Project No.: 285150

Project Acronym: SEEDS

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

PERIODIC REPORT

(Publishable Summary)

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Period number: 1st

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1 Publishable summary

1.1 Overview and project objectives

The target of the SEEDS project is the development of an innovative Building Energy Management System (BEMS) which will optimize energy consumption over a predefined time period while keeping user requirements and environment conditions. SEEDS will perform a detailed modelling of energy systems and subsystems oriented towards the completion of comfort and environment conditions of the user and the building. Energy equipment is structured into energy sources (coming from utilities or included in the building such as Renewable Energy Sources), energy storages and energy demand. Building energy demands are classified into HVAC, hot water and lighting. For the sake of reusability and interoperability, the building modelling pursued in the SEEDS project follows BIM approach.

The main features of the SEEDS' BEMS are shown below:

- The building modelling is based on measurements and structured in reusable libraries.
- Self-learning techniques are applied for the estimation of environment conditions and for the modelling of energy equipment.
- Optimization techniques oriented towards minimization of energy consumption over a predefined time period ensure optimal behaviour of the building.
- Wireless technologies facilitate the application of the SEEDS BEMS to the retrofitting of existing buildings and simplify its application in new buildings.

The use of self-learning allows the adaptation and refinement of the SEEDS models to the requirements and characteristics of the energy equipment of the building, the user behaviour and the environment conditions. The implementation of the SEEDS methodology includes two stages. During the initial or commissioning stage, self-learning algorithms are trained. During the operation stage, self-learning algorithms allow the continuous refinement of the building model, the user behaviour and environment characteristics.

The main **goals/objectives (O)** of the project are:

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.

The main **scientific/technical objectives (STO)** and their current status in the first period of the project are:

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	Advanced state
STO2	Research and development of scalable implementations of global optimization algorithms.	WP3, WP5	On-going
STO3	Development of self learning and optimization behavioural models for energy systems and subsystems in buildings.	WP1, WP2, WP5	On-going
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	On-going
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	Initial state

The main **technical achievements (TA)** and their current status can be summarised as follows:

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	On-going
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	On-going
TA4	Design, development and implementation of a network of WISA and communication middleware and configuration tools.	WP3, WP4	On-going
TA5	Development of anytime self-learning and optimization algorithms tuned specifically for BEMS.	WP3, 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	Initial state

1.2 Description of work performed and main results

During the first period (M1-M12) of the project activities has focused on:

- Classification of energy demands (T1.1 on WP1).
- Classification of energy sources (T1.2 on WP1).
- Modelling of energy sources and demands (T1.3 on WP1).
- Analysis of control system requirement (T1.4 on WP1).

- Definition of the requirements for the validation pilots (T1.5 on WP1).
- Analysis of the different energy consuming devices/appliances/facilities, energy sources and energy storages (T2.1 on WP2).
- Analysis of different modelling approaches, platforms and standards (T2.2 on WP2).
- Investigations of the modelling methodology for the subsystems and the whole system (T2.3 on WP2).
- Definition of a coding and implementation methodology for building models of the relevant energy-consuming systems and sub-systems (T2.4 on WP2).
- Analysis of different approaches for the architecture of the building model library (T2.5 on WP2).
- Evaluation of wireless technologies and sensor/actuator node hardware for building automation (T3.1 on WP3).
- WISA design and development (T3.2 on WP3).
- Positioning systems evaluation and Network Design Framework (T3.5 on WP3).
- Mesh management and self configuration (T4.1 on WP4).
- Reliability and QoS management (T4.2 on WP4).
- Security Support (T4.3 on WP4).
- Research on Self-Learning and Optimization Methods for Efficient Energy Building Management (T5.1 on WP5).
- Development of Self-Learning Algorithms (T5.2 on WP5).
- First steps on Optimisation Methods (T5.3 on WP5).
- Research on GUI strategies and technologies for Energy Building Management (T6.1 on WP6).
- Definition of the common GUI design (T6.2 on WP6).
- Analysis at energy systems in each validation pilot (T7.1 on WP7)
- Analysis of energy measures to be applied each validation pilot (T7.2 on WP7)
- Development of the Validation Methodology (T8.1 on WP8).

The main results achieved or in progress in this period are:

- A holistic analysis and classification of a wide range of building and construction types and definition of energy systems and subsystems (achieved)
- A validation methodology to assess building energy performance (achieved)
- Sensor/actuator selection, evaluation and integration (achieved)
- Selection of wireless mesh networks for building automation control (achieved)
- Hardware and software design of the sensor/actuator nodes (on-going)
- Definition of plug-play conformance requirements for WISAN. Libraries and Web Services (on-going)
- Rules for Sensor Placement (achieved)
- Checklist for Sensor Placement (achieved)
- An innovative building modelling methodology based on measurements and self-learning techniques (on-going)

- Selection and definition of self-learning techniques to estimate the evaluation of environment variables and the behaviour of energy equipment performance (on-going)
- Analysis and definition of optimization techniques for the optimal selection of those control settings that minimize energy consumption and CO2 emissions for a selected time horizon (on-going)
- Research on GUI strategies and technologies for Energy Building Management (achieved)
- Definition of the common GUI design. This includes the general GUI structure, the structure and operation of each component and the structure and content of the individual screens (on going)
- Implementation and validation of the technologies in the validation pilots and energy analysis (on going).

1.3 Expected final results and potential impacts

The SEEDS project will mean an important step forward towards the development and opening to the market of novel ICT customized solutions for building operation. 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. Therefore, SEEDS approach is oriented towards effective customizations of solutions that is 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.

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 as a consequence of the development 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