Project No.: 285150

Project Acronym: SEEDS

Project Full Name: Self learning Energy Efficient builDings and open Spaces

SECOND PERIODIC REPORT

(Publishable Summary)

Period covered: from 01/09/2012 to 31/08/2013

Period number: 2nd

Start date of project: 01/09/2011

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Version: 1

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1 Publishable summary

1.1 Overview and project objectives

SEEDS is an on-going FP7 project on ICT technologies for Energy Efficient Buildings. It develops innovative technologies for optimizing building's performance in terms of energy, comfort, and life cycle costs. It is based on an innovative modelling methodology based on measurements, self-learning, optimization techniques and wireless technologies. SEEDS can be applied to buildings and surrounding open spaces. SEEDS is particularly attractive for the retrofitting of existing buildings.

SEEDS focuses on the operation stage of the building. It develops a *Building Energy Management Systems* (BEMS) to optimize energy behavior of the building over a time period. It performs detailed modeling of the HVAC and lighting equipment, energy sources and energy storages. The modeling of the energy equipment in the building is based on IFC – an Open BIM data exchange format.

SEEDS implements an innovative model predictive control strategy based on sensor measurements and self-learning techniques. This methodology allows taking into account the properties of a building and its energy behavior without the need of having explicitly the architecture model of the building. If available, SEEDS uses BIM data about the building floorplan/layout and the building services structure. In other words, SEEDS allows designing a BEMS using only the information available on the building facilities and the appropriate set of measurements that are captured by wireless sensor nodes which are also required to implement the most energy efficient control strategy. There is no need to have detailed architecture information (such as material parameters, thermal capacities etc.) and thus, SEEDS can be easily applied to the energy-aware upgrading/optimization of existing building services systems and to the retrofitting of old buildings which may lack constructional specification details necessary for traditional systems. Moreover, the use of wireless technologies allows an easy and fast deployment

The final goal of SEEDS is the development of a BEMS based on measurements, self-learning and wireless technologies. SEEDS' BEMS relies on the following objectives (O):

O1. Development of innovative methodologies for the monitoring and control of energy consumption parameters inside buildings and surroundings or districts based on self-learning and optimization techniques.

O2. Optimization of the building's (including surrounding space and district) performance in terms of comfort, functionality, energy efficiency, resource efficiency, economic return and lifecycle value.

O3. Development, demonstration and validation of a methodology suitable for retrofitting and new construction including open spaces.

O4. Integration with existing control systems (like safety, security, fire alarm or lifts).

O5. Exploitation and dissemination of the technologies developed and best practises learned.

O6. Contribution to the reduction of greenhouse gas (GHG) emissions and, by hence, contribution to the fulfilment of the SET-Plan on energy efficiency.

To achieve this goal, the following scientific/technical objectives (STO) are pursued:

STO	Objective Description	Related to WP	State
STO1	Development of a modelling methodology for a wide spectrum of building types and energy systems and subsystems.	WP1, WP2	Finished
STO2	Research and development of scalable implementations of global optimization algorithms.	WP5	On-going
STO3	Development of self learning and optimization behavioural models for energy systems and subsystems in buildings.	WP1, WP2, WP5	Advanced state
STO4	Development and adaptation of a network of Wireless Intelligent Sensors and Actuators (WISA) and design and implementation of communication middleware and configuration tools for the WISA.	WP3, WP4	Finished
STO5	Development and refinement of anytime self-learning and optimization algorithms able to cope with the requirements of energy management systems.	WP5	On-going
STO6	Validation and implementation in two pilot demonstrators.	WP1, WP7, WP8	On-going

Table 1. Scientif/technical objectives

The above STO are linked to the following technical achievements (TA)

TA#	Technical achievement description	Related to WP	State
TA1	Processes, systems and tools for the development of a BEMS based on self-learning and optimization techniques.	WP1, WP2, WP3, WP4, WP5, WP6	Advanced state
TA2	Holistic classification of building types and energy systems and subsystem and methodology for energy control systems modelling.	WP1, WP2	Finished
TA3	Design of energy systems and subsystem behavioural models and implementation into a library.	WP1, WP2	Finished
TA4	Design, development and implementation of a network of WISA and communication middleware and configuration tools.	WP3, WP4	Finished
TA5	Development of anytime self-learning and optimization algorithms tuned specifically for BEMS.	WP5	On-going
TA6	Implementation of scalable global optimization algorithms with relevant computational infrastructure.	WP5	On-going
TA7	Validation and implementation of the technologies developed. Drafting of 'Best ICT practises for energy efficient buildings and surrounding spaces'.	WP1, WP7, WP8	On-going

Table 2. Technical achievements

Table 1 and Table 2 above include the status of STO and TA at the end of the 2nd year of the project.

1.2 Description of the work performed

The main activities during the period M13-M24 are summarised below:

1. Development of the SEEDS architecture which is based on the definition of 5 components (Building Facility Model, Optimizing, Self-Learning, Wireless Intelligent Sensors and

Actuators Network –WISAN- and Archive) organized in 3 layers: controller layer (which includes Building Facility Model, Optimizing and Self-Learning), data management layer (or Archive) and process interface layer (WISAN and GUI).

2. Development of SEEDS' modelling methodology which defines the steps and the interaction among the different SEEDS' components to apply the SEEDS' concept to any building. It also includes the definition of a scheme to perform the data input and hence to implement SEEDS to a target building.
3. Development of the library concept for executable Building Facility Models.
4. Development of data base and software architecture for the modelling, configuration and execution of the SEEDS BEMS (Building energy management system).
5. Development of Control Strategy, Self-Learning and Optimization techniques suitable for Building Energy Systems.
6. Development of a network of an intelligent wireless sensors and actuators and its communication middleware and network configuration tool suitable for hihgly variable environments in Building Automation Systems (BAS).
7. Design of the Graphical User Interface (GUI) and development of the full functionally GUI for the first demonstrator "Helicopter Garage".
8. Development of a validation methodology for proving the concept.
9. Implementation and test of the SEEDS components and running integration tests for the SEEDS architecture into the Helicopter Garage (HG) test bench.
10. Definition of the RoadMap for the implementation and commissioning of SEEDS into the two validation pilots.
11. Analysis of the energy facilities and performance of the two demo pilots, selection of sensor to evaluate initial condition of the two demo pilots.
12. Final selection of the equipment to be monitored and controlled in both demo pilots, selection of sensors and actuators and design of nodes.
13. Initial developments for the application of the validation methodology to the demo pilots, post-occupancy study and definition of the Impact Assessment Methodology (to be concluded during the 3rd year of the project).
14. Activities for dissemination and management issues.

1.3 Expected final results and potential impacts

1.3.1 Final activities to be performed during the last year of the project

During the last year of the project, the following activities will be performed:

1. Refinement of optimization algorithms to reduce computational time in case it is required during the validation phase.
2. Refinement of different components.
3. Commissioning and implementation of SEEDS in the two validation projects.
4. Development and validation of the GUI for the two demo pilots.

5. Analysis of the energy behavior of the pilots after SEEDS implementation.
6. Analysis of results and lessons learnt.
7. Dissemination and management activities.

1.3.2 Expected impact

One of the main advantages of SEEDS' concept is its easibility to be applied to any building. The modelling methodology based on measurements and self-learning and structured into re-usable libraries makes SEEDS a very flexible approach which allows an easy integration of new and current energy devices and subsystems and an easy adaptation to different buildings. SEEDS approach is oriented towards effective customizations of solutions that are more effective and can provide a competitive advantage. Moreover, the well-defined interfaces, libraries of different energy subsystems, and communication middleware will allow easy integration of products from different vendors. As a consequence, SEEDS will mean an important step forward towards the development and opening to the market of novel ICT customized solutions for building operation.

The main competitiveness, economic, environmental and sustainability benefits of the project are:

- Reduction of energy consumption, costs and CO2 emissions due to an efficient management of the energy performance of the building.
- Improved health, quality of life and comfort.
- Reduction of first adjustment and maintenance costs.
- Maintenance of natural resources and reduction of generated waste.
- Reduction of the cost for the development and implementation of building energy control systems thanks to SEEDS' methodology aimed at an easy customization of Building Energy Management Systems
- Enhancement of market penetration of efficient control systems for building operation.

1.4 Consortium and Contact details

The SEEDS consortium includes an appropriate mix of parcitioners and researchers from industry and academia, with a range of expertise that aims to ensure a successful outcome. The consortium is made up of the following organizations: CEMOSA (Project Coordinator, Spain), Fraunhofer (Germany), SOFTCRITS (Spain), Fundacion CIDAUT (Spain), University of Salford (United Kingdom), University of Stavanger (Norway), NSC (Germany), Ferrovial Agromán (Spain) and FASA (Germany).

The contacts details can be addressed to www.seeds-fp7.eu and www.seeds-fp7.com