

**Diseminare rezultate proiect RetroKit
„Toolboxes for systemic retrofitting”**

Lucrare

„Wireless monitoring system for Air Quality Parameters”

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Forumul Regional al Energiei pentru Europa Centrală și de Est - a 13-a Ediție

FOREN 2016

„ENERGIE SIGURĂ ȘI SUSTENABILĂ PENTRU REGIUNE”

12-16 iunie 2016, Vox Maris Grand Resort, Costinești, România



Poze eveniment:





Reference no:

Wireless monitoring system for Air Quality Parameters

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1) Executive Summary (one page):

Indoor air quality (IAQ) is a term which refers to the air quality within and around buildings and structures, especially as it relates to the health and comfort of building occupants.

This paper is focused on the continuous monitoring for IAQ (Indoor air quality). The work was developed in the frame EU Fp7 program for the Retrokit project. For this it was used 3 demo buildings placed in Frankfurt, Madrid and Pitea – Sweden where different kind of retrofitting systems were installed in order to increase the overall building energy efficiency.

One of the Icpe tasks was to develop the continuous monitoring and control system for the IAQ. So Icpe designed a dedicated system composed of the following components: Combined wireless temperature/relative humidity and CO₂ sensors, access points and 3g data logger. All information is monitored by means of a 3G data logger that collects all the data from sensors placed in different parts of the sites and then transmit them to a data server. All the monitored data can be observed and download online.

Keywords (3-5 keywords):

Indoor air Quality, Monitoring, energy management, control optimization, energy performance, commissioning

1) Introduction

Indoor air quality (IAQ) is a term which refers to the air quality within and around buildings and structures, especially as it relates to the health and comfort of building occupants.

This paper is focused on the continuous monitoring for IAQ (Indoor air quality). The work was developed in the frame EU Fp7 program for the Retrokit project. For this it was used 3 demo buildings placed in Frankfurt, Madrid and Pitea – Sweden where different kind of retrofitting systems were installed in order to increase the overall building energy efficiency.

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2) Objectives and demo Sites presentation

The concept used for this work is based on the monitoring system developed by Icpe and its partners to the project.

In the following table (Table 1) there are presented the characteristics to be measured in the Retrokit demo buildings:

Type	Measurement	When	Location (inside ³ /outside ⁴)	Position inside
Continuous ¹	Temperature	Continuous measurements one year before, during and one year after renovation	Inside outside	All rooms
	Relative humidity			Living room
	CO2			Main bedroom
Weekly ²	PFT (passive)	Continuous passive sampling in winter during one week before and one week after renovation	Inside outside	All rooms
	Chemical (passive) (T)VOC Aldehydes NO2			Living room Main bedroom
Daily ²	Operative temperature	Continuous sampling/measurements during one (part of a) day in winter before and after renovation	Inside	Living room
	Air velocity (draught)			Living room
	PM2.5		Inside outside	Living room
	Noise level (indoor sources)		Inside	Living room Main bedroom
Instantaneous ²	Mechanical ventilation (supply and exhaust air flows)	Instantaneous measurements in winter before and after renovation	Inside	All exhaust and supply air devices
	Air tightness		n.a.	n.a.
	IR thermography		n.a.	n.a.

Table. 1 Types of measured data

The *Continuous* measurements are done one year before, during and one year after the retrofit if still possible; if not possible they will be done at least in winter before and after the retrofit; The *Weekly*, *Daily* and *Instantaneous* measurements will be done in winter, once before and once after the retrofit;
 The inside measurements will be done in 5 dwellings at least;
 The outside measurement will be done on the roof of the retrofit building (1 position) or at the front and at the back of the building (two positions).

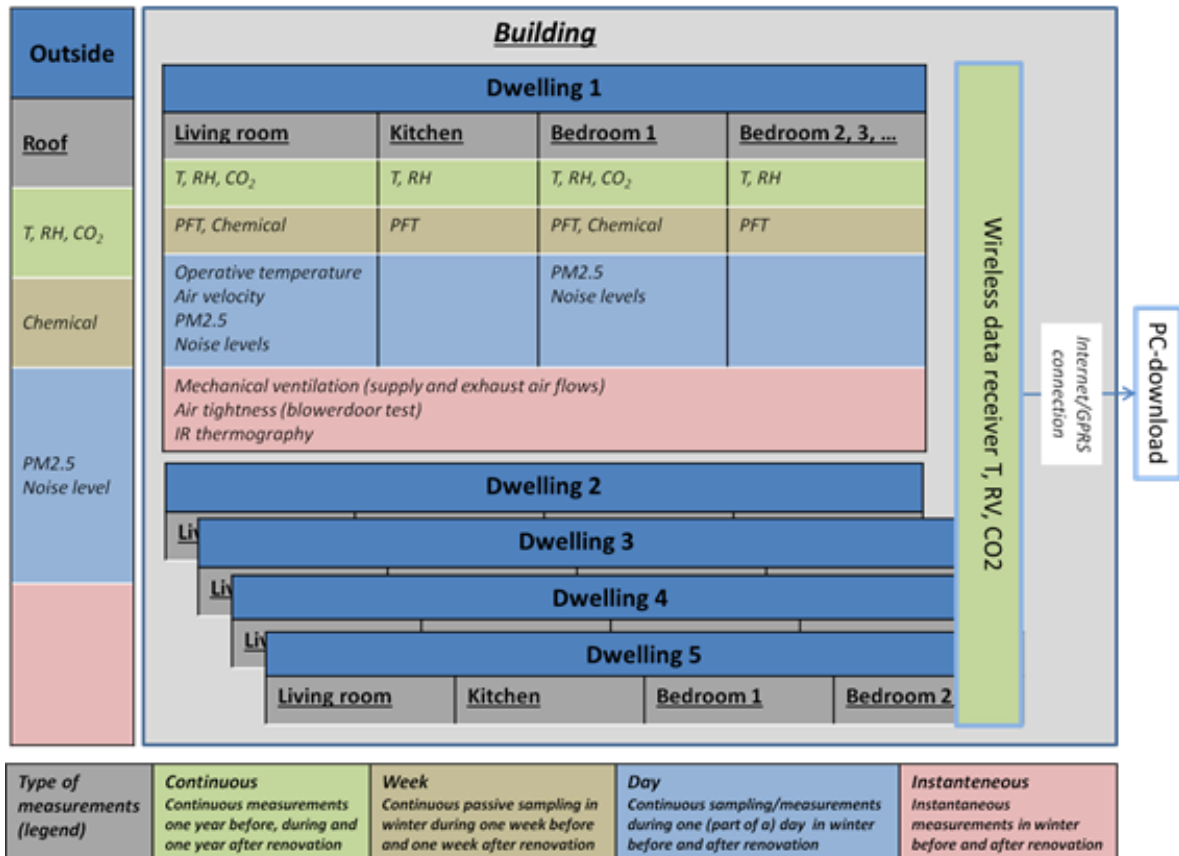


Fig. 1 Retrokit - Overview of basic and additional measurements: scheme of all WPI measurements inside and outside the building

The objective is to measure and record the Indoor Air Quality in 5 dwellings in Madrid, 5 dwellings in Frankfurt and 4 dwellings in Pitea.

To carry out the tasks of the projects, Icp together with other partners involved in the project for the Frankfurt demo Site designed and realised a dedicated monitoring system of the indoor air parameters.

Next we will present the proposed and installed monitoring system in demo Sites.

2.1) System description:

The solution chosen for the measurements required in the project is based on wireless sensor data automatically transmitted to a data logger with 3G communication. This solution does not limit the positioning of sensors in the house and has a low impact on the occupants. From the functional point of view the system satisfies the majority of the requirements.

System components for each location:

- Wireless sensor: t, RH - 15 pcs.
- Wireless sensor: with display: t, RH, CO2 - 5 pcs.
- Sensor wireless: t, RH, CO2 - 7 pcs.
- Access point - max 5 pcs.
- 3G Data logger - 1 pcs.
- Server for data acquisition - 1 pcs.
- Notebook - 1 pcs.

Location of Equipment:

- 2 - Wireless sensor: T, RH, CO2 outside the building, with protection against direct sunlight and rainfall;
- 2 - Wireless sensor: T, RH kitchen and bedrooms 2 and 3 of an apartment on each floor;
- 1 - wireless sensor with display: t, RH, CO2 in bedroom 1;
- 1 - Wireless sensor: T, RH, CO2 in the living room;
- 1 - wireless access point for each floor;
- 1 - 3G Data logger mounted on the 3rd floor staircase.

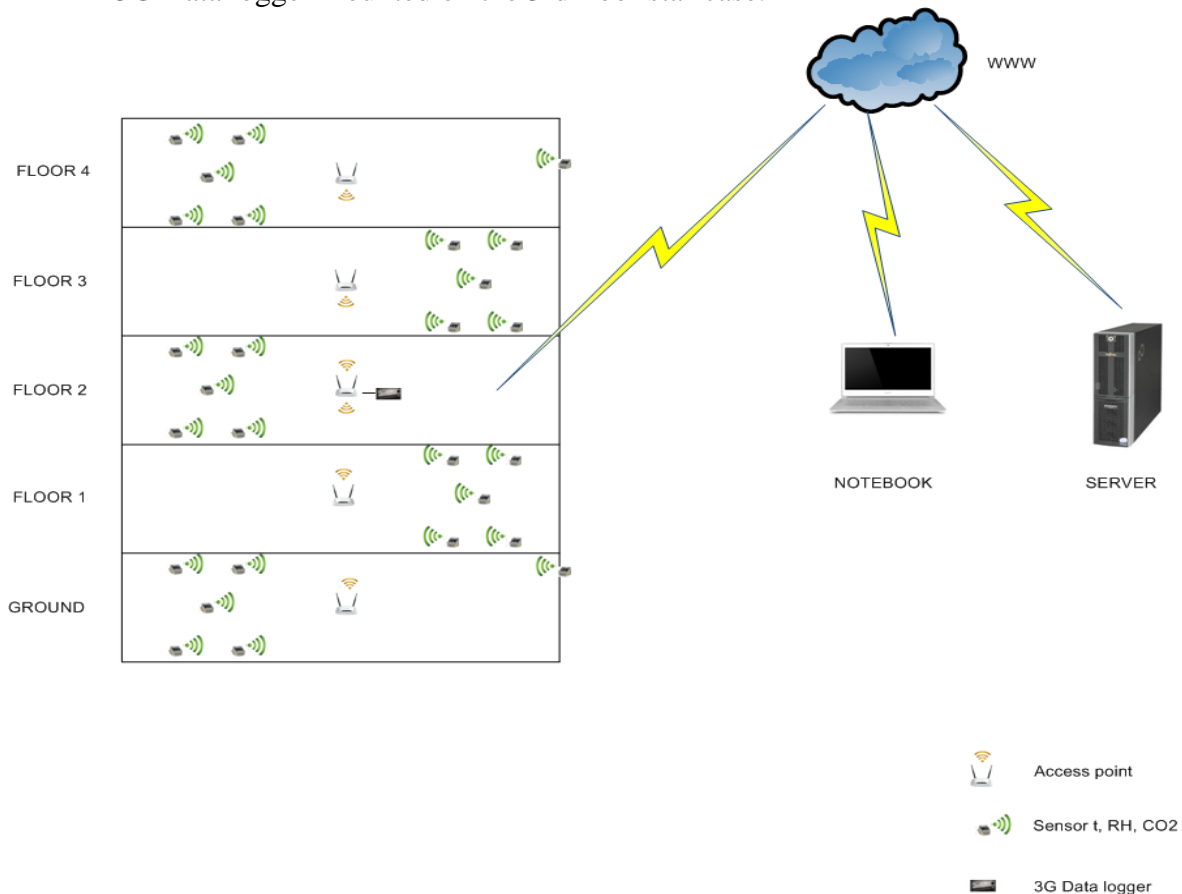


Fig. 2 System architecture

Functional description system:

Wireless sensors (t, RH, CO2) transmit the measured parameters at an interval of 15 minutes to the access point with the best radio coverage area, and then the data is retrieved from the access point base that is bound (wired) with Ethernet 3G data logger.

Communication between access points is done by means of Wireless Distribution System (WDS), a system that enables the wireless interconnection of access point sites in an IEEE 802.11 network. It allows a wireless network to be expanded using multiple access point's sites without the need for a wired backbone to link them, as traditionally required. The advantage of this solution is that it interconnects these points based on physical addresses of each device (MAC address) and provides radio coverage of the entire building.

All wireless system must use the same radio channel and the same encryption key.

Data from 3G logger is sent to the server where it is stored and from where it can download for processing and interpretation.

The monitoring systems installed in sites

In order to monitor and record the Indoor Air Quality parameters the following equipment is installed in each demo site:

Device	Description	Quantity Madrid	Quantity Frankfurt	Quantity Pitea
Wii Sensors	Temperature and humidity sensor	15	12	4
Wii Sensors with CO2	Temperature humidity and CO2 sensor	7	7	6
Wii Sensors with CO2 and Display	Temperature humidity and CO2 sensor with local display	5	5	4
TP-Link 841	Routers	5	3	2
Analytics 3G data Logger	Network data logger with 3G capability	1	1	1

Table 2 Equipment used in each of the 3 sites

The demo site in Madrid is represented by a block P +4 with 2 apartments with 4 rooms per floor. The monitoring system is installed in 5 of the 10 apartments in the block. Each apartment is monitored by 5 sensors, temperature/humidity sensors by 2 temperature / humidity / CO2. The sensors that monitor the amount of CO2 are located in the living room and in one of the bedrooms respectively. The access Points were mounted 2 on the ground floor, and one from the first, the second and the third floor. The 3G data logger is mounted in a cabinet at ground floor.

The demo site in Frankfurt is represented by a P +3 building with 2 staircases and 5 apartments per floor. The monitoring system is installed in 5 of the 20 apartments in the site. The sensors that monitor the amount of CO2 are located in the living room and in one of the bedrooms respectively. The Access points are mounted as follows: 2 in the attic and one in the basement. The 3G data logger is mounted in the attic.

The demo site in Pitea is represented by a block P +1 with 2 staircase. On one staircase there are 8 dwellings and on the other there are 4. The monitoring system is installed in the staircase with 4 dwellings. The sensors that monitor the amount of CO2 are located in the living room and in one of the bedrooms respectively. The access points are mounted one

on the staircase and one in a technical room. The 3G data logger is mounted also in the technical room.

Web platform

All recorded data can be viewed and downloaded online. Data is stored on an internet server. Recorded data is temperature, relative humidity and CO2 with sample rate at 15 minutes. The main page of the online platform (figure 3) displays the overview of all tree sites monitored: Madrid, Frankfurt and Pitea with the last measured value for each dwelling. Figures 4 and 5 present an example of how data is displayed for the last recorded values.

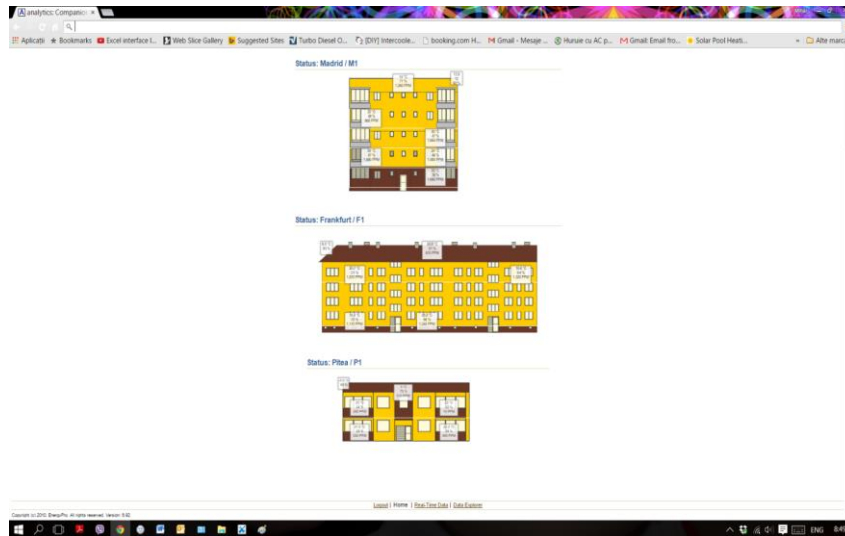


Fig 3 Main page of the measurement system

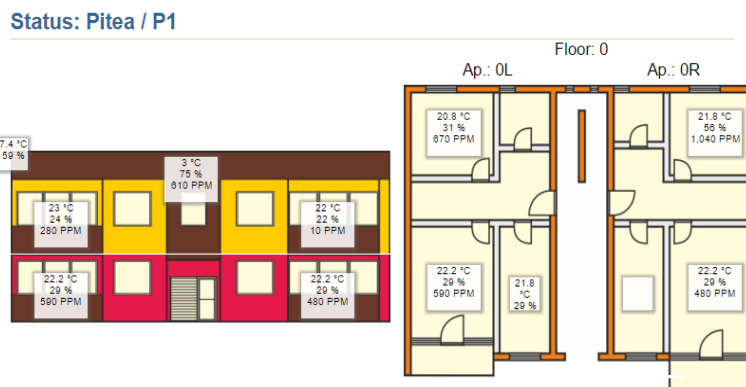


Fig.4 Web image for floor 0

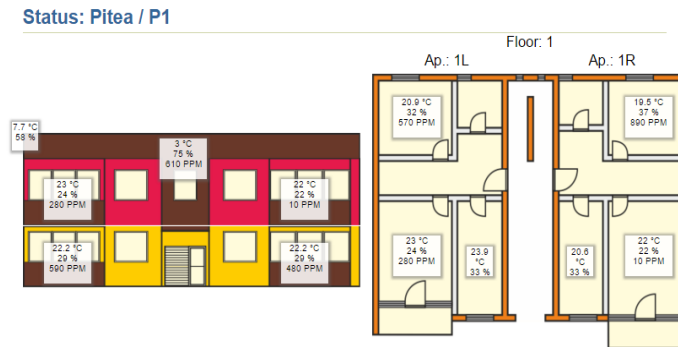


Fig.5. Web image for floor 1

3) Conclusion

The developed system achieves the requirements in order to measure and control not only the IAQ, but also in order to assess the impact of the coating and the insulation materials in the buildings energy efficiency.

Acknowledgement

This work is financed by the European Commission within the Collaborative project funding scheme, project number 314229 and call identifier: Fp7-2012-NMP-Energy-ICT-EeB-EeB and co-financed by UEFISCDI under the program PN II Capacities: Fp7-Module III (Contract no. 203 EU /21.06.2013).

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