

ICT for a Low Carbon Economy

Smart Buildings

JULY 2009

... Findings by the High-Level
Advisory Group and the REEB
Consortium

On the Building and Construction sector

European Commission
Information Society and Media



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Table of **content**

Foreword by the European Commission.....	6
1. Executive Summary	8
2. Keynote Messages	10
3. State of the Art of ICT for Smart Buildings	16
4. Barriers and Challenges Ahead.....	22
5. ICT-enabled EeB	25
6. Business Opportunities.....	30
7. Recommendations	32
Annex 1: Methodology and Credits.....	36
Annex 2: Relevant European projects.....	38

Foreword

by the European Commission

To make sure the economy that will emerge from the recovery is solid and stronger it is essential for governments to embed long term visionary measures in their short term responses to the actual crisis. This makes it necessary to invest in research and innovation, in infrastructures and in skills in areas of strategic importance.

It is agreed that investments in a green, low carbon economy would be specifically rewarding and that Information and Communication Technologies, ICT, are the engine for making this possible.

Two Communications to the Institutions have already been adopted by the Commission. While the first Communication of May 2008 identified the many ways in which ICT can contribute to energy efficiency gains, the second Communication adopted by the Commission last March identified concrete actions for the ICT industry, for EU Member State governments, and their regional and local administrations. It highlighted the importance of close working partnerships between the ICT, the energy and the energy-intensive sectors such as construction or transport logistics.

To set up this ambitious framework we have been assisted by a High-level Advisory Group from leading companies and research institutions that worked during the second half of 2008. Their visions were discussed and

enriched during the ICT for Energy Efficiency Event in March 2009. This booklet, prepared by the REEB consortium, is a compilation of the main findings focussing on the Building and Construction sector. It has provided valuable input to our policy process and it has the potential to contribute to national policies and to reinforce cooperation between the building and construction, the energy and the ICT research and industrial communities.

Although Europe is making progress, notably via the Energy-efficient Buildings Public Private Partnership, there are still many challenges and much work to be done.

European citizens have become increasingly sensitive to environmental issues. Supported by legislation and incentives (often at the local level), citizens and businesses alike have taken the initiative to better insulate homes and buildings, to better monitor and control their energy performance, and to avail of and install renewable energy sources such as solar panels and wind turbines. It is clear that if "green buildings" are to become commonplace, that this can only be facilitated by ICT. By way of example:

- New ICT based Neighbourhood Management Systems will allow peer-to-peer sharing of energy produced through renewable schemes

- New ICT based meters will allow households not only to buy but also to sell energy
- ICT will allow information on energy consumption of every energy-consuming appliance in a home or a building to be provided in real-time, in a user friendly way, thereby empowering citizens to take decisions that lead to energy savings.

Today, most of those who are charged with implementing energy efficient solutions are flying blind. Buildings - which account for 40% of energy end-use in the EU - provide a prime example. Building components (cement, steel, insulation, glass windows, coatings) and systems (lighting, heating, ventilation and air conditioning appliances) are developed by independent companies whose products are tested for individual performance independently of each other. While this must be encouraged and is necessary, it is insufficient. A whole building approach to the design and operation of buildings, where these components are integrated in a way that they reduce energy consumption through cooperation, is rarely used. This often leads to significant system-level inefficiencies. The ICT sector can deliver simulation, modelling, analysis, monitoring and visualisation tools that are vitally needed to facilitate a whole building approach to both the design and operation of buildings.

ICT will also play an essential role in facilitating the implementation of policy

and in measuring its effectiveness. The Directive on the Energy Performance of Buildings introduces a general framework for a methodology to calculate the energy performance of buildings. Implementation of the Directive will yield a large amount of data that is useful for the buildings and construction sector, as well as for policy-makers. Such data, if readily available and easily accessible, will facilitate the identification of common inefficiencies, best practices and best opportunities. The ICT sector can deliver tools that are vitally needed to collect, process and manage the data, and present it in a standardised format.

I would like to take this opportunity to thank all contributors from industry and research who worked hard to make this publication a reality and I would like to encourage you to have good and inspiring reading.



Antti Peltomäki
Deputy Director-General
for Information Society
and Media, European
Commission

1 Executive summary

Information and Communication Technologies (ICT) have an important role to play in reducing the energy intensity¹ and therefore increasing the energy efficiency of the economy, in other words, in reducing emissions and contributing to sustainable growth. Indeed emerging changes offer the possibility of modernising the European economy, towards a future where technology and society will be attuned to new needs and where innovation will create new opportunities. ICT will not only improve energy efficiency and help combat climate change, they will also stimulate the development of a large leading-edge market for ICT enabled energy-efficiency technologies that will foster the competitiveness of European industry and create new business opportunities. As ICT is today pervasive to all industrial and business domains, it is expected to generate a deep impact in the energy efficiency of buildings of tomorrow (should they be new or renovated).



This document focuses on ICT as a support to energy efficiency in so-called smart buildings. Moreover, the focus is on the building itself, including equipments and devices, the envelope, and the potential connection with the outside (e.g. electric grids). It also includes considerations from an urban point of view.

It is clear that, if Europe is to succeed and achieve its ambitious objectives², the role of ICT as an enabler of energy efficiency across the economy³ needs to be fully explored and exploited - Europe needs to ensure that ICT-enabled solutions will be:

- available: in addition to developing the necessary individual components, more has to be done in terms of system integration and proof of concept;
- fully deployed: this means initial deployments in terms of assessment and feedback, and further generalisation of deployments in the built environment;

² As defined at various levels, should it be European (e.g. reducing Energy consumption by 20% by 2020), or national, e.g. in France with the "Grenelle de l'Environnement": for new houses/buildings, all to be Positive Energy Buildings (PEB) by 2020, with 1/3 with max 50 KWh/m²/an and 10% being PEB ; for non-residential buildings, 50% with less than 50KWh/m²/year and 20% being PEB. For existing houses/buildings, decrease by 2020 the average consumption down to 150 KWh/m²/year (today: 240 KWh/m²), and for non-residential buildings, by 2020, down to 80 KWh/m²/year (today: 220 KWh/m²/year).

³ Which includes fostering the change in citizen's behaviour, as well as in improving efficiency in the use of natur

¹ this is a measure of energy efficiency of a nation's economy: EI = Energy units/GDP =MJ/\$.
8

- operational: all stakeholders should have the ICT enabled solutions installed and perfectly operating, and users should be made aware of these systems and being able to “work/live with them”, which will probably lead to drastic change in their behaviour.

In order to put ICT at the core of the energy efficiency effort and to enable them to reach their full potential, it is necessary to foster research into novel ICT-based solutions and strengthen their take-up — so that the energy intensity of the economy can be further reduced by adding intelligence to components, equipment and services. Therefore, it is essential, as expressed several times by European Commission Communications, to reinforce multidisciplinary RTD involving researchers from the ICT, the energy and the building domains, to foster the use of national and regional programmes for the deployment of ICT-enabled research results (like large-scale pilots of energy management systems for public and commercial buildings), and to support awareness raising and foster exchanges of information involving these issues⁴.

⁴ http://ec.europa.eu/information_society/activities/sustainable_growth/docs/com_2008_241_1_en.pdf

2 Keynote Messages

Framing the research needs and required partnerships for ICT development supporting energy-positive buildings and neighborhoods



By Carole Le Gall, CEO, Centre Scientifique et Technique des Bâtiments (CSTB)

According to the European Union Directive on the Energy Performance of Buildings (EPBD 2002/91/EC), more than 40% of the energy consumption in Europe is due to heating, cooling and lighting operations within buildings. Moreover, buildings are the largest source of CO₂ emissions in the EU15 (including their electric power consumption), and their total energy consumption has been rising since 1990. As such, construction stakeholders need to deal with new challenges including addressing construction from the viewpoint of sustainable development – energy efficiency and decrease of GHG emissions, improved innovation in the built environment for better comfort and safety.

As ICT is today pervasive to all industrial and business domains, it is expected to generate a deep impact in the energy efficiency of

the buildings of tomorrow (should they be new or renovated). The cross-fertilisation of buildings and ICT (with new innovative ICT architectures and tools integrated in the Built environment) has to deal with the key following expectations:

- 1) The generalisation of “Energy-positive Smart Buildings”. Energy-positive buildings are transforming buildings from pure consumers to “prosumers” (producers and consumers). Smart buildings means buildings empowered by ICT in the context of the merging Ubiquitous Computing and the Internet of Things: the generalisation in instrumenting buildings with sensors, actuators, micro-chips, micro- and nano-embedded systems will allow to collect, filter and produce more and more information locally, to be further consolidated and managed globally according to business functions and services;
- 2) Relying on point 1, buildings will play a new and key role in innovative distributed energy production, and new associated business models, for renewable energy management, storage and peak shaving: they are to move from “end of pipe” buildings to active nodes in smart grids. They will permit to optimise the local distributed production and storage of energy/electricity, to deal with shaving consumption peaks and the optimisation of energy consumption, to deal with the management of some local coordination of the energetic system, while at the same

time ensuring appropriate integration with smart energy grids - including securing the provision at any time of the energy (where ever it comes from - local or global), all this in a systemic approach and according to some various contexts (user profiling, security level, etc.).

3) The development of interoperable business applications and services (especially atop BIMs – Building Information Models), to deal with enhanced diagnostic and renovation of existing buildings and infrastructures and simulations to assess variants of environmental performance of buildings, tools for dynamic building evaluation at run-time, and allowing optimisation based on multi-dimensions / multi-criteria constraints, etc.;

4) The required need to deal with the increasing volume and complexity of all the information generated by the systems mentioned in the previous points, potentially coupled whenever required with the huge mass of information over the Internet, and also to deal with knowledge that is already available but not easily accessible: tools already exist in this area (e.g. for instance the CSTB tool “ELODIE” for the environmental impact of materials) or are currently emerging, but still need developments and have to be apprehended by Construction stakeholders to fully take benefits of the advances in this area, e.g. thanks to large-scale pilots and demonstrators;

5) A final key point is construction stakeholders and users awareness, to be achieved through innovative, pervasive and friendly user interfaces. User awareness is a key factor for moving to eco-friendly behaviour. However, very few building-owners know what consumes the most energy in their building(s) and even fewer look regularly and accurately at the energy meter attached to their building since it remains an uneasy and tedious task. There is a need for new user interfaces/energy-displays that will provide attractive content at the appropriated time, through a motivational approach and with an intuitive and smart design. As a consequence, there is a need to reinforce multidisciplinary RTD involving researchers from the ICT, the energy and the building domains, the necessity to foster the use of European, national and regional programmes for the deployment of ICT-enabled research results, and the need for new Public-Private partnerships that have to be established, and the need to support awareness raising and foster exchanges of information among all actors.

Energy Efficient Buildings: towards a new era for cross-sectoral research cooperation



By Juan Manuel Mieres, Director, Acciona Research and Development. President, Energy Efficient Buildings Association

Construction is one of Europe's biggest industries, including the building, civil engineering, demolition and maintenance industries. With a total annual turnover of 910 billion € (EU-15) and 12 million workers, the construction sector represents a strategically important sector for the European Union, providing building and infrastructure on which all sectors of the economy depend. Construction, operation and maintenance of facilities is about 20% of GNP in industrialised countries and life cycle costs are dominated by operation and maintenance while design & construction are less than 25%. The construction sector has been typically characterized by many small enterprises and high labour intensity, being also highly dependent on public regulations and public investments. During the last years, within the European Construction Technology Platform (ECTP), Energy

Efficiency in Buildings has been identified as the main challenge for the coming years since it is well known that buildings are the largest source of CO₂ emissions in the EU15.

In order to address this strategic topic, the construction model must evolve towards a new multidisciplinary approach which will empower the scope and impact of future developments, improving cooperation with ICT, Energy and other sectors.

This is a big responsibility. It can also be seen as a fantastic opportunity if the right actions are taken. This cross-sectoral initiative could really contribute in a significant way to the fight against climate change issues, in addition to decreasing the EU's fossil fuel dependence on countries outside Europe.

For that purpose, public-private cooperation models are required to boost research and experimental developments through the whole life cycle of the building, starting from the design and programming phase, where ICT tools will enable significant energy consumption reductions at an early stage, to the building operation phase, where, as an example, advanced metering infrastructure could provide the framework for joint business models among energy utilities, telecom operators and building management companies.

The Sustainability Imperative in the Commercial Building Sector



By Bruno Berthon,
Managing Director,
Accenture, Growth
and Strategy

The potential to reduce the world's energy consumption by focusing on the commercial building sector is tremendous. Governments and businesses need to quickly focus on making commercial buildings "smarter". Building owners and operators have been generally slow to adopt practices that could improve their energy efficiencies. This is due to many factors, including a lack of incentives for owners, insufficient demand from tenants, and the expense associated with retrofitting legacy.

The inability to centralize and manage data found within building equipment is a challenge. Existing commercial buildings are full of technology and communication devices that have been installed ad hoc over time. These technologies – which include security devices, computer/Internet connections, heating and cooling systems, and lighting – tend to operate on different protocol

standards. In this non-integrated, multi-protocol environment, monitoring energy usage and device performance is difficult, if not impossible. Compounding this challenge is the issue with data. No one typically "owns" a given building's system data. Nor is a dedicated person or team typically assigned to monitor or use building data to drive building-management efficiencies. On top of this, there is often a lack of accountability among a building's owner, operator and tenants, which results in a lack of contractual incentives to improve that building's energy efficiency.

One solution which we've been working on is based on the premise that facility data, regardless of technology protocols and locations, must be analyzed quickly and in a common way to enable an owner or tenant to manage the building as a highly efficient energy-consuming enterprise.

Building on advances in IT, this approach is allowing building operators to become more data driven by enabling different devices (using different protocols) to communicate with each other. Information—which is gathered remotely from sensors, meters, lighting, heaters and other equipment— informs operators when preventative maintenance should be carried out and identifies operational inefficiencies that require action.

In effect, this digitizes buildings and makes it possible for devices to work together more effectively and use less energy. It can also be scaled so that many buildings can be managed through a Web interface from one point at the same time. Once a building is “fixed”, building operators stay connected and pull data out of every set point every 60 seconds. This gives a constant stream of data to understand how the building is operating—and how it can be run more efficiently.

In short, we are finding that we can make buildings smarter on a continuous basis—not with iron wrenches, but with keystrokes. And it’s proving to be a cost-effective solution – with 20% efficiency gains in less than one year.

This is of course just one piece to the global sustainability puzzle. What is ultimately needed is a concerted and collaborative effort among many parties—from device manufacturers to architects to utility companies to governments—to create a truly sustainable future.

The Energy Transition in the Residential Sector and the potential of the Social Housing Sector.



By David Orr,
President,
Comité Européenne
de Coordination
de l’Habitat Social
(CECODHAS)

Social and cooperative housing represents 12% of the housing stock, if 5% of stock is refurbished annually, backed up with a sustained change in residents’ behaviour, this can deliver 30% energy reduction by 2020. With a stock of 25 million dwellings providing homes for approximately 70 million people, Social Housing actors can direct and boost energy efficiency and renewable energy market development which will trigger the retrofitting boom and market transformation across the entire residential sector.

Social housing organizations are in a unique position to work in partnership with citizens, by empowering residents to become agents of climate protection through active information and participation campaigns. Additionally, because of central role in the building chain in urban planning and regeneration processes, CECODHAS Members can direct urban

development models towards the creation of smart green living places in close partnership with local authorities.

Alongside local customized energy advice services, accessible for all, ICT can play a role in delivering the objectives of empowerment of residents and the creation of smart green living places.

This potential role of ICT in empowerment has been investigated and demonstrated by a number of social housing organizations in the SAVE@work4homes⁵ initiative. The social housing companies involved have developed a set of Energy Awareness Services, based on a 'toolbox' of components including: automatic monitoring of consumption and transmission of consumption data; analysis and presentation of consumption data for access by tenants via Internet or other methods; self-assessment scheme to assess the success of residents of a housing unit in reducing their energy consumption; improvement of heating controls and feedback to users of heating settings.

In these pilot projects, internet access was provided at subsidized prices to residents and it is worth noting that where this is not possible, mobile telephony could be a very effective means of communication, guaranteed to reach a larger proportion of residents.

⁵ <http://save.atwork4homes.eu/>

3 State of the Art of ICT for

According to the European Union Directive on the Energy Performance of Buildings (EPBD 2002/91/EC), more than 40% of Energy consumption in Europe is due to heating and lighting operations in buildings. Moreover, buildings are the largest source of CO₂ emissions in the EU15 (including their electric power consumption), and their total energy consumption has been rising since 1990⁶.

The majority of energy consumption is due to space and water heating, although the share of consumption of lighting and appliances is rising over time (this situation is similar within the service sector although the share of lighting and appliance consumption is higher than in households due to greater utilisation of ICT equipment).

Buildings can be considered as energy-intensive systems through their whole life-cycle, being particularly important figures the ones related to the building operation phase which account for 85% of the total energy consumption.



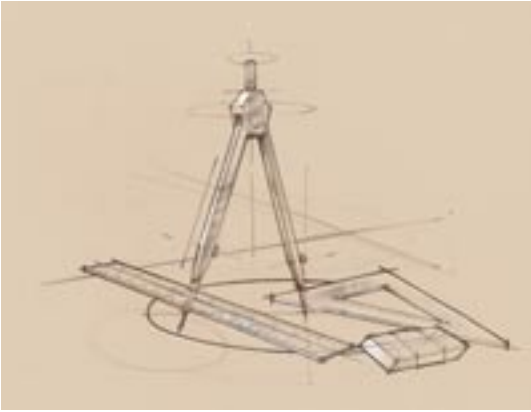
Concerns (and therefore solutions) on Energy Efficiency exist throughout the whole construction product life cycle (PLC). In each stage of the PLC one can overlook solutions and approaches that positively contribute to more Energy Efficient buildings.

Roughly one can consider three main phases in the construction PLC, namely the design phase (early and detailed design and engineering), the realisation phase (construction itself) and the support phase (maintenance, renovation, etc). Throughout each of the phases of the PLC, several considerations in respect to Energy Efficiency (EE) of buildings could be set, namely:

Design Phase: At design phase the focus on EE should be on realising the best efficient design considering the many variables to be potentially taken into account (health and comfort performance, building costs, whole life costs, etc).

⁶ Fourth National Communication from the European Community under the UN Framework Convention on Climate Change (UNFCCC). <http://unfccc.int/resource/docs/natc/eunce4add.pdf>

Smart Buildings



For a designer and engineer (D&E), and from the Energy Efficiency (and also Sustainability) viewpoint, the need is to have comprehensive (account the many variables at stake) and enhanced (with enriched knowledge) Energy Efficiency analysis and simulation services in order to optimize (e.g. by testing alternate design solutions, changing materials, trialling distinct scenarios, etc.) the overall design towards a more suitable design, that presents the optimal energy efficiency levels while considering the many competing dimensions under concern.

Realisation Phase: At realisation, the first aspect is the procurement activities, and the need for the establishment of a Sustainable Procurement process, evolving from the typical price and quality criteria to account in the case the energy efficiency of purchased materials. Another aspect that is of major importance for the authorities (and therefore for construction stakeholders) is the conformance assessment of a building in view of existing codes and regulations for Energy Efficiency, enabling e.g. the establishment

of rankings that would set distinct taxation levels given the level of efficiency, or to adapt building codes and regulations for EE to the specific characteristics and properties of given locations or applications.

Support Phase: From the support phase view point, one can distinguish from two kinds of processes that greatly impact on Energy Efficiency of buildings – Operation and Renovation. From an operation perspective, there is much that the so-called smart buildings can perform to support a more efficient operation, namely by the supervision using networked ambient intelligence and control of building devices and systems to maintain comfort and operative levels while being more Energy Efficient. Considering Renovation, the important aspect is on how to support the reformation of existing buildings towards being more energy efficiency performing thus towards sustainable modernisation and renovation of buildings.

Taking into account the targets agreed for 2020 by the European Council in 2007⁷, reducing the energy consumption in buildings is an unavoidable issue to approach in order to fulfil these challenges as stated in the Set Plan (European Strategic Energy Technology Plan).⁸ In order to achieve this

⁷ The targets are as follows: 20 % reduction in emissions compared to 1990 levels; 20 % share of renewable energies compared to projections in overall E U energy consumption; and 20% savings in E U energy consumption compared to 2005

⁸ http://ec.europa.eu/energy/res/setplan/communication_2007_en.htm

ambition, one of the most important aims that the European Commission points to in its Communications “Addressing the challenge of energy efficiency through Information and Communication Technologies” (Brussels, 13.5.2008) and “Mobilising Information and Communication Technologies to facilitate the transition to an energy-efficient, low-carbon economy” (Brussels, 12.3.2009), is the use of ICT among other technologies.

According to a recent study⁹, the worldwide energy consumption for buildings will grow by 45% from 2002 to 2025 – where buildings account for about 40% of energy demand with 33% in commercial buildings and even 67% in residential buildings. This study is also corroborated by national reports about Climate Change¹⁰, which identify the “diffused sectors”¹¹ as the main contributors to Greenhouse Gas Emissions in the next year. The reduction of energy consumption through the use of ICT as key enabler technology is expected to be about 15% in the next years.

⁹ SMART 2020: Enabling the low carbon economy in the information age. The Climate Group

¹⁰ “Estrategia Española de Cambio Climático y Energía Limpia. Horizonte 2012”.
http://www.mma.es/portal/csceiones/cambio_climatico/documentacion_cc/estrategia_cc/dpf/estrategia_esp_ccel.pdf

¹¹ “Diffused Sectors” are characterized by compiling a lot of small sources of Greenhouse Gas Emissions and energy consumptions. Typical examples of

The report estimates contributions to that reduction figure from different technologies and policies emphasizing that ICT tools for the improvement of energy efficiency in buildings at a design phase and smart building management systems could have the biggest impact.

For that purpose, the R&D targeting the EE in future smart buildings is to be developed around the following fundamental pillars:

The “intelligent” objects: these objects must have embedded electronic chips, as well as the appropriate resources (including potential OS or platform such as J2ME) to achieve local computing and interact with the outside, therefore being able to manage appropriate protocol(s) so as to acquire and supply information.

The communications: these must allow sensors, actuators, indeed all intelligent objects to communicate among them and with services over the network. They have to be based on protocols that are standardised and open.

The “smart BMS / ECMS”¹² relying on embedded intelligent objects and communications, they are to be new systems characterised not only by improved features

¹² Building Management Systems / Energy Control Management Systems.

(e.g. optimising the equation EE/duration/cost), but being able to communicate by embedding appropriate tags (RFID, etc.), and to improve global monitoring of complex assembling of products and equipments in the built environment. They have to potentially allow dynamic control & (re-) configuration of devices (based on strategies), through new algorithms and architectures for any configuration of smart devices (i.e. any set of such devices being inter-connected) to be able to dynamically evolve according to the environment or change in a choice of a global strategy. Ultimately, networks of such BMC/ECMS are to be the foundations of self-configuring home & building systems for EE, based on architectures where Component-based in-house systems learn from their own use and user behaviour, and are able to adapt to new situations, locating and incorporating new functionality as required, including the potential use of pattern recognition to identify and prioritise key issues to be addressed, and to identify relevant information.

The multimodal interactive interfaces: the ultimate objective of those interfaces is to make the in-house network as simple to use as possible, thanks to a right combination of intelligent and interoperable services, new techniques of man-machine interactions (ambient intelligence, augmented/dual reality, tangible interfaces, robots, and so on), and learning technologies for all communicating objects. These interfaces should also be means to share ambient information spaces

or ambient working environments thanks to personal advanced communication devices. They should adapt to the available attention of users, using and avoid overloading their “cognitive bandwidth” with unnecessary warnings or redundant feedbacks.

The development of these pillars has to be based on the current legacy and State of the Art, which includes:

Wired and wireless sensors: lots of various remote controlled devices, with the use of such devices (HVAC, lighting, audio-video equipments...) being currently investigated in the built environment through preliminary deployment and experimentations.

Wireless and wireline connection models & protocols: still under development and even more looking for harmonisation and standardisation (NFC - Near Field Communication, Bluetooth, Wi-Fi, RFID, ZigBee, Z-Wave, en Ocean, PLC, etc.), they aim at establishing and managing communication between objects.

Proprietary platforms & networks: current platforms implementing connected objects are mainly experimental platforms, with no standardisation of management of and communication between any kind of “intelligent” objects. There are already developments around de-facto standard platforms or execution environments, but these are still mainly at an experimental level.

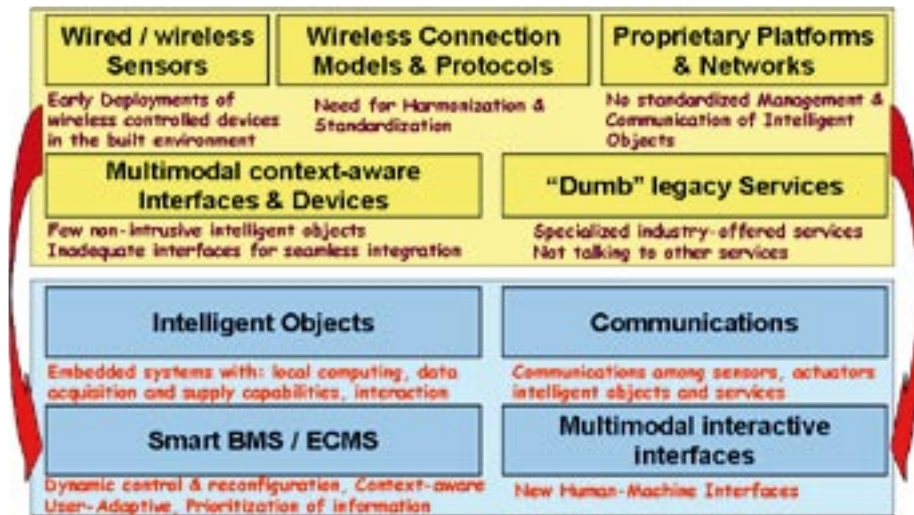


Figure 1: Technologies for smart buildings

"Dumb" legacy services: all services deployed by industry so far are specialised / dedicated services that ensure one given function, without providing interoperability, and no capacity to "talk" with other services or to take into account the full environment.

Multimodal context-aware interfaces / devices: still few intelligent objects that are not intrusive and offer appropriate interfaces to allow the final user to seamlessly integrate the ubiquitous network.

Figure 1 synthesises the current state of the art regarding the identified pillars.

It is worth noticing that to evaluate the current state of the art of practices (therefore identifying good or so-called "best practices") and to benchmark future practices, it is required to identify a set of selection criteria. Along key criteria may be mentioned the following (only indicative) ones:

Actual impact in terms of energy savings: in order to be considered as a "best practice", the identified examples need to be evaluated by considering the difference in energy consumption between the conventional techniques and the proposed solution.

Possibilities of replication: the basic purpose of this Best Practices Guide is to exchange ideas and experience between actors on ICT for EE in buildings and construction market. Selected examples must be as replicable as possible to other buildings, countries or climates. Of course, given the sector's nature (each building is a "one of a kind"), slight adjustments may be needed.

Level of interoperability: identified ICT solutions (being either technologies, equipments or services¹³) need to integrate seamlessly into existing networks, workflows, software tools, models or buildings.

User-friendliness: at all levels, the identified solutions shall be easy to understand, easy to operate, easy to use and easy to maintain.

Economic efficiency: the identified examples must be affordable to the target population. In fact this aspect affects the "possibilities of replication" criterion, because a solution which is not economically efficient appears less attractive to decision-makers, and thus will less likely be replicated to other places or buildings.

¹³ Technology: a general distinction can be made between "information technology" and "communication technology". "Information technology" covers hardware elements such as active and passive electronic components and micro-systems, used for data processing, storage, input and output. "Communication technology" covers the principle data transmission and network technologies, like wired & mobile telephony, radio broadcast, wired & wireless data transmission.

Equipment: the term covers "end-user-devices" (computers & peripherals, digital data recorder-storage-player devices, modems, phones and multimedia mobiles, fax machines, settop boxes and TV & peripherals) as well as "infrastructure" that consist of both hardware and software elements (server and data centers, wired core telecom networks, cellular phone networks, Wireless Local Area Networks, Radio/TV broadcast equipment and micro systems).

Services: the final level of ICT is defined by the use or application of products including the respective hardware, software, and individual media content. The ICT services provided through the utilization of computers and networks form the basis for dematerialization of processes and objects. ICT services can be defined as computer based (data- and media-processing, computer-aided design (CAD) and computer simulations), telecom-based (tele-working, shopping & conferencing), internet-based (e-business, ecommerce, e-government and e-learning), and GPS-based (navigation, traffic control, security and rescue systems).

4 Barriers and Challenges

As a first step, both problems and barriers for the ICT for Energy Efficiency massive deployment in buildings shall be identified.

4.1. PROBLEM AREAS

The following problem areas have been identified¹⁴:

- Inadequate ICT-based informed decision-making (both human and automated) in the current delivery and use of sustainable and energy-efficient facilities, with issues related to Data and Information (D/I): availability, appropriateness of D/I Source, reliability, D/I collection methods and integration, transfer (between actors and between applications), transformation, use and delivery to stakeholders, etc.;

- Current delivery and use of facilities do not necessarily lead to sustainable and energy-efficient buildings, due to:

- Lack of (common) agreement of what sustainable and energy-efficient buildings are;
- Too many standards regulating buildings that affect delivery and use, with some being in conflict with others towards achieving sustainability and energy-efficiency;

- Lack of (common) agreement on holistic and systems-based view of buildings, and of industry agreement on measurement and control;

- Too many options to choose from regarding environmental systems and their configurations;

- Decision-making not supported by adequate information, in a context of complex and difficult automation.

- Need for occupancy feedback to user to enable behaviour modification towards sustainability and energy efficiency, including definition of user requirements and preferences, dynamic and personalized environmental controls, visualization of data associated with energy use, etc.;

- Need for management of energy types and distribution in buildings and urban areas, including integration of sources of energy, and balancing and optimization of energy sources and uses; - Inadequate D/I on, and methods for establishing, sustainability, energy efficiency, and other attributes of materials and products used in facilities, including assessment, smart labelling, logistics, etc..

¹⁴ International Workshop on Global Roadmap and Strategic Actions for ICT in Construction. 22-24 August 2017, Helsinki, Finland

Ahead

4.2. BARRIERS

Additionally, some of the barriers identified¹⁵, related to future business models based on ICT, are:

- Lack of incentives for architects, builders, developers and owners to invest in smart building technology from which they will not benefit;
- Unclear business case and absence of business models supporting/promoting investments on energy efficiency: energy consumption is a small part of building cost structure, yet building automation costs can be high and payback periods are often long;
- The buildings sector is slow to adopt new technology – a 20-25-year cycle for residential units and a 15-year cycle for commercial buildings is typical;
- A lack of skilled technicians to handle complex BMS – most buildings of less than 10,000 sq ft (930 sq metres) do not have trained operating staff;
- As each building is designed and built as unique, it is difficult to apply common standards for efficiency and operations;

- Lack of incentives for energy companies to sell less energy and encourage efficiency among customers.



4.3. CHALLENGES

The current gaps and foreseen Research/Technological challenges related to ICT for energy-efficiency in the built environment include:

- Systems-thinking, multi-stakeholder, and multi-disciplinary design and construction of sustainable and energy-efficient facilities;
- Pre-designed/engineered, replicable, and flexible environmental systems solutions, e.g. optimization, adaptation, and scaling to specific context applications, and configuration tools to do so;

¹⁵ SMART 2020: Enabling the low carbon economy in the information age. The Climate Group

- Cost-effective deployment of specific ubiquitous sensing networks – along with the seamless adaptation of moving environment context, e.g. adding or removing resources;
- Incorporation of the human dimension (for instance, needs from the end-users) in ICT, especially through solutions that are “accepted” by the user, e.g. with systems naturally interacting with the user (voice, avatar, ...), with systems having the capacity to learn and adapt themselves to the way of living or working, with dynamic adaptability to the user specificity (handicap, health, age,...), etc. – overall issues related to human activity and energy efficiency, and to the design of interfaces accordingly;
- Adaptation to the user’s instantaneous activity , situation and context;
- Scaled and selective mining, as well as visualisation, of D/I within large databases, along with integration of disparate databases;
- Development of mature cross-domain / multi-disciplinary software tools and ICT-based services for industry;
- Development of formal models for performance metrics for sustainability and energy-efficiency in buildings and urban areas.



- Understanding and development of quantitative tools that match reality;

5 ICT-enabled EeB

The key role of ICT is identified during the whole construction product life cycle. Different research priorities in each stage of the PLC can positively contribute to more Energy Efficient buildings (EeB).

5.1. DIGITAL MODELS

5.1.1. DESIGN, SIMULATION AND OPTIMIZATION FOR ENERGY EFFICIENCY

ICT tools are deployed to design and plan buildings that fit within the environments in which they are built. Energy aspects are integrated into various everyday design tools with minimum need to rely on advanced special purpose tools.

5.1.2. BUILDING INFORMATION MODELS

Various application tools of different stakeholders are supported by "Building Information Model" and, in the case of already existing buildings, real time D/I and Energy Efficiency related attributes of products and components are available in reusable form from catalogues. Components and buildings are characterised with performance indicators which can be assessed using standardised methods.

5.1.3. IMPACT MODELS

The mechanisms and potential impacts of ICT on energy efficiency are well understood and supported by causal models and evidence. This enables grounded decisions to use ICT solutions for improved energy efficiency.

5.1.4. URBAN PLANNING

ICT applications are used, not only to design individual buildings but, to simulate and analyse holistically complex urban systems and seek solutions that increase quality of life while reducing overall energy use and generating a minimum amount of GHG emissions.

5.2. INDUSTRIALIZED CONSTRUCTION

5.2.1. MANUFACTURING

Improvements of the production of building materials and integration of the supply chain reduce embodied energy in buildings. In particular steel, concrete/cement, bricks and glass require very high temperatures that can only be reached today by the burning of fossil fuels. It is considered that today about 10% of all CO₂ emissions globally come from from the production of building materials.

5.2.2. LOGISTICS

It is considered that 15% of whole CO₂ emissions during the construction process is due to the lack of a smart logistics approach.

Tools for effective logistics planning and management from suppliers to site and ambient/embedded guidance for on-site assembly work are widely deployed in construction sites. This also ensures the optimisation of resource management and quality control.

5.2.3. KNOWLEDGE SHARING

There will be a capability to support the sharing of Energy Efficiency related previous experiences, best practices and knowledge within and, increasingly between organisations from ICT, energy and construction sectors. The aim is to have seamless connectivity to the right information, at the right time, in the right format, and from the right sources, both internal and external. Open knowledge sharing among all stakeholders from a European and global perspective will enable an improvement on cross-sectoral jointcooperation.

5.2.4. COLLABORATION SUPPORT

Collaboration environments where project partners are connected in a transparent way are easy to use without system specific training. These kind of tools will enable collaborative design and construction processes shared by architects, engineers and even clients. Entering this virtual working environment, the architect could control the Energy Efficient design, the engineer could assess the timetable and the building-costs and the client could choose among different solutions at an early stage.

5.3. INTELLIGENT CONSTRUCTIONS



5.3.1. AUTOMATION AND CONTROL SYSTEMS

These are modular, easily customisable with configuration tools and self learning. Advanced ICT solutions adapt the buildings' behaviour and performance for optimisation taking into account the external environment and their users needs.

Applying novel ICT solutions for control systems and home automation promises to have an impact on electricity demand at the level of households and much more at the level of publicly owned buildings which are professionally managed. Building control

systems enable the integrated interaction of a number of technological elements such as heating, ventilation, air conditioning, lighting, safety equipment etc. The embedding of ambient intelligence in building, thanks to advances in nanotechnologies, sensors, wireless communications and data processing contributes to for instance better temperature management, leading to reduced energy consumption.

5.3.2. LOCAL ENERGY GENERATION AND STORAGE SYSTEMS

Buildings are integrated with local generation and storage systems. Buildings use renewable energy sources that are locally available e.g. biomass, geothermal, photovoltaics, solar thermal, wind. Excess energy is exchanged between buildings at neighbourhood level or fed into the grids.

5.3.3. SMART METERING

Smart metering systems enable individual users to see their consumption pattern and adopt appropriate measures for energy saving. Their bi-directional communication capabilities enable utility companies to perform demand-side management in order to reduce energy peaks risks as well as energy production costs.

5.3.4. USER-AWARENESS TOOLS

Intuitive feedback to users on real time energy consumption in order to change behaviour on energy-intensive systems usage could

reduce 5-15% of energy consumption. In addition, human-centric graphic interfaces ensure the acceptance of embedded systems and other ICT-based solutions. Users do not get bombarded by a barrage of feedback data about something that they do not require in the first place: information provided by the system is unobtrusive, and attuned to the user's available attention, taking into account both his/her activity and the urgency of the notified information.

5.3.5. BUILDING AND NEIGHBOURHOOD MANAGEMENT

Recent researches¹⁶ regarding intelligent management systems inside buildings, among other ICT applications, have shown that important energy savings can be reached using these technologies. The use of these intelligent systems inside buildings can improve the control and management of heating, ventilation, air conditioning, lighting, and other energy-hungry devices.

However, buildings are not energy-hungry systems any more. They also produce energy. System of systems architecture provides open interfaces to external services and enable energy balancing and trading at neighbourhood level.

¹⁶ Emerging Trend Update 3. The Role of ICT as Enabler for Energy Efficiency EPI SWork Package 1 – Deliverable 1.3 ETU.JRC

5.3.6. AMBIENT INTELLIGENCE / CONTEXT-BASED SYSTEM USAGE:

Spaces can detect user presence and personalize the environment to the user's preferences: lighting, temperature, indoor air quality etc.. The user's identity is protected.

optimising strategies. The most significant weakness of current control systems is that, in most cases, separate controllers are used for each application. For instance, there are often separate controllers for solar thermal, space heating and cooling, lighting and

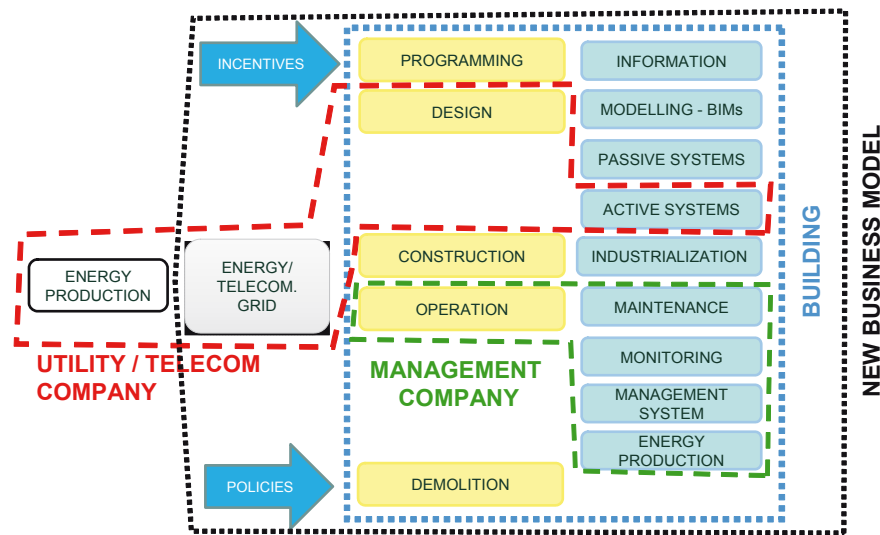


Figure 2: New ICT-enabled business models for the smart buildings

5.4. INTEROPERABILITY & STANDARDS

5.4.1. STANDARDS

Today, most control systems are based on micro-processor technology. Sensors, for example, for determination of temperature or flow rates, are typically connected to the control system by wires. The algorithms implemented in the control system are wide ranging, from simple temperature difference control functions to complex self-

air-conditioning systems. Typically, the individual controllers operate separately, without exchanging information and, as a consequence, the building is not considered and controlled as one single system, but as a number of individual sub-systems. This leads to sub-optimal results in terms of energy flow, comfort, cost and controllability¹⁷. The most appropriate solution will be interoperable control systems, governing all HVAC, lighting

and other electrical applications, and related sub-systems installed in a building.



5.4.2. INTEROPERABILITY

Common ontology, open interfaces and communication protocols provide interoperability between various ICT tools and systems in a seamless way.

Interoperability may indeed be examined according to two different foci – that indeed share common specificities:

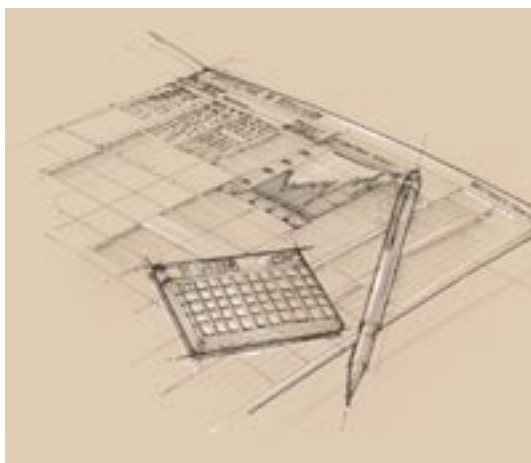
- The first one is related to interoperability as defined in the “buildingSMART®” Alliance: interoperability is to support an ICT-based (automated) global environment where all participants (owners, operators, designers,

constructors, regulators and other stakeholders) can readily and transparently share, communicate, apply and maintain information about facilities and infrastructures - around a BuildingInformation Model (BIM), that is a unified data resource system that makes accuracy, speed and economy in building design, construction, and facility operations possible. In order to do it quickly, efficiently and safely, especially avoiding ambiguities, the concept is related to the one of open standards.

- The second one is related to smart homes increasingly relying on all types of consumer electronics and embedded systems, targeting a goal of comfort and efficiency that can be reached through the convergence of consumer electronics appliances, communicating devices and applications/services in homes. This secondpoint obviously links with interoperability technologies and tools to achieve embedded intelligence: interoperability will allow devices and applications in smart homes to collaborate and provide consumers with greater flexibility in selecting their desired services, and will support the potential cooperation between construction, energy and ICT-based services companies.

6 Business Opportunities

In the area of business and trading, detailed analysis of potential impacts of ICT-based solutions on Energy Efficiency is needed as well as the creation of energy saving business models supported by ICT. Last but not least, local building energy trading would have a definitive impact on the way energy is generated and distributed moving the building from a demand side to a “prosumer” (producer+consumer) profile.



In that sense, new business opportunities¹⁸ will appear based on ICT-enabled energy efficient buildings:

- Innovative Building-technology products and electrical devices: dealing with more energy efficient space-heating, HVAC equipments, elevators, water boilers, appliances, white goods, etc.
- Transparency-creating products: educating energy end users about the impact of their choices and behaviours on their energy consumption and therefore encouraging more conscious use of energy. These products will include smart meters and graphic user interfaces at the consumer’s location.
- Remote operational services: this is typically an area where the telecom provider can play an important role in the end-to-end delivery of smart building applications, whether these services are targeted to the end-user or to the utility provider. To end-users, the telecom provider is able to offer energy-efficiency applications using multimodal interactive interfaces (TV, PC, mobile phone...), e.g. smart metering details, per-appliance real-time power consumption, temperature monitoring, etc. To the utility company, the telecom provider can offer smart metering services. In addition, the telecom provider enables maintenance of the BMS, and other services like remote monitoring, surveillance and management/control of appliances. ICT can empower people to remotely manage their vacation homes, enable technicians to manage many buildings from a central location thereby achieving scale and energy efficiencies (less commuting). The telecom provider is likely to play an important role in providing secure remote access to smart homes and buildings.

- Energy services: Energy Services Companies (ESCOs) will offer a wide range of activities to energy users, including operation and maintenance of installations, energy supply, often in the form of power and heat from co-generation, facility management (covering technical, cleaning, safety and security) and energy management including energy audits, consulting, demand monitoring and management.

- Engineering customized solutions: integrating numerous products from different vendors, companies involved in this area will offer services from design of integrated systems to operation and maintenance phases.



7 Recommendations

A set of recommendations can be structured in two main parts:

1. recommendations in terms of key axis / topics for future RTD;
2. recommendations addressing potential European initiatives to be supported by the EC.



7.1 RECOMMENDATIONS FOR FUTURE RTD TOPICS

Even if it is necessary to continue research in new technologies and components, what it is drastically missing are tools and services for an integrated approach so as to reduce energy consumptions (and GHG emissions) from the diverse and fragmented building sector. Such an approach must coordinate across technical and policy solutions, integrate engineering approaches with architectural design, consider design decisions within the realities of building operation, integrate green building with smart-growth concepts,

and take into account the numerous decision-makers within the industry.

All in all, a comprehensive and systemic view needs to consider future construction including life-cycle aspects (of buildings materials, design, and demolition), use (including on-site power generation and its interface with the electric grid), and location (in terms of urban densities and access to employment and services). When studying the range of technologies, it is important to consider the entire building system and to evaluate the interactions between the technologies. In this context, improved techniques for integrated building analysis and new technologies that optimize the overall building system are especially important.

7.2 RECOMMENDATIONS ADDRESSING POTENTIAL EUROPEAN INITIATIVES TO BE SUPPORTED BY THE EC

Increase synergies and potential collaborations between multiple actors and partners in the fields of building construction, energy efficiency and ICT.

Partnerships should be supported and favoured, including public-private partnerships. In this sense, Joint Technology Initiatives are powerful tools to support this kind of collaboration, particularly:

-ARTEMIS JTI¹⁹, which has been approved by the EC, has established a priority research

topic within its work-programme dealing with Embedded Systems for Sustainable Urban Life, including new electronic devices for supporting Energy Efficiency in Buildings among other services such as security;

-EeB (Energy Efficient Buildings) PPP, currently under elaboration, which objective is to deliver and implement building and district concepts that have the technical, economic and societal potential to cut the energy consumption in existing and new buildings by 50 % within 2030, thereby contributing to improve the energy independence of EU. To reach this goal a holistic combination of technologies is needed to realise the building concepts. These technologies include ICT as a key element for improving energy efficiency in buildings and districts.

In addition, initiatives such as NESSI (Networked European Software & Services Initiative) will encourage the creation of new businesses towards Service Oriented business models.

Increase cross-sectoral synergies between the various sectors concerned by greater efficiencies enabled through the use of ICT (buildings, lighting, electric grids).

A cross collaboration between these sectors has to be organised, at the common interfaces between them – the table below is an initial draw of already identified strong links between “Smart Buildings” and the 5 other groups addressing specific themes. This is an area where DG INFSO – and especially the “ICT for sustainable Growth Unit” – may play a key role, in favouring ambitious joint projects with all or at least part of the key players in the 6 sectors. In a second stage, extension to international collaboration may be envisaged, typically through the IMS²⁰ collaborative scheme.

Smart Manufacturing	<ul style="list-style-type: none"> • Link with embodied energy in buildings and building materials. It is considered that about 10% of all CO₂ emissions globally comes from the production of building materials. In particular steel, concrete (cement), bricks and glass require very high production temperatures that can only be reached today by the burning of fossil fuels. Knowledge from Smart Manufacturing is of high interest here so as to take into account these constraints in future buildings. • Processes in the Construction sector largely involve a complex supply chain – improvement from Smart Manufacturing considering Construction supply chain constraints will have impact in terms of reduction of CO₂ emissions.
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¹⁹ <http://www.artemisia-association.org>

Smart Electric Grids	<ul style="list-style-type: none"> • Need for improvement in Smart Metering, including within the Built environment, and customers' communication / awareness. • Home Energy Controlling box (Internet box). • Development of ICT-based NMS (Neighborhood Management Systems), considering future positive-energy buildings as potential active nodes (supply of energy) in future Smart Electric Grids.
Lighting & Photonic	<ul style="list-style-type: none"> • It is considered that about 12% of energy consumption in buildings is due to lighting. This figure increases in the non-residential building sector. • Smart integration of new lighting technology (high performance technology) and devices (e.g. intelligent LED solutions) in Smart Buildings.
Smart Mobility	<ul style="list-style-type: none"> • Smart integration of Buildings & Networks in Energy efficient Urban monitoring • Integration of ICT tools for the design phase of buildings and urban developments
Re-Structuring	<ul style="list-style-type: none"> • New business cases and new (ICT-based) business models • Establishment of common (integrated) platform for measuring and informing citizens, service providers and organisations about the carbon footprint of all activities of, e.g. a city's life.

Provide incentives to favour information sharing and collaborative developments at a trans-national level

This will lead to collaborative European RTD, but taking into account specificities of countries and providing opportunities of sharing of experiences and good practices, as well as International cooperation.

Propose instruments to create a critical mass of research, development and innovation at EU level

In the areas of ICT-based technologies and services for energy efficiency in buildings, with the establishment of a favourable environment for participation of construction SMEs, these instruments could act as "front-runners" in construction for the prescription

and deployment of new optimised solutions in buildings. An important effort is currently being done in this sense with the potential creation of a Public Private Partnership on Energy Efficiency in Buildings²¹ where one of the main research topics is the integration of ICT-based solutions for Energy Efficiency.

Support the development and integration of technical ICT-based solutions

Accompanying the construction industry in the innovation process (after the RTD phase), by providing a coherent European framework for developing common approaches, with common European standards, and the localisation and adaptation of common solutions which have to be compatible with

varying environmental contexts, social (user) preferences and regulatory aspects at national or regional level across Europe; One of the key points here is to overcome the standardisation barrier, with means to stimulate/look at some potential standardization of building systems in a standards body;

Valorising the ICT-based solutions by helping and pushing evaluation and certification of packages, digital services (in buildings) and processes – overall with the development of labels. The evaluation should be relying on the usage value of technical solutions, for instance through large-scale pilots, user panels, development of showrooms, education, etc.

Public procurement should clearly encourage ICT-enabled energy efficient buildings taking into account that approximately 40% of the construction turnover is still public (hospitals, schools, etc.).

Annex 1: Methodology and Credits

In the autumn of 2008 the European Commission set up a (high level) advisory group aiming at providing information on potential as well as recommendations in terms of ICT for Energy Efficiency. This high-level advisory group was composed of seven working groups and one of these on Smart Buildings. This group has also been seen, from the “Construction” side, as the channel for involving ICT and DG INFSO in the activities the Construction sector.

The mandate of the group was:

- To provide a “preliminary” set of references about potential current data and trend analysis of the impact of ICT on EE in the Building sector, taking into account good practices applied worldwide. However, today it still seems difficult to find exhaustive useful references to proven data, but the group should at least provide some links and demonstrate that this is an ongoing activity in the community. There are various sources about the distribution of energy usage in buildings e.g. convection through the envelope, windows, air leakages, ventilation, lighting, hot water generation, sewage (warm waste water), micro-generators, thermal storage, etc.. This group should explore the (indirect) relations of all these items with ICT e.g. tools for analysis, design, simulation etc. but also new embedded systems based techniques for control and actuation.

- To provide early drafted RTD roadmaps and priorities, potential actions that the Commission could take that would intensify/accelerate the existing trend, including awareness raising and sharing of good practices.

The Group was structured as follows:

Chairman:

- Jose-Javier De Las Heras, Acciona

Rapporteur:

- Alain Zarli, CSTB

Industry:

- Jose-Javier De Las Heras, Acciona, Spain
- Marta Fernandez, ARUP, UK
- Dr.-Ing. Rudolf Julio, PB (OBERMEYER PLANEN + BERATEN GmbH), Germany
- Eliav I. Haskal, Philips, NL
- Christian Glatte, Schüco International KG, Germany
- Gilles Privat, Orange-FT, France
- Mélanie Biette, Atos Origin (Atos Research & Innovation), Spain
- Pawel Poneta, Mostostal, Poland
- Akos Kriston, T-Online (with Eotvos Lorand University Budapest), Hungary
- Sven Claes, Alcatel-Lucent Bell NV, Belgium
- Claude Lenglet, Bouygues, France
- Jose Basilio Simoes, ISA, Portugal

Academics & Research centres:

- Alain Zarli, CSTB, France
- Matti Hannus, VTT, Finland
- Wim Gielingh, TU Delft, Netherlands
- David Corgier, CEA, France
- Raimar Scherer, TU Dresden, Germany
- Juan Perez, Labein, Spain
- Sven Schimpf, Fraunhofer/Univ. of Stuttgart, Germany
- Pedro Malo Celson Lima, Uninova, Portugal

Associations of stakeholders (end user associations, local governments,...)

- Manuel Martinez, FIVEC / City of Valencia, Spain
- Luc Bourdeau, ECTP
- Johan Vyncke Myriam Olislaegers, ECCREDI, Belgium
- Alain Sagne, ACE/CAE, Belgium

European Commission

- Mercè Griera i Fisa, DG INFSO (Merce.Griera-I-Fisa@ec.europa.eu)

This booklet is a compendium of the findings of the group complemented by four keynote messages delivered by high-level representatives of stakeholders at the ICT for Energy Efficiency event organised by the European Commission and the Czech Presidency in March 2009.

Annex 2: Relevant European projects

The ICT for Sustainable Growth Unit is part of the ICT for Societal Challenges Directorate of the Directorate-General Information Society and Media of the European Commission. It manages projects under the Seventh Framework Programme (FP7) as well as the Competitiveness and Innovation Programme (CIP, ICT-PSP).

The following is a brief presentation of the most relevant projects supported in the building and construction domains.

9.1 PILOT PROJECTS

BEST ENERGY

www.bestenergyproject.eu



The project main objective is to improve the energy efficiency in public buildings and in street public lighting, by the ICT-based centralized monitoring and management of the energy consumption and production and by providing decision makers with the necessary tools to be able to plan energy saving measures. The initially quantified objective is to achieve a 12% reduction on the energy consumption of the buildings, and at least a 30% reduction of the energy consumption of the public lighting systems.

Four pilots will be implemented and validated: two related to energy efficiency in public buildings (one in a Sports centre in Spain and one in a University building in Germany), and another two regarding energy efficiency in public street lighting. Based on these experiences there will be a later replication of the pilot in other buildings, located in Spain, Denmark and the Czech Republic. The aim is to experiment during the project a first replication of the pilot experiences that will serve other Municipalities to take advantage of the project results.

HOSPILOT

<http://www.hospilot.eu>



The concern of European society for the well being of its residents and the sustainability of the environment has led to the consciousness that energy savings need to be at the top of the political agenda. Until recently, the focus of energy reduction has been on schools and offices.

Hospitals, however, also use large amounts of energy. Therefore, the project will address specifically the hospital domain. HosPilot will address the two main technology areas Lighting and HVAC, thus covering the largest part of the energy consuming areas. By

adding intelligence, ICT will play a vital role to achieve significant energy reduction in the complex environment of a hospital.

The main goal of HosPilot is to prove that the proposed energy reduction service leads to reduced energy consumption and improved level of comfort for the end users. This goal will be achieved by identifying requirements of hospitals with respect to the building, its surroundings and its usage; designing a generic methodology addressing the needs, yielding the most energy efficient solution.

The methodology will be interlinked with expert knowledge of the various technologies into one holistic energy saving service. Three pilots will be executed in hospitals during normal operation. HosPilot will provide the most advanced ICT technology for future replications at European level. The HosPilot project will support the decision makers with an ICT based service that will drastically reduce the energy consumption of newly built hospitals and existing hospitals being refurbished, increasing well being and comfort.

The consortium comprises the required players, – lighting and healthcare industry, industry (including SME) and applied research organisations on energy efficient building construction, system integration and clinical sites – and makes sure that appropriate knowledge is available to introduce the new service. The HosPilot consortium is capable of bringing the best solution forward.

SAVE ENERGY

www.ict4saveenergy.eu



The project will develop a serious game providing an engaging virtual environment for citizens and policy makers to gain awareness, understanding and experience with regard to the issues associated with behavioural change and energy efficiency. The project includes five pilots in public buildings from Helsinki, Manchester, Lisbon, Lulea and Leiden.

The pilots will use electronic sensors to measure energy usage, plug adapters between wall sockets and the devices that plugs into them, the mains electricity as both a power source and means of communication. The information of a network of sensors will be gathered by a central server allowing for the data analysis and identification of consumption patterns and real time visualisation. The pilot implementation will follow the Living Lab methodology, involving large communities of motivated citizens co-creating ideas, decisions and recommendations in the project open innovation environment.

9.2 RESEARCH PROJECTS

AIM

www.ict-aim.eu



The main objective of the project is to foster a harmonised technology for profiling and managing the energy consumption of appliances at home. AIM will introduce energy monitoring and management mechanisms in the home network and will provide a proper service creation environment to serve virtualisation of energy consumption, with the final aim of offering users a number of standalone and operator services. Behind this goal, the main idea is to forge a generalised method for managing the power consumption of devices that are either powered on or in stand-by state. Especially for the second category of devices, the project will define intelligent mechanisms for stand-by state detection, using all-device-fit control interfaces. The AIM technology will be applied on white goods (refrigerators, kitchens, washing machines, driers), communication devices (cordless phones and wireless communication devices for domestic use) and audiovisual equipment (TV Sets and Set-top-boxes) and will be built around three use-cases: use-case for residential users (intelligent power management service for

autonomous energy preservation), use-case for power distribution network operators (metering service for energy planning), use-case for network operators (remote monitoring and management).

BE AWARE

www.energyawareness.eu



Reduction of energy consumption is a societal challenge that requires combination of technical, economical, and social means. So far, energy conservation has focused on new technologies and automation, treating users as passive consumers. However, strong evidence suggests that users can adapt actively their behaviour to energy saving with suitable feedback, support, and incentives, reducing significantly and cost-effectively energy use without impacting adversely their comfort. At present, energy information flows are slow, aggregated, and hidden, being operated by a market lacking incentives and proper service models. The opaqueness discourages users to learn and apply conservation strategies in their everyday lives. However, novel ICT's offer opportunities for removing this bottleneck. In particular, ubiquitous interfaces combined with low-cost sensors support real-time information from energy networks and consumption, empowering users to learn and share conservation strategies.

BEY WATCH

www.beywatch.eu



Targeting environmental sustainability, energy efficiency and new power distribution business models, BeyWatch aims to design, develop and evaluate an innovative, energy-aware, flexible and user-centric solution, able to provide interactive energy monitoring, intelligent control and power demand balancing at home, block and neighbourhood level. The system will interconnect legacy/consumer electronic devices with a new generation of energy-aware white-goods in a common network, where multilevel hierarchic metering, control, and scheduling will be applied, based on power demand, network conditions and personal preferences. By scheduling and controlling the electronic devices operation, Bey-Watch aims to minimize power distribution peaks, balancing energy load in power distribution networks and ultimately achieving predictable large-scale energy-consumption profiles. Moreover, BeyWatch will integrate an innovative combined photovoltaic/solar (CPS) system, which will provide hot water for white goods in order to reduce/remove the energy-hungry heating operational cycles and generate electrical energy, which can be utilised at home, or during peak periods even

fed to the electricity network in a reverse power generation/ distribution business model.

DEHEMS

www.dehems.eu



The project will extend the current state of the art in intelligent meters, moving beyond energy 'input' models that monitor the levels of energy being used to an 'energy performance model' that also looks at the way in which the energy is used. It will bring together sensor data in areas such as household heat loss and appliance performance as well as energy usage monitoring to give real time information on emissions and the energy performance of appliances and services. It will enable changes to be made to those appliances/services remotely from the mobile phone or PC and provide specific energy efficiency recommendations, for the household.

The impact will be to personalize action on climate change, and so help enable new policies such as Personal Carbon Allowances as well as supporting the move towards increased localized generation and distribution of energy.

INTUBE

www.intube.eu



The main aim of the IntUBE project is to develop and make use of information and communications technologies to improve the energy efficiency of these existing buildings in compliance with the EU's aims of improving energy efficiency. IntUBE will develop tools for measuring and analysing building energy profiles based on user comfort needs. These will offer efficient solutions for better use and management of energy use within buildings over their lifecycles. Intelligent Building Management Systems will be developed to enable real-time monitoring of energy use and optimisation. They will, through interactive visualisation of energy use, offer solutions for user comfort maximisation and energy use optimisation. Neighbourhood Management Systems will be developed to support efficient energy distribution across groups of buildings. These will support timely and optimal energy transfers from building to building based on user needs and requirements. New Business Models to make best use of the developed Management Systems will be created. The results of IntUBE are expected to enhance not only the comfort levels of building users, but to also reduce overall energy costs through better energy efficiency.

SMART HOUSE/SMART GRID

www.smarthouse-smartgrid.eu



SmartHouse/SmartGrid

Current smart house/energy technologies treat home and working environments as effectively consisting of isolated and passive individual units. This severely limits achieved energy efficiency, as it ignores the potential delivered by homes, offices, and commercial buildings seen as intelligent networked collaborations. Thus, the SmartHouse/Smart-Grid project introduces a holistic concept for smart houses situated and intelligently managed within their broader environment. It develops intelligent networked ICT technology for collaborative technical-commercial aggregations of Smart Houses able to communicate, interact and negotiate with both customers and energy devices in the local energy grid so as to achieve maximum overall energy efficiency as a whole. Our technology is built on (i) using available open industry standards in both the ICT and energy sectors; (ii) employing communication and computing capabilities that are already in widespread use in mainstream home and working environments.

9.3 SUPPORT ACTIONS

E4U

www.e4efficiency.eu



The aim is foster world-leadership in ICT enabled energy efficiency in the EU through accelerating research and development in power electronics. It will achieve this through the creation of a strategic research roadmap for power electronics in alignment with the national, EU, and international policy framework. E4U will create impact through targeted interaction with the research community, leading European industry, and research policy makers at the national and European level. E4U will also advertise the benefits of power electronics and information technology for energy efficiency to the broad public.

One of the application areas the project is considering is buildings and lighting. Automation and control systems exist for several building subsystems like heating, air conditioning, cooling and lighting. To be energy efficient, a building needs a management system that integrates all these elements and abandons the conventional separation of electrical engineering and building automation. Moreover the system should be linked to security, safety and presence subsystems in a holistic approach.

GENESYS

www.genesys-project.eu



The main idea behind the project is that the needs of optimising Energy consumption across the world can turn into innovation drivers, designing the requirements for new ICT applications, which could have significant impact in the Energy consumption patterns at European and larger scale. The project will build a well structured link between ICT research on Energy Efficiency and the concrete specifications given by the frameworks to which those applications could be adapted. The project targets primarily Europe, but attaches importance to countries like the US or India, seen as potential markets for European research derived applications.

One of the selected domains is Intelligent buildings. Project results gathered from CORDIS and other private initiatives will be analysed from a technical and business perspective. Research results and best practices will be disseminated in Europe and in foreign Countries such as India and USA.

REEB

www.ict-reeb.eu



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 objectives of the project are the following:

- 1) the establishment of a European-led community tailored to ICT for energy efficiency in construction sector involving all the most significant stakeholders in the ICT, Energy and Construction communities;
- 2) the development of national communities with similar objectives;
- 3) the identification and analysis of relevant best practices at European level in the aforementioned domains;
- 4) the analysis of the most important R&D projects related to the REEB objectives;
- 5) the development of a coordinated vision, a roadmap and a set of recommendation actions by merging all the fragmented visions and roadmaps elaborated by different European Technology Platforms (especially the ECTP - European Construction Technology Platform and its JTI, the E2B Energy Efficient Buildings Initiative);
- 6) the definition of a plan for disseminating knowledge and synchronizing efforts with other similar initiatives.

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