

The IEA ECBCS: Research and Development for Near Zero Energy and Carbon Emissions in Buildings and Communities

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ABSTRACT

The Energy Conservation for Buildings and Communities Systems (ECBCS) is an Implementing Agreement among 23 countries of the IEA (International Energy Agency) for energy research and development in buildings and communities. The ECBCS has now completed 43 major international projects resulting in demonstrated and adopted technologies and tools with major impacts on energy efficiency and environmental impacts in buildings and communities. The ECBCS has now completed its 2008-13 strategic plan. As of today, 10 new projects are now in place to support the feasibility of near-zero energy and carbon emissions in both buildings and communities. This invited paper summarizes the content of the keynote address, to highlight the ECBCS current activities and future research priorities for buildings and communities.

The ECBCS member countries, as of today, include: Australia, Austria, Belgium, Canada, Czech Republic, Denmark, Finland, France, Germany, Greece, Italy, Japan, Netherlands, New Zealand, Norway, Poland, Portugal, South Korea, Sweden, Switzerland, United Kingdom, and the United States.

1. ECBCS: ENERGY R&D AND IMPACTS

The International Energy Agency's (IEA) Implementing Agreement on Energy

Conservation in Buildings and Communities systems (ECBCS) has recently celebrated 30 years of effective research and technology development toward reducing energy consumption in buildings and communities, while minimizing environmental impacts. The ECBCS website has now a website activity of 1.3 Millions visitors/year, and its research and demonstration reports have been downloaded more than 1 Million times during 2007-08. The primary receptors of these technologies and deliverables are primarily the various players involved in the practice and innovation the built environment. The ECBCS has now completed 43 Annexes – i.e. four-year research projects-, with major impact on energy efficiency and effective integration of new energy sources in buildings and communities.

The ECBCS has recently completed its 2008-13 strategic plan. This process included, among others, an environment scan and review of technologies and applications in the built environment, with a special focus on energy and environmental impacts. The objective of this paper is to highlight mandate, current and future activities of the ECBCS, and energy R&D trends in buildings.

2. TODAY'S BUILT ENVIRONMENT: SECTOR, ENERGY, AND ENVIRONMENT

Today, the literature and current trends on energy use and environmental impacts demand immediate measures and strategies to reduce

drastically energy consumption and environmental impacts from the built environment. The built environment - i.e., construction sector - represents more than 10% of GDP, but also consumes between 30-40% of total energy consumption and 50% of total primary resources. It is also responsible for 25-40% of the total solid waste.

The sector is also recognized as uniquely fragmented especially in the decision-making process. It is critical to economy and people's lives-, but widely recognized as slow and relatively "resistant" in adopting innovative technologies. More than ever before, the sector is facing challenging societal and regulatory demands, in aspects related to energy, ventilation, safety, etc. These stem from the most pressing economic and societal drivers for the built environment today. These are (Indoor) *Health, Energy, Environment, and Costs (Productivity)*. It is widely recognized that indoor health and wellbeing and costs, have been major barriers for the implementation of adoption of energy and environmental solutions and technologies for the built environment.

The drivers of health and costs, explains why now the definition of sustainability in the built environment in many references, encompasses more than energy and environment, to include health and wellbeing. This has translated in the recent sustainable building-rating attempts, to rate sustainable aspects, including not only energy and impacts on environment, but also indoor environment "quality" –ventilation, acoustics, indoor pollutants, lighting/daylighting-, among others.

3. ENERGY RESEARCH TRENDS FOR BUILDINGS AND COMMUNITIES

R&D energy trends for buildings and communities since 1970's have been significant, but it did not result in major changes in the decision-making practices and also technologies for buildings. However, significant improvements have been made for the energy efficiency building appliances,

lamps, cooling and heating equipments, and thermal resistance of construction materials. With the exception of appliances, the literature shows that the adoption of these technologies is lacking or slow, and that there are very few cases of demonstrated energy in real and occupied buildings. This applies also to introduction of renewables –solar- in buildings. With raising energy and constructions, today there is demand for technologies and practices for drastic reduction of energy consumption in the order of 50 to near zero by 2030. Such policies and targets have been listed in several national priorities and much research is underway to determine feasibility and develop or improve technologies and tools.

In the 1990's, environmental challenges have brought about significant R&D and industry focus on the environmental impacts of buildings, including impacts from building energy technologies. Sustainability was then often broken down into energy and environmental indicators, resulting into very aggressive targets for energy efficiency and carbon emissions for the built environment. Learning from the past R&D performance and case studies, have brought a newly and revised focus in many national R&D priorities. This includes exploiting emerging findings on material sciences (nanotechnology), information technologies, and energy sources – co-generation and fuel cell, and also reliable R&D on effective integration of building systems. The latter include integrated building systems –envelope, HVAC, Lighting - to reduce thermal loads from envelope, operation, and maintenance, while improving indoor environment and complying with regulations and other requirements.

4. THE ECBCS: R&D ACTIVITIES AND PRIORITIES

The IEA ECBCS has completed 43 Annexes since 1977 to advance the science and application of energy in buildings and communities, and to deploy resulting technologies and tools to practitioners and the

research community. These Annexes – four-year large collaborative projects- were part of five-year strategic plans, to respond to evolving trends and drivers of the building sector and energy. These Annexes have addressed science and application gaps that targeted the design, operation and maintenance of building and communities systems. The Annexes have resulted, among others on:

- Improved thermal resistance and durability of building envelope systems
- Improved energy efficiency of HVAC and lighting systems, including commissioning
- Better understanding of integration of renewables- solar, fuel cell
- Adoption of energy technologies through demonstrations and monitoring in occupied buildings and communities, and through effective deployment of tools
- Integration of technologies from emerging material sciences –vacuum insulation- and new energy sources- low exergy, fuel cell, LED, etc.
- Reliable best practices and information in support of ventilation and air leakage, through ECBCS’ Annex 5 - Air Infiltration and Ventilation Center (AIVC).

During this 2002-07 cycle, the ECBCS completed 10 Annexes resulting in deliverables on improving energy efficiency and environmental impacts of buildings and communities. These are widely adopted by industry as standards, applied tools, and/or benchmarking. During this period, there were also 10 new Annexes, and related technology transfer activities. Examples include:

- New Annexes on integration of leading edge technologies such as fuel cell, vacuum insulation, low exergy, LED lighting, etc.

- New Annexes on integration of renewables and exergy both in buildings and communities.
- New Annexes on priorities: integrated energy retrofit, including prefabrication; energy efficiency for building services and envelopes; integrated life-cycle decision making; and energy efficient and sustainable communities.
- New and effective business model and new products for Annex 5: the Air Infiltration and Ventilation Center.
- More than 30 international conferences and seminars.
- Future Building Forum workshops for forward outlooks on energy situation in the built environment

As a result of the recent strategic plan exercise, The ECBCS is aligning its R&D activities towards the goal of *near-zero energy and carbon emissions in the built environment by 2030*. The ECBCS will build on its mission of R&D and innovation to develop and facilitate the integration of technologies and processes for energy efficiency and conservation into healthy, low emission, and sustainable buildings and communities. These technologies and processes will target a much radical decrease of energy consumption and carbon emissions from buildings and communities. The aim is to impact three aspects of the industry’s business environment:

- *Decision-making*. This includes tools, standards and regulations, benchmarking, etc. Examples of past deliverables include: HVAC fault-detection software; hygrothermal properties of building materials and envelopes; HVAC commissioning tools; software and tools for community energy planning;

- *Building products and systems.* This includes, among others, the products and integrated systems of building envelope, HVAC, lighting, community systems. Examples of past deliverables include integrated vacuum insulation in building envelope systems; fuel cell energy performance in homes; application of low exergy in heating and cooling, etc.
- *Deployment and dissemination.* This includes tools, performance data in real buildings and communities, and seminars. The ECBCS' Annex 5 -Air Infiltration and Ventilation Center- provides reliable and consensus-based best practices and information on building ventilation and air leakage.

current and future needs of the industry and society. Finally, the ECBCS collaborates with different organizations to disseminate technologies and tools at national and international seminars and conferences. For more information, please refer to: www.ecbcs.org.

The following priorities have been identified:

- Develop, benchmark, and demonstrate energy performance of *promising and accepted* integrated systems, as opposed to products, in real building and communities
- Exploit best emerging findings from material sciences, information technologies, and new energy sources
- Develop technologies and processes for effective building energy retrofits.

The energy situation in buildings and communities has evolved where performance targets only energy efficiency; but also clean energy and integration of renewables.

The ECBCS collaborates with other IEA building-related Implementing Agreements, national energy and building programs, as well as associations related to buildings, communities, and energy. The ECBCS engages the building industry, municipalities, and research community worldwide on workshops and consultations on future energy outlook in buildings and communities. This serves to build projects targeted toward the