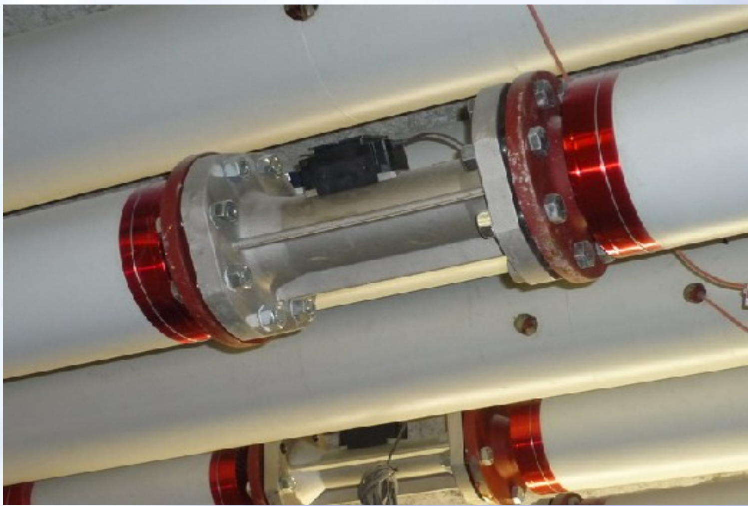
MONITORING CAMPAIGN IN GRAND LYON

Description of the methodology used for monitoring high energy performance large residential and tertiary buildings

A CONCERTO- RENAISSANCE PUBLICATION



What is CONCERTO ?

CONCERTO was launched and co-funded by the European Commission under the 6th and 7th Framework for Research and Technological Development of the Directorate-General for Transport and Energy (DG TREN).

The main objective of CONCERTO is to join innovation and demonstration efforts in the fields of renewable energy, energy efficiency and the building sector. CONCERTO focuses both on existing and new buildings, transforming them into high energy performance infrastructures in a **cost effective way** to offer **up to 80 percent in conventional energy savings** potential**.**

The CONCERTO initiative currently comprises 45 communities in 18 different projects in 18 European countries.

The CONCERTO project is often presented as a full-sized laboratory that is able to dare restrictive perspectives. **Capitalization and diffusion of contributions will be realized by CONCERTO PREMIUM**, an interdisciplinary team who conveys cities' recommendations to European Commission and national authorities.

What is RENAISSANCE?

RENAISSANCE stands for : **R**enewable **EN**ergy **A**cting **I**n **S**u**S**tainable **A**nd **N**ovel **C**ommunity **E**nterprises

RENAISSANCE was lauched in 2003. It currently comprises the consortium formed by Saragossa's Municipality (Spain), Grand Lyon area (France) and the region of Lombardia (Italy) as observer.

The project submitted by these cities stands for 2 exemplary urban operations and has been graded first rank by experts. **Grand Lyon** is the project leader since 2006.

In Saragossa, 616 social housings the Sustainable Town Planning Centre have been constructed in *Valdespartera* and 196 social housings and a school refurbished in *El Picarral. A Centre for Sustainable Urbanism* has also been constructed as an exhibiton and training centre.

In Grand Lyon, 660 dwellings and 15,000 sqm of office have been constructed in La Confluence as part of an ambitious city-centre urban regeneration.

The Region of Lombardia is involved on research and development project activites.

- RENAISSANCE project duration: 7 years - October 2005 to October 2012
- Total cost of project: 18 billions Euros, European contribution: 8,5 billions Euros

CONTENT

I. Introduction

The objective of the monitoring campaign is to evaluate in a detailed way the energy performances of the block A built in the framework of the RENAISSANCE project (CONCERTO European Program in Lyon Confluence). The present document describes the monitoring methodology used in 3 sections of estate of Lyon Confluence, and in particular the objectives, the type of devices used and type of measured flows. The 3 sections are to amount to approximately 78 000 square meters, of which 77 percent are for 660 dwellings and the rest a vast commercial area composed of offices and shops.

The monitoring campaign, conceived and implemented by the energy consultant office ENERTECH, covers all energy uses, air quality, system characteristics, and hygrothermal comfort. In addition, it encompasses surveys on occupants' behavior in the space, such as length and frequency of utilization of certain equipments. The ultimate goal is clearly to gain knowledge how well are implemented measures able to reduce energy demand, in view of modifying the design and global operation of high energy performance buildings so as to improve their actual energy performances.

II. Objectives

The monitoring campaign presented here is a deliverable of the CONCERTO RENAISSANCE project financed by the European Commission. The campaign concerns specifically an urban zone called Lyon Confluence, located in Grand Lyon, which is divided in three parcels further designated as blocks A, B and C.

Enertech contributed to key project phases prior to the implementation of the monitoring campaign, of which can be noted as milestones the support to design teams, analysis of Enterprise consultation documents (for the selection of property developers by the land planning company, here the SPLA), construction site follow-up through regular on site visits, and evaluation of the actual quality of the completed buildings compared to initial objectives. Enertech thus enters now in the last, but nevertheless one of the most important, part of the project. The monitoring campaign should indeed reveal actual energy consumption of the buildings, as well as air quality, behavior of different system and building characteristics and induced hygrothermal comfort. Technical data acquisition will be completed with surveys on occupants' behavior in the space, such as length and frequency of utilization of certain equipments.

The ultimate goal is clearly to gain knowledge how well are implemented measures able to reduce energy demand, in view of modifying the design and global operation of high energy performance buildings so as to improve their actual energy performances. Rather than pointing to specific master builders, the team in charge of monitoring and evaluation addresses the problem of inadequacy of design and implementation by identifying where in the chain of actors, is theoretical and practical knowledge missing, leading to a failure to reach initial performance objectives.

II.1. Measured quantities

A very large number of measuring devices have been put in place for the evaluation of energy performance. The length of the data acquisition period is one year.
Measurements are taken every 10 min. They cover the following flows and quantities:

- External climatic data (solar radiation on the horizontal plane, temperature and humidity, wind speed and direction);
- For boilers (2 gas boilers and one wood fuel boiler):
  - gas consumption,
  - useful energy production (at the level of heat meters) for heating and complementary hot water provision,
  - useful energy production for hot water by each heat pump,
  - useful energy production for heating by each heat pump,
  - air conditioning consumption (at the level of heat meters),
  - electrical consumption of boilers and substations in general,
  - total electrical consumption of devices permitting the generation and distribution of thermal energy (pumps, boilers, regulation, etc),
  - start and return temperature for heating loops (primary and secondary) and hot water networks,
  - temperatures characterizing the operation of heat pumps,
- General public services (for each staircase):
  - Electrical consumption at the main low-voltage board,
  - Electrical consumption of the main consuming elements connected to the main low-voltage board,
  - Electrical consumption of each staircase,
  - Electrical consumption of elevators, lighting, ventilation, heat pumps (4 over 10 are monitored in much details), in each staircase
  - Photovoltaic (PV) production – 4 staircases are equipped with PV panels,
  - Detailed electrical consumption of lighting circuits (levels, stairs, garages…) for four staircases,
  - Air extraction rate of 4 air treatment centers.

In addition, 10 percent of dwellings in block A, corresponding to 22 dwellings, have been monitored to evaluate the quality of services and the quantity of internal gains that contribute to heating. The following flows and quantities have been measured:

- Temperature (2 probes per dwelling) and humidity (one probe per dwelling),
- Total electrical consumption,
- Electrical consumption by use: lighting, audio-visual station, computer, air conditioning (all devices), cooking, complementary heating devices, and central temperature regulation device.

III. Implementation of the monitoring campaign

III.1. Measuring devices installed in the Renaissance area

The table below, table 1, describes the principal measurements taken in block A, and those that are expected to be realized in blocks B and C according to plan. The instrumentation of block B is identical to block A, however since block B is larger (345 dwellings in block A versus 176 in block B) than block A, not all buildings of block B will be monitored. For block C, the residential section (167 dwellings) will not be monitored entirely in order to keep a portion of measuring devices for the tertiary area.

In total, close to 2800 measuring devices had been installed over the three blocks by April 2010, which should have set the start of the monitoring campaign. However, delays occurred due to missing heat and electricity meters and damaging of certain equipment during the end of the construction phase. Thus, the campaign began in June 2010. All measuring devices will remain in place during one year, with a few intermediate acquisitions. The measuring devices are of the data logger type, meaning that they store data until it is emptied by download on a computer.

Table 1. Measuring devices installed or to be installed in blocks A, B, C.*

Measuring device types	Block A	Block B	Block C	Total
Outside temperature probe	1	0	0	**1**
Outside humidity probe	1	0	0	**1**
Radiation probe	1	0	0	**1**
Wind speed probe	1	0	0	**1**
Wind direction probe	1	0	0	**1**
Gas meter	2	2	2	**6**
Heat meter	27	10	12	**49**
Pressure measurement device + tachometer	4	6	10	**20**
Power meter with ammeter clamp or torus	313	320	450	**1083**
Wattmeter in series	74	125	150	**349**
Optical reader electrical sub-meters	130	130	140	**400**
Position sensor for heat pump	1	0	0	**1**
Lamp meter	79	80	120	**279**
CO2 sensor	8	8	10	**26**
OVC sensor	5	5	5	**15**
Inside humidity probe	32	55	65	**152**
Inside temperature probe	93	120	190	**403**
Totals	773	861	1154	**2788**

**Measuring devices are described more thoroughly in Annex 1.*

One-off measures of carbon dioxide (CO_2) and organic volatile compounds (OVC) are realized during the monitoring campaign in the majority of dwellings. CO_2 levels will be measured for one month during both summer and winter period of the monitoring year. Air flows have been measured at each dwelling air vent during the installation of measurement devices.

III.2. Measuring devices and measured flows in Block A

The following table 2, describes in greater details the instrumentation of block A.

Table 2. List of measuring devices installed in common parts and dwellings in Block A.

Location	Type of device	Nature of measurement	Number of sensors installed
Outside	Weather station	Measures temperature, humidity, radiation, wind speed and direction	1
Electric panel in 10 staircases	Multichannel systems	Electrical consumption for lighting and lifts	126
	Optical electronic reader	Electrical consumption of devices equipped with sub-metering (heat recovery ventilation, heat pump, Lighting, PV panels, …)	72
Elevator	Lamp meter	Lighting duration for cabins and elevator shaft	20
Boiler	Optical reader pulse counter	Counting number of pulses on heat meters, water meters, gas meters	8
	Multichannel systems	Electrical consumption of pumps, regulation system, …	42
	Thermometer	Measurement of heating temperature and temperature of hot water	34
Air treatment centers Heat pumps	Multichannel systems (for 4 staircases)	Electrical consumption of different motors and other elements (compressor, fan, regulation system, …)	24
	Flow meters (for 4 staircases)	Air extraction rate measurement	4
	Thermometer	Measurement of start, production and return temperature for hot water (for 4 staircases)	16
	Optical reader pulse counter	Counting number of pulses on heat meters	30
Lighting in staircase	Lamp meter	Lighting duration on levels and in stairwells in buildings Acajou, Acacia, Teck et Saule	40
Lighting in basement	Lamp meter	Lighting duration in parkings and certain common spaces	19
Dwellings	Multichannel systems	Electrical consumption of lighting, heating, etc.	132
	Optical reader	Total electrical consumption for each dwelling	22
	Thermometer	Measurement of room temperature	22
	Thermohygrometer	Measurement of room temperature and humidity	22
	Wattmeter in series	Electrical consumption of air conditioning, audio-visual stations and computer stations…	78
	Lamp meter	Plugged lighting	23

IV. Concept and methodology of the monitoring campaign

The steps for realizing the monitoring campaign are described below, from the conception phase to data acquisition and analysis. The procedure is summarized graphically in Figure 1 below.

IV.1. Conception and preparation of the monitoring campaign

This phase last approximately four weeks. The different milestones are the plan of the measuring campaign, identification of all measuring elements (location in building and nature of the flow to be measured), preparation of the material. Each block has 750 to 1000 measured points, this requiring rigorous work.

Simultaneously, contacts are made with households in order to identify occupants that are willing to participate in part of the monitoring campaign on private areas. In all, a little less than twelve percent of the total number of dwellings of blocks A, B, C will be monitored, totaling 75. Following agreement with a sufficient number of families, appointments must be made with them to install measuring equipment in designated dwellings.

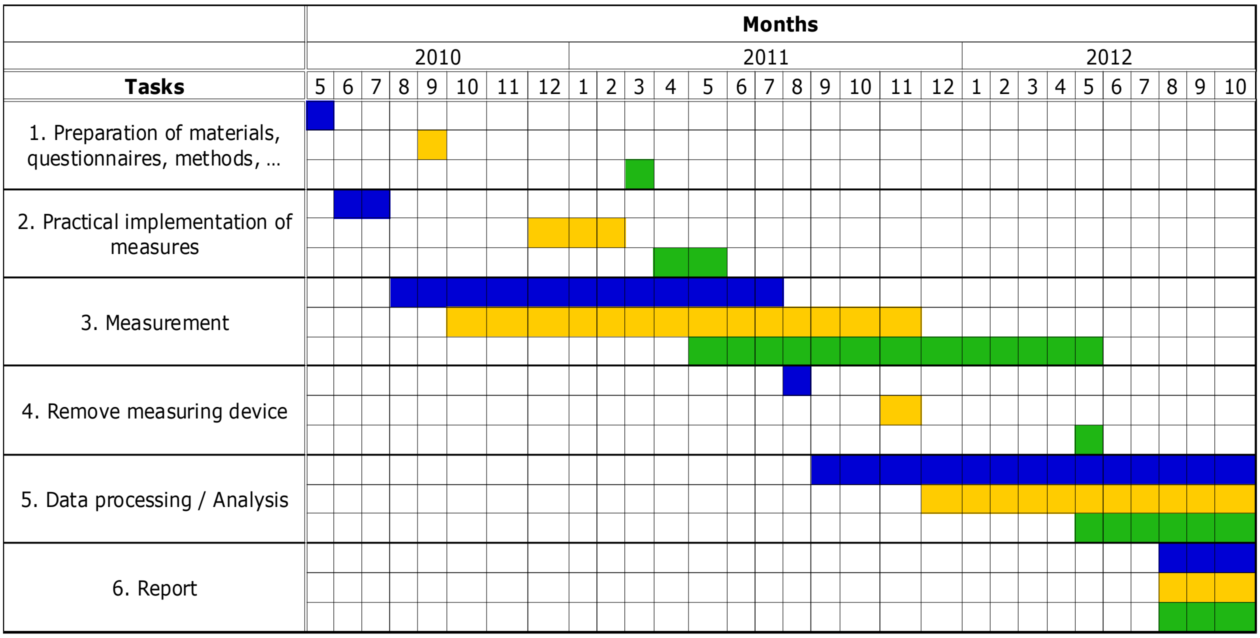
IV.2. Installing of measuring devices

The installation is realized entirely by ENERTECH. All devices stay in place for one year. However, due to size capacity of data loggers, two intermediate readings are made in order to empty the memory space of loggers and in certain cases, change batteries.

During the instrumentation period, which last several weeks on each site, surveys are filled with occupants of dwellings and offices.

IV.3. Measuring devices take off

All devices are taken off after one year.



Îlot	Total Number of households	Number of households
A	280	22
B	298	24
C	157	17

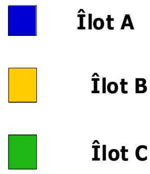


Figure 1. Essential steps and timeline of the monitoring campaign

IV.4. Data treatment and analysis

In total, 147 million data points are to be collected. These data points will be treated in a relational database. This work is lengthy and necessitates first to verify that the database is clean, in other words that there is no missing data points or double readings. Many coherence tests have to be performed in order to eliminate potential outsiders, data points that make no sense compared to the rest of the readings, so as to obtain a reliable database that can be analyzed.

The analysis of data comprises of two steps. In a first step, we determine averages consumptions and ratios of standard consumption of different fuels or for different usage. In a second step, we look for differences compared to what is observed in standard buildings, in order to highlight operation characteristics of this type of building. For this last step, ENERTECH has created powerful tools that allow a visual analysis of data and comparison of data using of several parameters simultaneously (up to 4 on the same graph). It is with this type of tool that we can track functional deficiencies. These are the focus of data analysis because they reveal what remains to be improved so that high performance buildings operate as they were design to do.

V. Annex 1: Description of measuring devices

V.1. The multichannel system

The multichannel system ensures the measurement of active power for electrical usages coming from different electrical panels. The consumption is registered every 10 min.

The multichannel system encompasses the following elements:

- a concentrator which registers only one voltage point for all measurements realized in the same electrical panel,
- modules equipped with closed toroids, ammeter clamps or flexibles toroids allowing measurement of current,
- a Palm allowing programming of the whole system.

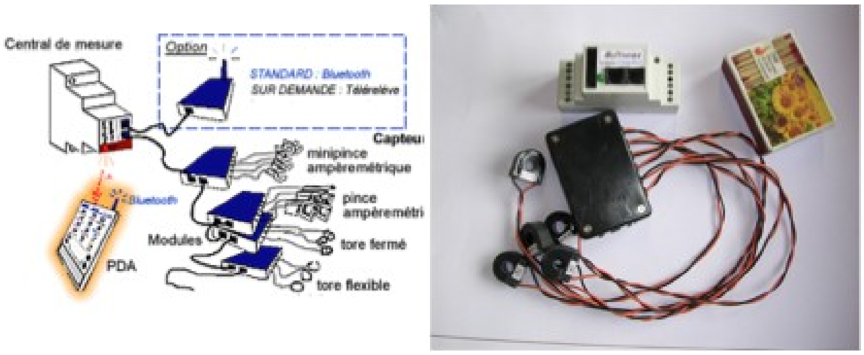


Figure 1 : The multichannel system for monitoring departures from the electrical panel.

The multichannel system stores data on electrical power but also allow the user to visualize in real time recorded measurements on the palm screen.

V.2. Wattmeter in series

This is a box 12 x 6,5 x 4 cm that can be placed in series on any kind of usage connected to an electrical plug. For this reason, it has both a plug and a socket 16A. It measures energy at a 10 min interval and has a memory large enough to store one-year data.

Figure 2 : Picture of a Wattmeter in series.

V.3. Optical reader

The optical reader is an apparatus that counts luminous impulses (or flash) emitted by electronic meters at each impulse. All meters in the building have been monitored with this kind of device. These data recorders are completely autonomous on batteries and their memory is large enough to store one-year data.

Figure 3 : Picture of an optical reader.

V.4. Pulse counter

The pulse counter records pulses coming from different devices such as heat or gas meters, at an interval of 10 min. These data recorders are completely autonomous on batteries and their memory is large enough to store one-year data.

V.5. Lamp meter

Lamp meters record lighting at constant power in dwellings. A lamp meter is a electronic recorder of small dimensions (5 x 2,5 x 1,5 cm) installed in proximity of each light source to be monitored. A flashing light indicates is the sensor is well positioned. The lamp meter has an optical sensor that measures only duration of operation of light systems. Its installation thus does not require any intervention on electrical circuits. However, upon installation, power of the lighting systems to be monitored must be recorded in order to deduct energy consumptions (power x duration).

Figure 4 : Picture of a lamp meter

V.6. Thermometer

The autonomous thermometer is a recorder of small dimensions equipped with a temperature sensor. It measures temperature every 2min and averages data points to get a value every 10 min, which is then stored. The thermometer has a wide range of measurements (-50°C à 120°C) thus permitting a large panel of applications. Its precision is +/-0.5°C between -20 and +80°C. This device has been used to monitor outside temperature, dwelling heating temperature, …

Figure 5 : Picture of a thermometer

V.7. Thermohygrometer

This autonomous device is an electronic recorder of small dimensions (identical in size to the thermometer) equipped with a temperature and humidity sensor. Data every 10 min can be stored for many months at a time.

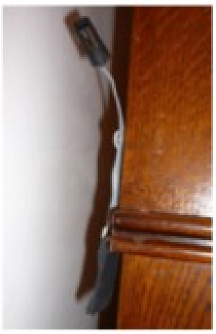


Figure 6 : Picture of a thermohygrometer installed in the back of a cabinet.

V.8. Weather station

A weather station has been installed on an another site close to Lyon Confluence (Bron). This station has a thermometer, an hygrometer, a pyranometer, a weather vane and an anemometer. These weather station were typically installed on roofs. They measure data at an interval of 10 min.

Figure 7: Picture of a weather station.

V.9. Air flow measuring device

Measurement of air extraction rate is realized by measuring the pressure drop at each end of the ventilation chamber as well as the motor speed. With these two measurements and the characteristic curve of the ventilator, it is possible to obtain the air extraction rate at an interval of 10 min.

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Sources ENERTECH

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Executive Summary

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