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WP 4.1.6

BENCHMARK ANALYSIS OF MEASURING AND MONITORING ENERGY EFFICIENCY

CENTRO DI ECOLOGIA TEORICA ED APPLICATA

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1 Introduction

The activity 4.1.6 is a preparatory phase for work plan 4.2 about ICT system to support energy efficiency measures and to reduce emissions in public and historical building cluster. New technologies provide utilities for knowledge in the interest of the human welfare. This includes ethical aspects of protecting human life as well as aspects of consumer safety and the preservation of our natural environment.

By incorporating the ITC system into a holistic, energy-saving green building strategy, building owners and operators may not only save money on utility bills, but also realize a positive return on investment over the life of the system while reducing the environmental impacts of greenhouse gas emissions and other harmful pollutants.

A key green building principle is to provide a high level of occupant comfort and improve the overall conditions of the building indoor environment. Studies have shown that people who are comfortable are more productive. In a work environment, increases in productivity can result in overall cost savings to a company due to higher efficiency worker output. The implementation of systems that contribute to better overall controllability can increase occupant comfort. Furthermore, the implementation of a web interface allows building maintenance staff to conveniently monitor system performance and address potential occupant comfort issues that may arise.

2 ICT system

ICT (Information and Communication Technology) is used as a general term for all kinds of technologies which enable users to create, access and manipulate information. It consists of all technical means used to handle information and aid communication, including intelligent building management systems.

The European Commission and stakeholders have set out what ICT can do to improve the energy performance of buildings. ICT can be instrumental in achieving more efficient use of energy through simulation, modelling, analysis, monitoring and visualisation tools that

are needed to facilitate a "whole building approach" to both design and operate buildings. Moreover ICT will also play an essential role in facilitating the implementation of policy and in measuring its effectiveness.

The vision for ICT supported energy efficiency of buildings is advocated as follows:

- in the short term: buildings meet the energy efficiency requirements of regulations and users;
- in the medium term: the energy performance of buildings is optimised considering the whole life cycle;
- in the long term: new business models are driven by energy efficiency and are supported by the public statements made by various stakeholders and decision makers.

Building automation and controls are most effective to enable energy savings in the building sector:

- contribute to optimal use of renewable energy;
- control a changing network topology with a huge number of energy providers;
- help to establish new energy services and solutions;
- contribute to smart energy market places;
- induce behavioural change.

The use of ICT system will:

- conserve energy and electricity;
- reduce Greenhouse Gas Emissions (GHE);
- increase occupant comfort and satisfaction.

3 Benchmark analisys in Europe

ICT is becoming increasingly diffuse within Europe for its big potential to save energy in many sectors. The European Commission (Work Programme for ICT research in FP7 for 2011 and 2012)[1] aims to make sure ICTs contribute to the development of a more

[1] URL: http://cordis.europa.eu/fp7/ict/home_en.html

sustainable Europe and to attaining the European Union's climate and energy goals of expanding the use of renewable energies, reducing greenhouse gas emissions and increasing energy efficiency by 20% by 2020.

SMART 2020[2] report found that ICT could enable emissions reduction of 15% of global emissions in 2020, but it must keep its own growing footprint in check and overcome a number of hurdles if it expects to deliver on this potential.

The Commission is, therefore, pursuing a wide variety of activities to advance the contribution of ICT in the areas of Energy Efficiency of the ICT Sector:

- Energy Efficient Buildings;
- Smart Cities;
- Smart Electricity Grids;
- Smart Metering;
- Climate Change Management:
- Water Management.

According to the European Parliament the use of such technologies can also increase construction industry's competitiveness:

- lightning of the public and private areas;
- control of heating and cooling;
- environment monitoring.

ICTs are technologies that will reduce greenhouse gas emissions through:

- intelligent electrical grids;
- intelligent buildings;
- remote meter reading;
- eco-efficient transport operation;
- environmentally friendly industrial processes;
- corporate sustainability.

[2] URL: http://www.smart2020.org

European Parliament intends to prod the Commission and the Member States into promoting efficient solutions with the use of ICT also through procurement and financial instruments. The benchmark analysis of measuring and monitoring energy efficiency in Europe cover:

- simulation based energy design;
- early energy design;
- integrated modelling solutions based on BIM (Building Information Model);
- smart metering for energy consumption awareness;
- building management systems;
- wireless sensor networks for energy performance monitoring;
- standards based energy performance assessment software;
- energy performance audit solutions;
- websites for collecting and disseminating energy-efficiency “good practices”;
- smart grids;
- standards-based solutions for building life-cycle management;
- standards-based energy data exchange solutions.

According to Smart2020, it’s possible identify different areas to improve energy efficiency in building through the use of ICT:

- design and simulation tools that minimize energy consumption (e.g. simulating and optimizing envelope measures and passive solar heating techniques);
- monitors and sensors that can help more accurately measure usage, system status and equipment conditions;
- single control system and related sub-system to have separate controllers for energy consumption (e.g. heating, cooling air conditioning, mater, etc.);
- building automation to improve life quality (e.g. more comfortable, safer homes, etc.);
- smart metering to enable more accurate measurement of consumption connected to a central unit through a communication network;
- users’ awareness tools to change incorrect behaviour on energy usage.

3.1 REEB

REEB[3] (the European strategic research roadmap to ICT enabled energy-efficiency in building and construction) is a project supported by the European Commission. The aim is to help the creation of a Strategic Research Agenda (SRA) and a supporting Implementation Activity Plan (IAP) for sustainable and energy-efficient smart building constructions. These objectives are achieved through the dialogue between interactive and complimentary communities of practice from energy, environment and building construction domains.

REEB will establish a community operating method that will allow these communities to act as breeding and nurturing grounds for innovation in bringing together the relevant organisations and stakeholders for the purpose of starting up innovation in ICT, supporting energy efficiency in smart building constructions.

The REEB consortium involves eight partners with complementary expertise drawn from six European countries (France, Finland, Spain, Ireland, UK, Germany) and promote participation in community discussions and decisions.

3.2 ICT4E2B Forum

ICT4E2B Forum[4] promotes communication and understanding between experts in different sectors in energy efficiency of buildings. ICT4E2B Forum is based on the Roadmap and International Community created within the framework of the REEB project with a clear business focus for translating ICT challenges for energy efficient buildings into a new generation of products, processes and services.

The Forum aims at bringing together all relevant stakeholders involved in ICT systems for Energy Efficiency in Buildings with the objective of identifying needs, challenges and opportunities for further research in this field:

- presentation of results and news on project;
- increase in visibility and dissemination opportunities;

[3] URL: http://www.ict-reeb.eu
[4] URL: http://www.ict4e2b.eu

- facilitation to take part to discussions, to ask for hints and suggestions, to give advices, to contribute to our roadmap highlighting future needs and challenges.

3.3 BeyWatch

BeyWatch[5] (Building Energy Watcher) is a project supported by the European Commission (DG Information Society and Media), in the project portfolio of the "ICT for sustainable growth Unit", aiming at ICT tools for environmental management and energy efficiency. BeyWatch will develop an energy-aware and user-centric solution, able to provide intelligent energy monitoring/control and power demand balancing at home/building & neighbourhood level. To reach its objectives, the project has undertaken the following:

- implement methods, techniques and services to reduce the power consumption by intelligent control of electrical devices;
- generate hot water and electricity from renewable energy sources at building level (flat, home, office or single building);
- elaborate business plans and business support system (BSS) applications, based on cooperation between the users and the utility, that will help them to reach better contracts;
- enable money saving and a greener home;
- balance energy distribution and reduce the service cost of the power distribution network;
- allow easy monitoring and control of home appliances through graphical user interface (GUI);
- motivate user's awareness, towards less CO_2 emissions on the whole energy value chain (production, transportation, distribution, supply) and cleaner environment.

[5] Beywatch project, winner of the Best ICT for Energy Efficiency project Award, is funded under the FP7 of the European Commission (DG Information Society and Media). URL: http://www.beywatch.eu

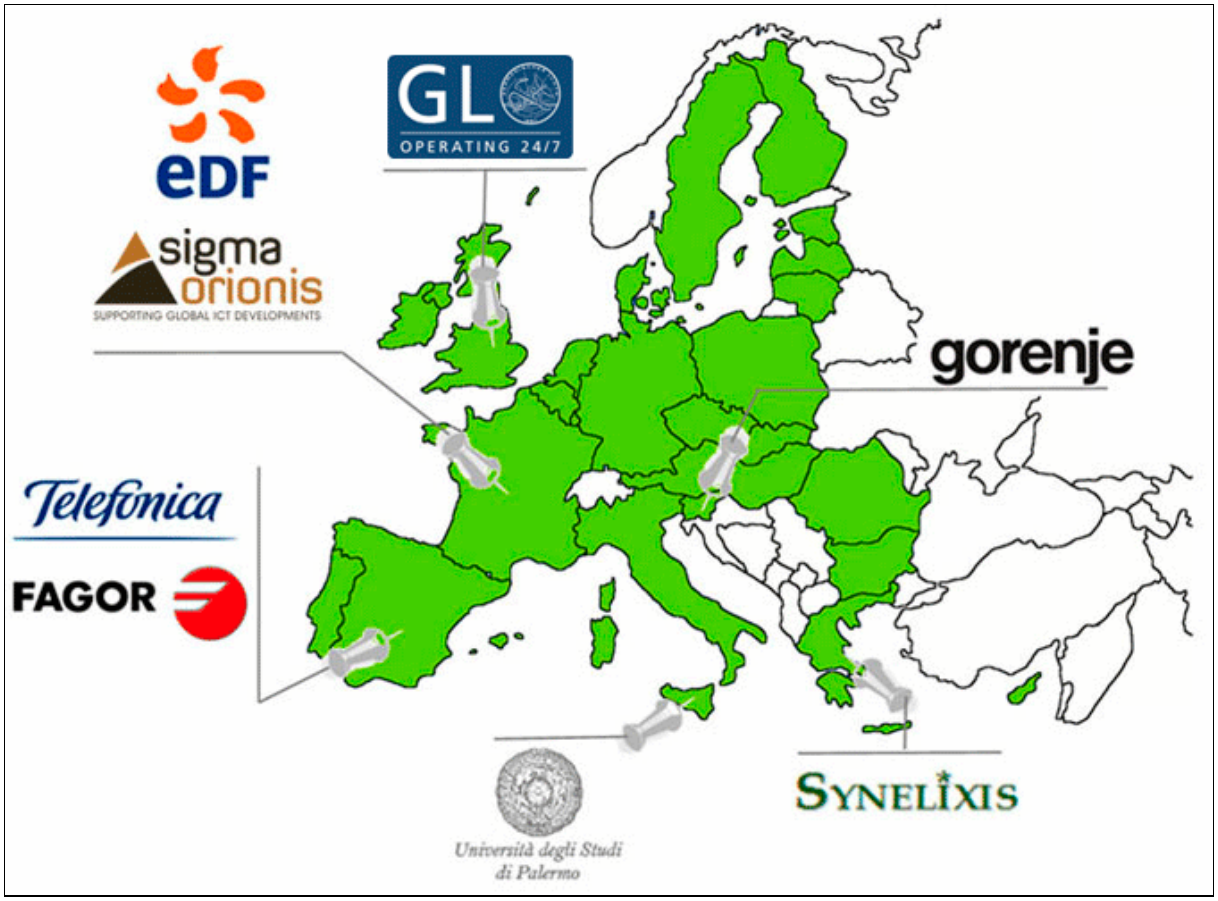


Fig. 1 – Organizations involved in the BayWatch project.

One of the most important results will be the incorporation of the system in a large-scale energy consumption smoothing and power demand planning system, as well as the cooperation with external service centres that will allow the remote reprogramming of the controller with different models, profiles, and operational parameters.

To achieve its objective and to support the European Commission's proposals to save energy consumption through improved energy efficiency, BeyWatch has established a consortium of eight key players in the field, including major service companies, manufacturers, technology companies, universities and SMEs.

3.4 International conference and exhibition

Every year in Nice (France) *Sigma Orionis*[6], in cooperation with the *Beywatch* project, organizes an international conference and exhibition called "ICT for sustainable homes". [7] Foreseen topics for the 2011 edition (October 24-25), now in its 3rd year in a row, include:

- smart grids;
- business models;
- building energy efficiency;
- smart home from inside;
- ICT for energy efficiency.

Innovative products and services for the home, among which those based on ICT, will have to be developed in the future and will be the main differentiation criteria of tomorrow's homes (or apartment buildings or community areas). ICT cannot only contribute to making homes "greener" (ICT for energy management, for environment monitoring, etc.) but more globally to ensure a more sustainable life (ICT for the elderly and the handicapped, ICT for all, ICT for social networking and interaction with local services, etc.).

[6] URL: http://www.sigma-orionis.com
[7] URL: http://www.ict-sustainablehomes.org

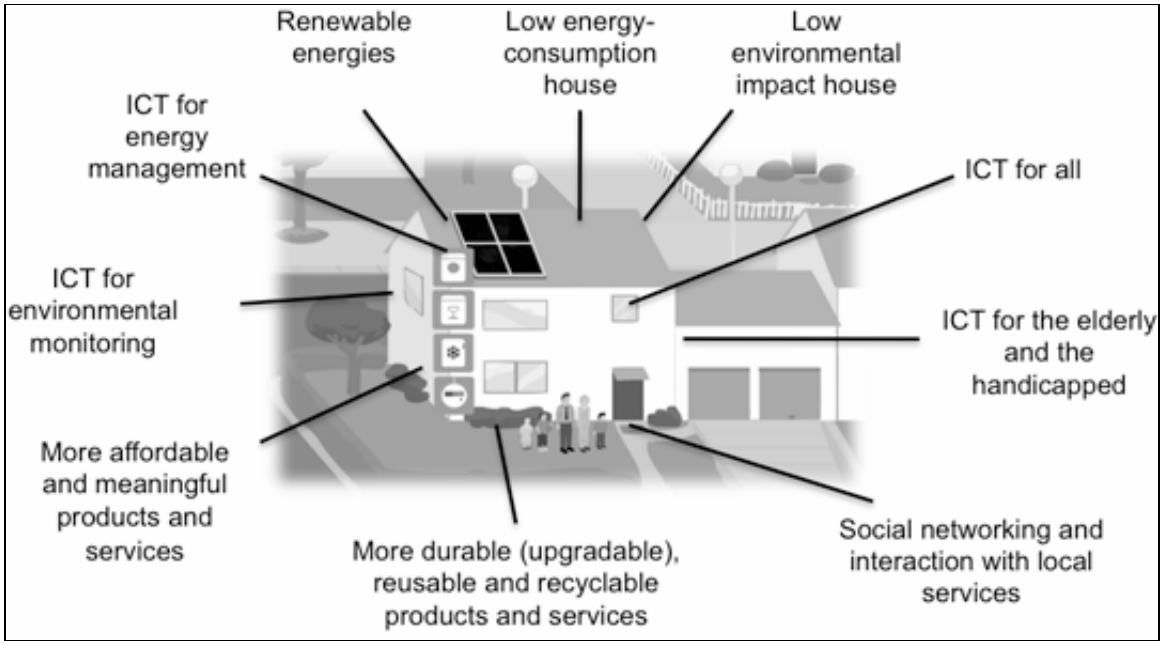


Fig. 2 – ICT for sustainable homes. Source: www.ict-sustainablehomes.org/about/background

4 Benchmark analisys in Italy

ICT is becoming increasingly diffuse within Europe, nevertheless it is not so common in Italy. Though it is one of the most important markets in Europe for the Information Technology and Communications sector, the market registered a significant decrease versus the previous years, but some signs of recovery manifested themselves towards the end of the year 2010. The Italian ICT market does still suffer from long-existing structural problems and is undersized and lags behind in comparison with the other major European countries. The technology gap is still significant, although ICT penetration is improving.

The Italian Government is committed to modernizing the country through the development of policies which will accelerate widespread acceptance and use of new information and communication technologies, both in the public and private sectors, by offering grants to small and medium size enterprises.

4.1 The eSESH project

The project called eSESH[8] (*Saving Energy in Social Housing with ICT*), started in March 2010, is partially funded under the ICT Policy Support Programme (ICT PSP) as part of the Competitiveness and Innovation Framework Programme by the European Community. Pilots of eSESH services are located at 10 sites in 6 countries across Europe and 32 organisation are cooperating to provide ICT, based Energy Management Services (EMS) and Energy Awareness Services (EAS) directly to social housing tenants.

In Italy three pilot sites (Brescia, Piacenza e Pesaro) are involved in the project and provide effective ICT monitoring and control of local generation of power and heat. By supplying social housing providers, regional and national government with the data they need to optimise their energy consumption (heating, electricity, water) and to adapt their behaviour. The project will help Europe meet emission targets by achieving a significant reduction of energy consumption in European social housing.

Data are evaluated in terms of whether their consumption is to be judged as high or not and in comparison to other consumers and over longer periods of time. The tenants will get access to these services (EAS) through a web-based platform which will allow them to quickly and easily obtain consumption information at monthly, daily or even shorter time-intervals. It's possible compare the consumption of a tenant to those of others or to same consumption in the past.

[8] URL: http://www.esesh.eu

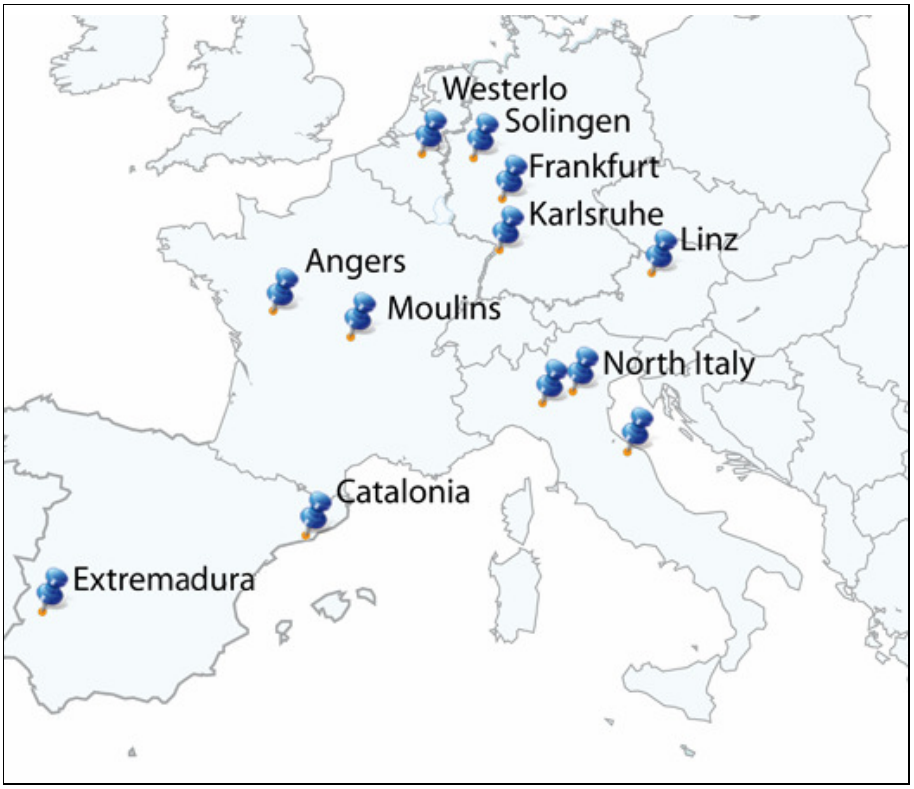


Fig. 3 – Countries and sites involved in the eSESH project.

In Italy three housing cooperatives (FINABITA, PIACENZA74, COOPCASA and VILLAGGIO DELL'AMICIZIA), supported by GREENERGY, will implement and pilot Energy Awareness Services for fixed timing peak demand reduction and for encouraging overall energy saving. The proposed actions will be implemented in around 540 flats located in the provinces of Brescia, Piacenza and Pesaro. The goals are:

- archive of building's energy consumption;
- archive of productivity of plants;
- easy internet accessibility;
- data input readings of the energy, gas and water counters, installed in building;
- instant view of fuel consumption through displaying devices;
- possibility to compare tenants' consumption;

- monitoring of energy consumption;
- control systems and optimization of internal housing temperature.

The project requires a interaction with users throughout the course of the initiative through:

- participation at specific events;
- publishing news on press;
- collective information through brochures;
- individual information through meetings;
- distribution and collection of questionnaires on approval of the initiative;
- device installation with support of cooperative staff.

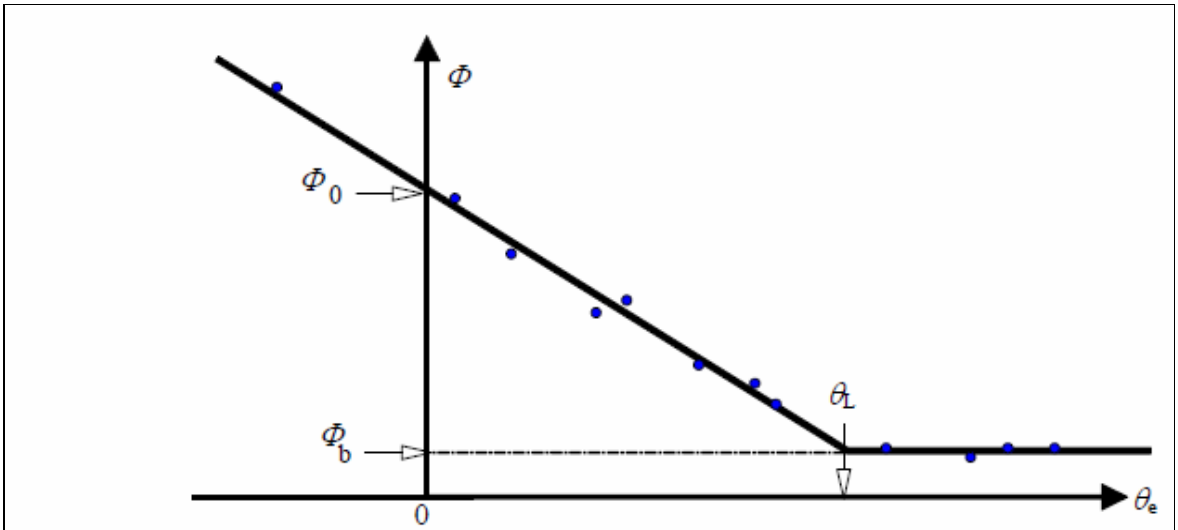
Tab. 1 – Input and output for ICT system in eSESH project.

INPUT	information on buildings and users
	data on direct/centralized energy supply
	reading of the counters of all supplies in building
OUTPUT	indicators of energy and water consumption, per unit area per year
	data regarding both the building and the individual accommodation
	presentation of data in the form of graphic and tabular
	reports printing of the building

4.2 "Energy signature" method

Recently a new monitoring method, called "Energy Signature" ("Firma Energetica" in Italy[9]) is developing. This tool in one possible means to optimize, regulate and control energy use within existing and future buildings. "Energy signature" is an innovative extrapolation method for the rapid calibration of heating and cooling energy consumption in new and existing buildings, historical too. Heating and cooling energy use is correlated to climatic data over a suitable period.

[9] URL: http://www.firmaenergetica.it



Key

H	slope
Φ	*average power between two successive records*
Φ_0	power at 0 °C
Φ_b	base power, not dependant on external temperature (e.g. for system loss and hot water)
θ_L	heating limit external temperature
θ_e	external average temperature between two successive records

Fig. 4 - Energy signature, principle.

This monitoring method is a graphic representation (linear regression) of real energy consumption (heating, cooling, power, ventilation, hot water, lighting, etc) in function of an external parameter (usually external temperature).

The method is recently implemented in prEN 15603 "*Energy performance of building – Overall energy use and definition of energy ratings*" (Annex "B"). The tool allows:

- to define energy auditing;
- to identify incorrect users' behaviour and malfunction system;
- to represent the system loss;
- to optimize and to measure heating and cooling system;
- to provide useful information on the building energy performance;
- to increase building energy efficiency;

to inform users and make them aware of the importance of their particular actions.

“Energy Signature” method might be inserted in a common software to evaluate and compare energy consumption of buildings which will be analysed to diagnose the performance and to improve the quality.

5 Conclusion

Information and Communication Technology can make a significant contribution to saving energy, both by autonomous optimization efforts and by inducing changes of user behaviour. Within Europe ICT is becoming increasingly diffuse, nevertheless it is not so common in Italy. Therefore in all countries it’s important to identify engagement strategies that help the diffusion of ICT and the consumers' involvement. This will require extensive cross-disciplinary and cross-sectoral approach for an enhanced holistic view of ICT for energy saving. Moreover, it must be supplied and supported with appropriate software (e.g. in the form of energy measurement, accounting and management systems) and human skills in order to maximise the use of ICT (e.g. through ongoing training, education, knowledge transfer, measuring, monitoring, control, optimization, simulations, reviews, business model innovation, e-government, etc.).

In the context of follow-up activities (e.g. Wp. 4.2: “ICT system to support energy efficiency measures”) it would be appropriate to consider and test the opportunity to establish an energy efficiency monitoring program in public buildings. The program should aim to create an international, intersectoral and interdisciplinary cooperation (e.g. Energy Monitoring Society) to compare consumption data and trends in different project partner countries, and to develop common energy saving plan and optimize the price of energy.

Local and regional authorities can take a leading role by promoting energy efficiency initiatives using ICT. When used in a “smart” way, it will help to significantly reduce our societies’ demand for carbon-based energy, while at the same time offering interesting business opportunities for industry and guaranteeing a desirable lifestyle for the citizens.