REEB – The European strategic research **R**oadmap to ICT enabled **E**nergy-**E**fficiency in **B**uildings and constructions

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Abstract— **The REEB project is a Co-ordination action addressing the Strategic Objective: ICT for Environmental Management & Energy Efficiency for the construction sector. The project aims at providing a vision and a roadmap for co-ordinating and rationalising current and future RTD in the fields of ICT support to energy-efficiency in the built environment of tomorrow. The main outcome is a strategic research agenda that has been elaborated with the support from a European-led community dedicated to the innovative use of ICT supporting EE in Construction, bringing together the ICT community and key actors of the (Construction) Environment and Energy business sectors.**

Keywords (Energy-efficient buildings, ICT, Vision and SRA (Strategic Research Agenda))

I. INTRODUCTION

Growing concerns priorities today, especially in Europe, are environment protection and energy conservation, moreover in a context where "systems" (should they be transportation systems, industrial systems, systems empowering the built environment, etc.) are more and more complex and demanding in terms of information management: it is nowadays acknowledged that ICT (Information and Communication Technologies) is the key for a 2-way flow of both energy and information in the Energy sector as a whole (production, distribution, consumption and management). Due to its impact and the opportunities it offers, ICT is considered too as the key for a liberalised market, leading to changes in business practices in the Energy sector (in a similar way this has been the case with ICT strongly impacting the Telecom sector and market). ICT is the key for empowering people in the (built) universe in which they live, with smart e-metering and new smart e-devices, A high potential is also foreseen for ICT becoming fully pervasive in the future optimization of energy in the built environment - where "Energy-efficient smart buildings" are buildings which contain systems that manage information for an optimal operation of building energy flows over the whole building lifecycle.

In this context, REEB (the European strategic research roadmap to ICT enabled Energy-Efficiency in Buildings and construction) is an ongoing European R&D technology roadmap initiative (achieved in the context of an EC-funded Coordination Action - http://www.ict-reeb.eu) for IT to support Energy Efficiency (EE) in the built environment.
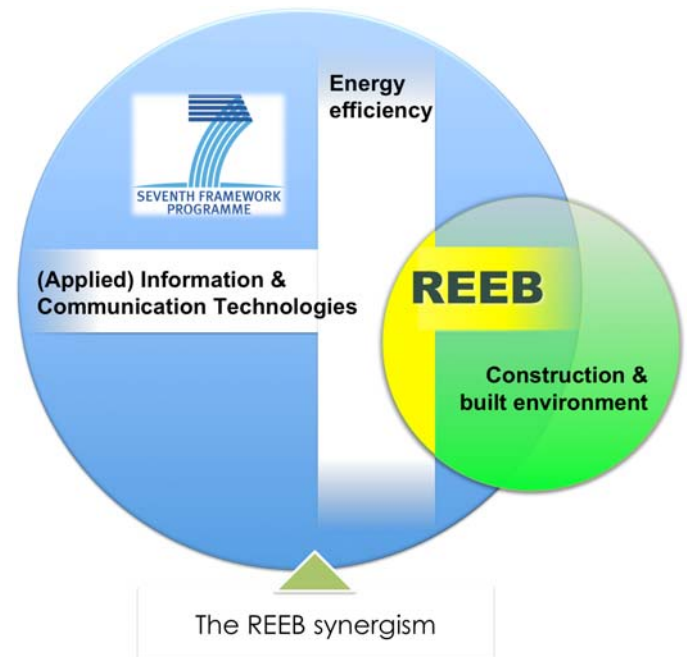

Figure 1. REEB framework

REEB has been launched as a response to the need for coordinating and rationalizing current and future RTD in Europe in the area of ICT support to EE in constructions: it has been set to develop a European-wide agreed vision and roadmap providing pathways to accelerate the adoption, take-up, development, and research of emerging and new technologies that may radically transform building

constructions and their associated services in terms of enhanced energy consumption.

This paper aims at introducing to the Vision and the Roadmap developed in REEB, after feedback and validation from many stakeholders at the crossing of ICT, Construction and Energy. REEB is a key milestone in identifying, synthesising, and prioritising a comprehensive set of agreed main problems, challenges and prescribed RTD for new ICT-based solutions related to the future delivery and use of EE facilities and buildings, in Europe and world-wide..

II. THE REEB VISION

The elaboration of the vision [1] has resulted from the crossing of inputs provided by the REEB partners, and many stakeholders having joined the International REEB Community [3], bringing together the ICT community and key actors of the (Construction) Environment and Energy business sectors. A key finding is that, while there is an emerging consensus about the key RTD issues in ICT-enabled EE of buildings, the potential impact of various technologies is not sufficiently well known. Thereby it is difficult to assess the relative importance of specific technologies, applications and systems, and it is necessary to develop a more holistic understanding of the potential effects of ICT on the EE of buildings. The vision in REEB is that the high level impacts of ICT to energy-efficient buildings are envisaged to evolve as follows (*figure 1*):

- Buildings meet the EE requirements of regulations and users – short term.

- The energy performance of buildings is optimized considering the whole life cycle – medium term.

- New business models are driven by energy efficient "prosumer" buildings at district level – long term.
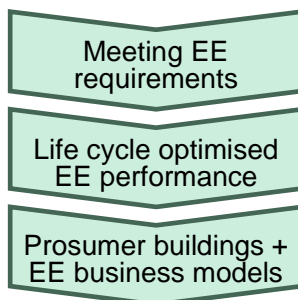

Figure 1: Envisioned evolution of energy efficient buildings

ICT is often perceived by practitioners as various specific computing and automation applications. However, ICT is also a generic enabler for integration of various processes, applications, systems and technologies: databases, collaboration & communication infrastructures, interoperability standards, knowledge management, modelling, optimisation, simulation, visualisation, etc.

REEB has identified 5 key research areas where ICT enables both new applications and integration:

- Integrated design and production management.

- Intelligent and integrated control.

- User awareness and decision support.

- Energy management & trading.

- Integration technologies.

The role of ICT in these areas is envisaged as follows:

- Life cycle approach: Integrated design teams, using interoperable model-based tools and communication/collaboration platforms optimize the whole life performance of buildings.

- Smart buildings: Most buildings will be "smart" and control themselves maintaining the required and optimal performance and responding proactively to external conditions and user behavior anticipating them, rather than reactively. Holistic operation of subsystems is supported by integrated system architectures, communication platforms, standard protocols for interoperability, sensors and wireless control technologies.

- Construction as a knowledge based industry: Industrialized solutions are available for configuring flexible new buildings as well as retrofitting existing buildings. Customized solutions are developed by configuring re-usable knowledge from catalogues within organizations and industry-wide.

- Business models and regulations are driven by user perceived value. Financing models provide incentives to stakeholder towards whole life performance of buildings. ICT tools support performance measurement, validation and holistic decision making.

III. THE REEB ROADMAP

The REEB Roadmap [2] is described under the form of 5 sub-roadmaps, providing for each category of research topics as identified in the REEB vision specific RTD challenges to face at short, medium and long term to achieve the vision. It also illustrates the long-term situation (and its evolution from now on) with the State-of-the-art and visionary scenarios of the future, and identifies drivers, barriers, impacts, and where applicable, related roadmaps developed in another context than REEB. Similarly to the REEB Vision, the methodology, leading to the REEB strategic research agenda and its various RTD priorities for ICT supported EE buildings, has been based on the integration and synthesis of inputs provided by the REEB partners and key target groups of the "ICT4EEB community" [3] including e.g. European Technology platforms and RTD projects in the 3 core areas of focus, and the European Commission. The baseline of the work is also relying on the EC policies and the visions and strategies of a

number of related initiatives (*see reference [2] for more detailed information*).

These are the main research priorities that have been identified by every sub-roadmap:

- Integrated design and production management: **Integrated engineering** (integration of various tools to support a holistic process bringing together the views of different stakeholders to address the whole life of buildings), **Design for energy efficiency tools (D4EE)** (covering a broad range of CAD and other applications for design and planning of buildings - both new and existing to be renovated - and the urban infrastructure), **Production management** (covering: contracts & supply network management; procurement; logistics; on-site and off-site production management), **Modelling** (Building modelling (BIM), district modelling, model granularities, ontologies for eeBIM, semantic mapping; Standardized Semantic Data Models), **Performance estimation** (covering various methods that are used at design stage to estimate the performance of the building for decision making and contracts e.g. simulation, wholelife costing and life cycle impact assessment).

- Intelligent and integrated control: **Automation and control** (methodologies, procedures and ICT systems that are able to manage all energy production and usage in a building, according to information received from inside the building and outside in order to ensure comfort, while optimizing the energy consumption of the building), **Monitoring** (relying on the instrumentation of the building with smart meters, other sensors, actuators, micro-chips, micro- and nano-embedded systems that allow collecting, filtering and producing information locally), **Quality of service** (covering issues such as improved diagnosis and secure communications), **Wireless sensors networks** (enabling all energy systems and conditions measurement devices to communicate).

- User awareness and decision support: **Performance management** (fine-tuning building performance indicators (accuracy, comprehensiveness, ease of use), and create tools to give support to the end-user for performance improvement (decision support), **Visualization of energy use** (ongoing research projects on this topic need to be further continued, especially through multidisciplinary pilot projects so as to work on energy efficiency incentives and adequate energy visualization presentations), **Behavioral change by real-time pricing** (new technologies for energy metering and local energy generation will considerably change the customer relationship with the energy providers. The implied change on regulation and business models offer new perspectives and need to be accompanied by new adapted ICT infrastructures).

- Energy management & trading: **Real-time response and Predictive Management** (Embedded sensing, automation and control, Secure ubiquitous communications), **Enhanced Design and Integration** (Network Planning, Plug and Play scalable integration of micro-generation and storage), **Distributed Generation and Demand Response** (Demand Response Capabilities, Low-latency communications, Load Balancing Techniques, Performance Analysis and Evaluation).

- Integration technologies: **Process integration** (collaboration support tools and business work flows), **System integration** (Plug & play; Connections, Service oriented architectures, Integration platforms+ value added services, Cabling, Gateways, Middleware, Development methods and tools (Integrated design environments (IDE), HW simulation & testing environments, UML profiles, Data modeling methods), **Interoperability & standards** (data models and real time (in-side and out-side building) communication protocols), **Knowledge sharing** (Access to knowledge, Knowledge management, Knowledge repositories (Contents; Personalization / user profiling), Knowledge mining and semantic search, Long-term data archival and recovery), **Virtualization of built environment** (Office optimization, Server virtualization).

JOIN US

REEB is not a close project**; we invite you to collaborate with us** and sending us your comments about the REEB Vision [1] and the technological roadmap [2]. Your contributions will be taken into account in the REEB book that will be issued by September 2010. We also invite you to be member of International REEB Community (IRC - http://ict-reeb.eu/irc.html), in such a way that you will be permanently updated with the last project results.

ACKNOWLEDGMENT

REFERENCES

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