which intervenes the head of reference.

In other words, the points of intervention of each group of heaters/radiators is established in percentage of the difference between the detected temperature and the set point temperature; in this philosophy:

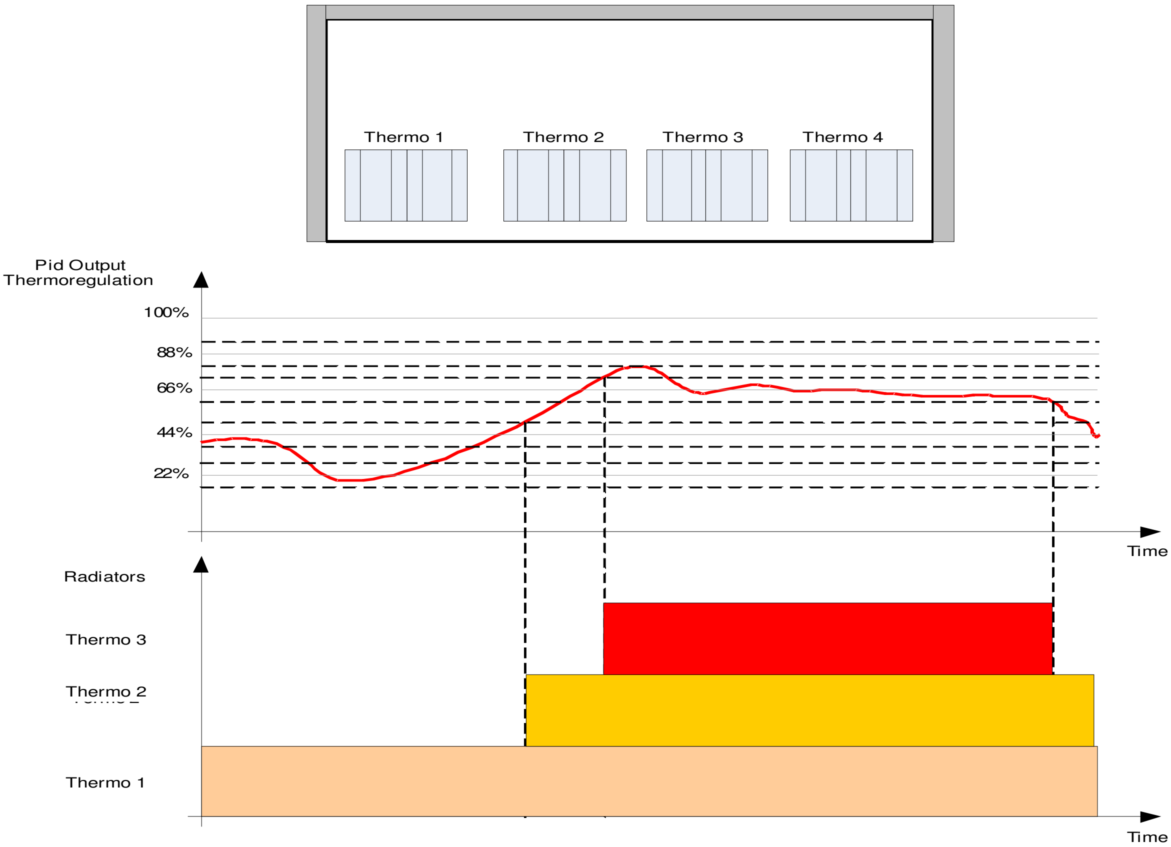
- The intervention threshold of Thermo 1 Classroom1 has a default value of 33% of the difference between actual room temperature and the settled temperature;
- The intervention threshold of Thermo 2 Classroom1 has a default value of 66% of the difference between actual room temperature and the settled temperature;
- The intervention threshold of Thermo 1 Classroom2 has a default value of 33% of the difference between actual room temperature and the settled temperature;
- The intervention threshold of Thermo 2 Classroom2 has a default value of 66% of the difference between actual room temperature and the settled temperature.

4.2.2 *Thermoregulation in one large room*

Thermoregulation Management is carried out with a control of the PID type, the parameters are different compared to the PID that manages the brightness, because the answer must be different with inertia completely different. Input parameters are Set Point temperature (set by chronostat Software) and the temperature probe (placed in the environment to be controlled).

Based on the output value is only activated a thermo or more, depending on how many are available (Section Parameters -> THERMOREGULATION), as illustrated in the following graph:

Figure 4-17: Thermoregulation in a single room with max 4 radiators groups



If the switch on of a radiator is enough to meet the needs of the classroom, the other heads will not be activated, while otherwise the EVO Module will trigger both, or, if necessary, also the other ones. This management is carried out in order to ensure maximum comfort (response time must be reasonable) combined with the best possible energy savings.

The best parameters depend on several factors. At the very beginning and during everyday use will be necessary to make on-site regulations. With the help of the “building modelling” will be possible to know the response time of the building based on energy inputs and to adjust more precisely the activation of the heads through a pre-calculation of energy balance. In addition, it’s possible to adjust also the intervention thresholds of the heads, adjusting the parameters that manage the PID algorithm.

Thermoregulation in one large room with a maximum of four radiators groups

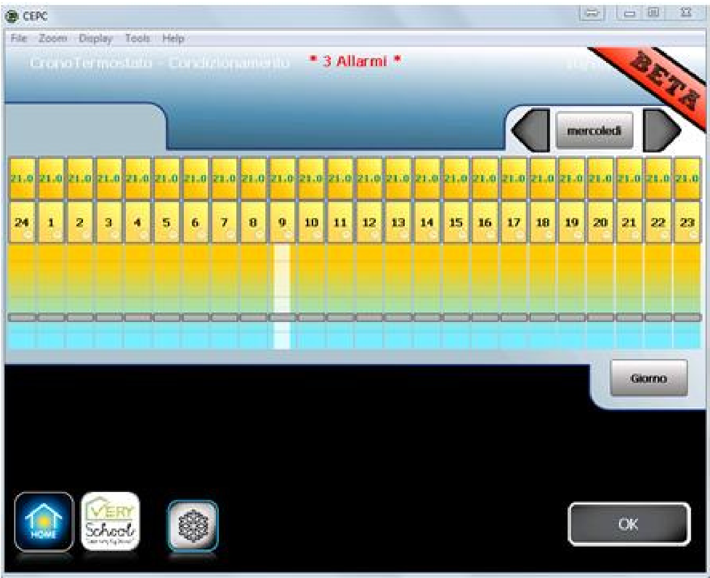
The part of the setting of Setpoint software is provided by using the Chronothermostat 7/24.

If the heads are of ON/OFF type it’s necessary to adjust the percentage of intervention of the heads themselves and inform the system of how many heads are available. The trigger threshold has the same notion of lights. Through a PID, which is informed of both the temperature set point and the detected room temperature, the need of heat is adjusted in analog mode. If we have “modulating heads” the regulation will be more specific, if we use the classic on / off you will have the opportunity to select the thresholds above which intervenes the head of reference.

- The intervention threshold of Thermo 1 has a default value of 22% of the difference between actual room temperature and the settled temperature;
- The intervention threshold of Thermo 2 has a default value of 44% of the difference between actual room temperature and the settled temperature;
- The intervention threshold of Thermo 1 has a default value of 66% of the difference between actual room temperature and the settled temperature;
- The intervention threshold of Thermo 1 has a default value of 66% of the difference between actual room temperature and the settled temperature.

All percentage values of intervention may be changed by the operator, according to the specific behaviour of the single room.

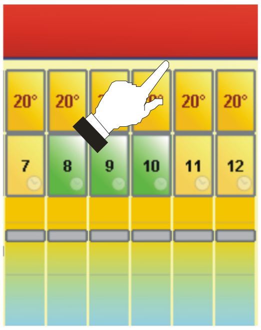
4.3 Basic operation of chrono-thermostat 24/24, 7/7.



Each hour is adjustable by dragging its title bar to the top (increase temperature set point) or down (decrease temperature set point).

Pressing the current day button (in the image above Wednesday) it is possible to choose the week or a single day of interest, only by using the key arrows.

You can select a time slot by scrolling with the cursor and the left mouse button pressed. In this way all the selected time slot may be changed. Pressing Week and Day the weekly thermostat will be changed.



To select the current season tap the following keys:

Summer  Winter  Off (Mid Season)

To change the whole week season you must first select "Week" and then enter the desired season. Same procedure may be applied to shut down the system (mid-season)

NOTE: to confirm this procedure press "OK" on the right- bottom part of the display.

4.4 Outputs Wear Counter

There is also a counter of time of the switch-on period for the outputs.

This means that in automatic, from the first power switch-on, a counter starts to monitor and to count the uptime of each output. So if you know the time of lights switching on or the time of heads opening it's possible to calculate the consumed value of energy. This calculation can be made from high level software, which may receive the accounting information, or, in addition these data can be stored in the local system itself. It's also possible to reset the counter to make it as accessible as possible.

Finally, there is the possibility to set a maximum number of hours beyond which an alarm is displayed. This can be handy if you know the average lifetime of the bulbs/lamps/valve actuators: the alarm displayed on the PC will inform that the bulbs/lamps/valve actuators have been switched-on for his "average life time" and it is time to think for a substitution. The FW is able to count the timing of activation of lamps and valves to allow a possible preventive maintenance, in order to reduce the substitutions in emergency situations.

The application of these results must still be subject to the approval of the response of the management of the individual school.

5 Next Steps and Future Work

Deliverable D6.1, and its four Annexes, is to be considered as reference for the next activities which will allow to demonstrate and to validate the BEMS itself, the execution of the Optimized scenarios and the overall performances of VSNavigator, through (i) real-time short-terms measurements and (ii) long-terms experimental campaign. Revision of the installed equipment may be possible, according to feedback for improvements coming from the experimental campaign. Whereas new equipment will be installed or change of the starting configuration may be required, the update of the documentation will be considered with the final report.

6 Implications for other Work packages

Deliverable D6.1 considered as inputs all the related information included in D5.1 “Energy Audit results”, and its four annexes. System specification documented with all the deliverables of WP2have been also taken into account, as well as contents, information and results of D3.3 VERYSchool BEMS: First version.

7 Conclusions

The content of deliverable D6.1 “Pilot implementation” focused on the results deriving from the DOKI BEMS installation in all the four Pilots, as outcome of completion of Tasks 6.1 “Pilot preparation” and Task 6.2 “Pilot installation”. Activities have been performed under WP6 “Demonstration (putting into action)”.

D6.1 is made by a master document (this report) and 4 Annexes, external to this document.

The overall set of documents include:

- technical specifications of each device (control module, sensors and actuators, LED technology, smart meters);
- drawing and layouts of the control networks, customized for the specific needs od each Pilot, together with a detailed connections of sensors and actuators to each control unit;
- technical specification of the monitoring and control performances and users manuals for the remote (web access) management of the DOKI BEMS;
- detailed list of Variables (physical measurement and HQDS calculations).

The result is a consistent documentation which enable Pilot Leaders to manage autonomously the DOKI BEMS when setting appropriate local conditions that may be required by school managers or by VERYSchool project requirement for implementing selected Optimization Scenarios.

DOKI BEMS provides all collected data (measurements, devices status, set-point configuration, alarms, and logs) to VSNavigator, so that VSNavigator applying the appropriate set-rules to the experimental data can extract from the Catalogue and suggest to the User all possible optimized scenarios.

Collected experimental data are stored into the VSNavigator database for feeding the simulation performances and validation of the Pilot calibrated models.