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First Newsletter

Energy consumption prediction with building usage measurements to support decision making in building retrofitting

Introduction

The current international crisis has been and will continue to be particularly severe to the European construction domain.

The outburst of the real estate bubble, which started in the decade 00, was globally connected to the outbreak of the financial crisis of 2007, of which no end is yet foreseen. We no longer have the previous availability and ease of credit for companies and families to invest in new real estate. The situation on the public sector is not better. A significant part of European countries have accumulated public debts much higher than markets are willing to accept. In the attempt to recover some ground, these countries have ceased or postponed investment in significant public infrastructures, which were before the motor of growth in the construction domain. This cooling in investments in new buildings has a significant negative impact in the economy, in general, and in employment, in particular.

Coincidently, or not, the crisis outburst matched an increase of oil prices to unregistered maximums. Like never before, it is imperative to make a rational use of the energy available to us, independent of its source.

It is in this context that building renovation is highlighted by many as a possible saving board for the construction sector. Some European countries, like France or Italy, where building retrofitting is around 70%, have been little affected by the crisis than other countries, such as Spain or Portugal, where building renovation has been a quite modest contribution to the construction domain. Additionally, building retrofitting is an opportunity to reduce energy consumption and CO2 emissions through the increase of energy efficiency and improvement of obsolete buildings.

Rui Neves-Silva
Project Coordinator

The EnPROVE project, started in 2010, focuses on the core of this issue at the right time. The project's main objective is to convince, in an objective and accurate way, the investors, either building owners or not, to invest in renovation of existing infrastructures. The recovery of invested capital happens by the reduction of energy consumption and in shorter periods than usually perceived.

This is the time to invest in conservation of existing patrimony, contributing to the preservation of our resources.

EnPROVE Rationale and Concept

When intending to renovate an existing infrastructure, with energy efficiency in mind, the question always arises: if the building owner is directing the available investment resources to an effective return and if this return could be improved by knowing the real usage of the infrastructure? Will it help to know how each area of the infrastructure is used to better predict the energy consumption and emissions impact of several technologies already available in the market?

EnPROVE is answering these questions using data collected from the infrastructure use and, based on it, provide accurate energy consumption predictions of alternative sets of technologies that could be installed. This will also serve to justify the necessary renovation investment based on a financial return-on-investment calculation.

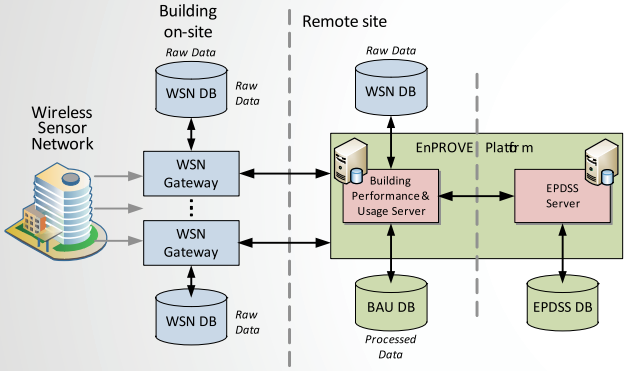
The objective of EnPROVE is to develop a decision support tool, which can communicate with existing architectural software programs, to help an investor in selecting the most appropriate set of technologies to install in a specific building, aiming at maximising the investment and improving energy efficiency.

Since each building is unique, EnPROVE needs to define how to obtain data on energy consumption of an existing structure based on the building's usage in an automated way. EnPROVE mines this data and uses it to predict future energy consumption in the structure within the software tool, as different options of energy-efficient technologies and control solutions are proposed.

EnPROVE focuses on the renovation of office buildings and supports different stakeholders: investor, consultancy service provider, equipment supplier and installer, certifier, auditing contractor and technical consultant.

EnPROVE Platform

EnPROVE includes solution aspects to audit a building, i.e. collect necessary usage data on the infrastructure, and a decision support system to enable the investor to select the best retrofitting scenario to apply in a specific building.



The EnPROVE Platform comprehends:

- the Building Performance and Usage Auditing (BAU) includes a wireless sensor network deployed in the building to be renovated, connected to local gateways that transmit data to the remote building performance and usage server, which processes this data and interacts with the auditing contractor; and
- the Energy Prediction and Decision Support System (EPDSS) responsible for interacting with the technical consultant to extrapolate the data collected from the building and predict energy consumption for several possible technical solutions, and enable the investor in selecting the best renovation scenario considering tangible (e.g. return on investment) and intangible (e.g. comfort level) criteria.

Project status

The EnPROVE project is now approaching the end of its second year, while progressing in the development of the EPDSS platform. The wireless sensor network has been deployed in a test site in Ireland, where the first tests of the project's results are occurring. The EPDSS is being finalised and will be fully integrated with the BAU-WSN in the beginning of 2012.

Building Usage and Performance Auditing

WSN technical description

The BAU-WSN (Building Usage and Performance Auditing – Wireless Sensor Network) is one of the cornerstones of the EnPROVE project as it gathers and records audited data regarding consumption, performance and usage within office buildings.

The first part of the system is the Wireless Sensor Network (WSN) itself comprising heterogeneous wireless sensor nodes installed throughout a building to monitor all aspects of how it is being used (e.g. presence, HVAC, light, doors, etc). These sensors report to a central gateway, belonging to the WSN, installed in the audited building.

Figure 1: WSN components & EnPROVE platform server

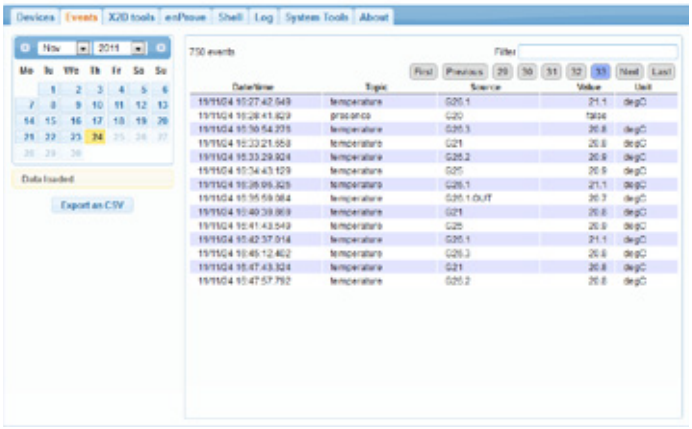


Figure 2: Audited data, recorded as Events, in an EnPROVE box database

The different gateways (EnPROVE boxes), deployed within the audited buildings, store this information locally, in their own database. A box is built on an OSGi software platform, in which each audited data is converted into an "Event" with a particular semantic (there are different kinds of events).

This information is then forwarded, on a daily basis, to the second part of the system which is the EnPROVE remote platform. The transmission is performed invoking a web-service, implemented on this platform. The platform holds a central database that stores the raw information of all audited buildings (all EnPROVE boxes deployed).

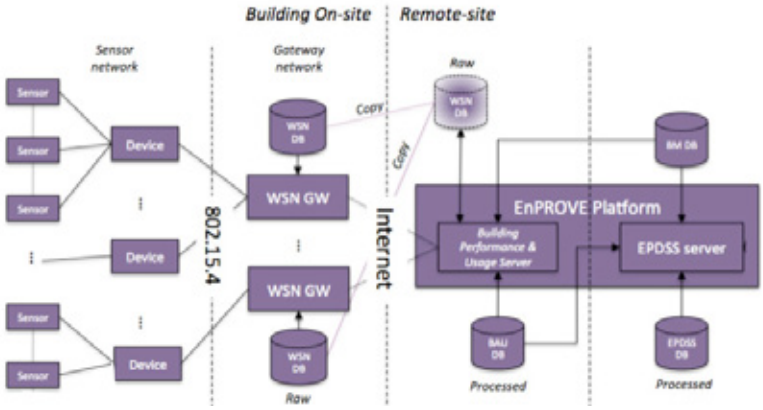


Figure 3: Overview of the BAU-WSN & EnPROVE server components and interactions

Raw audited data are processed by one of the EnPROVE server software component called the "Building Performance & Usage Server". The processed and refined information is thus made available to another key component of the system which is the EPDSS prediction engine, in charge of elaborating energy saving recommendations (which will be explained in a future newsletter).

WSN installation & on-site deployment

The EnPROVE platform will be validated in two test sites. The first is the site of one of the research partners in the project, CLARITY. The CLARITY Centre building is under use and it has the possibility to test several scenarios by turning on, or off, several energy-efficient devices, already installed. The measurements performed in this building are being used to evaluate the EnPROVE prediction accuracy in a real environment but under controlled testing conditions.

Before the deployment, an accurate map of the building to be audited, showing the physical areas and locations, must be retrieved. A selection of the audited areas and spots must be done (= audited scope).

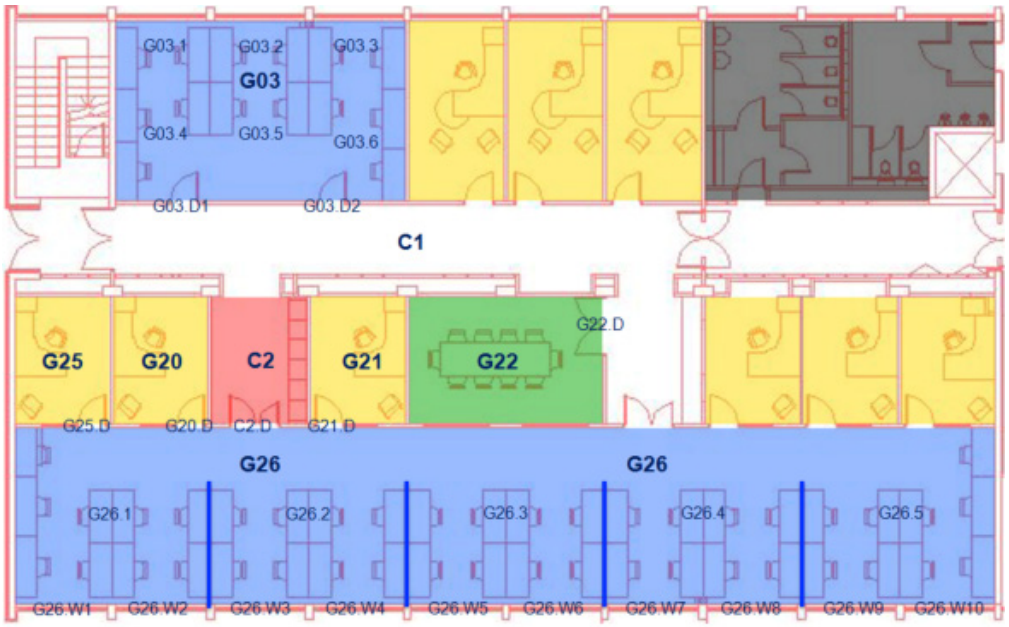


Figure 4: Physical locations

Then, within this physical map, it is necessary to perform a partitioning strategy defining the Lightings and HVAC zones (which can be significantly different).

Before performing the actual sensors deployment, each sensor must be identified and located on the building map, according to the auditing requirements.

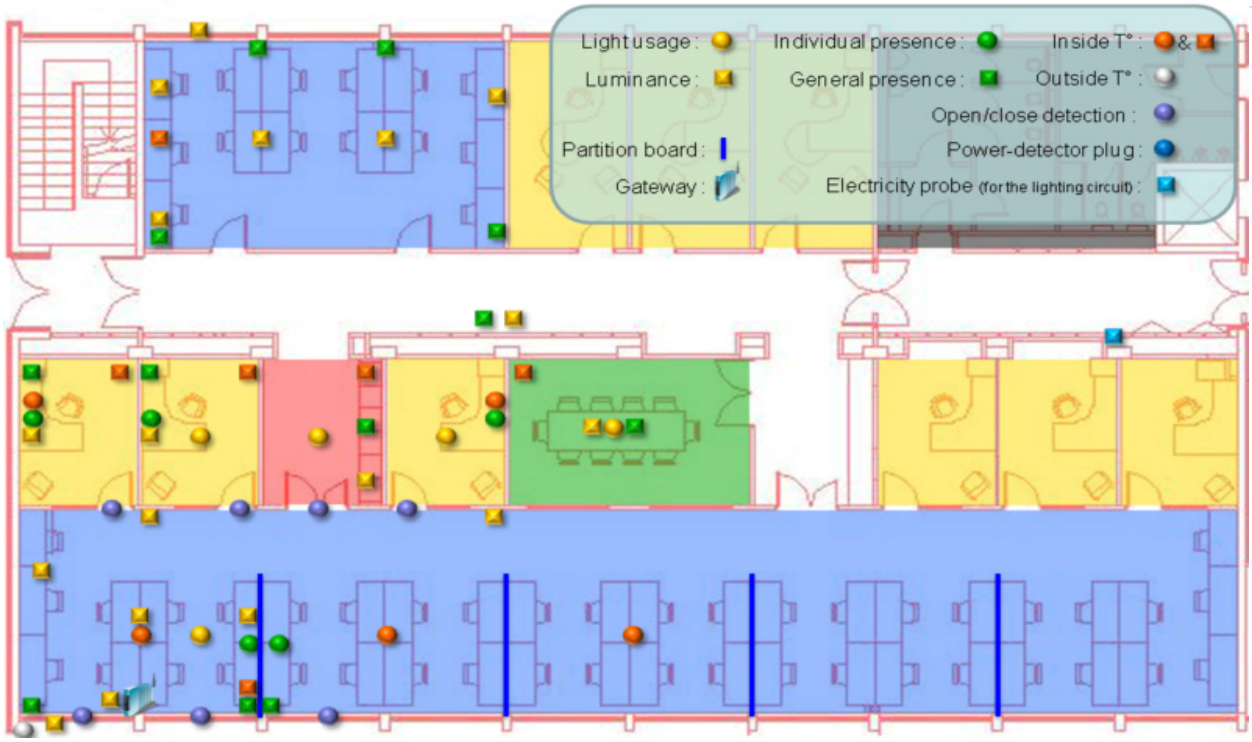


Figure 5: Sensors deployment map

Figure 6: WSN Deployment

Figure 6 demonstrates several parts of ongoing data collection by using the Wireless Sensor Network deployed at CLARITY premise in Ireland. The current testbed comprises luminance, presence, and temperature sensor nodes. We deploy these sensor nodes at several positions such as corridor, individual office, write-up area and meeting room, to measure light usage, temperature level, and people presence. As shown in the figure, a light sensor is enclosed by a paper cover while being attached on a window in order to measure the outside luminance. Moreover, we can observe several presence sensors have been put in proximity to desk in order to detect people presence.

Past events

ECTP – E2BA – Eracobuild conference 2011, Warsaw, Poland, 4 - 5 of October.

This 5th Conference of the European Construction Technology Platform, combined with a Conference of the Era-Net Eracobuild, showed how the Construction sector contributes to EU2020 ambitions and illustrated the ECTP objectives to develop Innovative Buildings and Infrastructures to construct Europe's future, to innovate through research and integration of inputs from other sectors using appropriate tools (such as PPPs) in the next Common Strategic Programme, and to conduct two major European Initiatives: E2B (Energy-Efficient Buildings European Initiative) and reFINE (Infrastructure Networks of Europe Initiative). EnPROVE project was presented by Piotr Dymarski representing Mostostal Warszawa. This presentation is available on our project website.

Photo: Luc Bourdeau (ECTP Secretary General), Jacek Czech (Deputy General Secretary, Polish Chamber of Commerce), Ger Maas (Strategy Director, Royal BAM Group, ECTP HLG Chairman - Construction and Europe's Societal Challenges), Minister Olgierd Dziekonski (Secretary of State, Cabinet of the President of the Republic of Poland), Andrzej Siemaszko (President of the Polish NCP for FP7 - 7th FP), José-Lorenzo Vallès (Head of Unit G.2, DG Research and Innovation, European Commission).

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Project partners

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