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IEA EBC annexes advance technologies and strategies to reduce energy use and GHG emissions in buildings and communities

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IEA EBC Annexes Advance Technologies and Strategies to Reduce Energy Use and GHG Emissions in Buildings and Communities

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More than one-third of the global primary energy is consumed in commercial and residential buildings for heating (space and hot water), ventilating, cooling, lighting and operation of appliances. In addition, a reasonable part of primary energy and greenhouse gas (GHG) emissions is embodied in construction materials. Hence the building sector represents a major contribution to fossil fuel use and related GHG emissions. With uncertainties in energy supply and concern over the risk of global climate change, many countries have set targets to reduce energy use (from 5% to 50%) and GHG emissions in buildings. To achieve such targets, international cooperation, in which research activities and knowledge can be shared, is seen as an essential activity.

The International Energy Agency (IEA)'s Energy in Buildings and Communities (EBC) Programme (iea-ebc.org) carries out research and development activities toward near-zero energy and carbon emissions in the built environment. These joint international research projects (annexes) are directed at energy saving technologies and activities that support technology application in practice. EBC Annexes focus on five high priority research themes: (1) Integrated planning and building design, (2) Building energy systems, (3) Building envelope, (4) Community scale methods, and (5) Real building energy use. Each EBC annex usually runs for four to five years, including one year preparation phase and three to four years working phase. The outcomes of EBC's Annexes address the determining factors for energy use in three domains: technological aspects, policy measures, and occupant behavior. Results are also used in the formulation of international and national energy conservation policies and standards.

EBC (formerly ECBCS) was established in 1977 and has currently 26 member countries. There are 63 completed annexes as of September 2017, and 12 on-going annexes. Figure 1 shows the mapping of Annexes 46-75 to EBC's five research themes defined in the Strategic Plan.

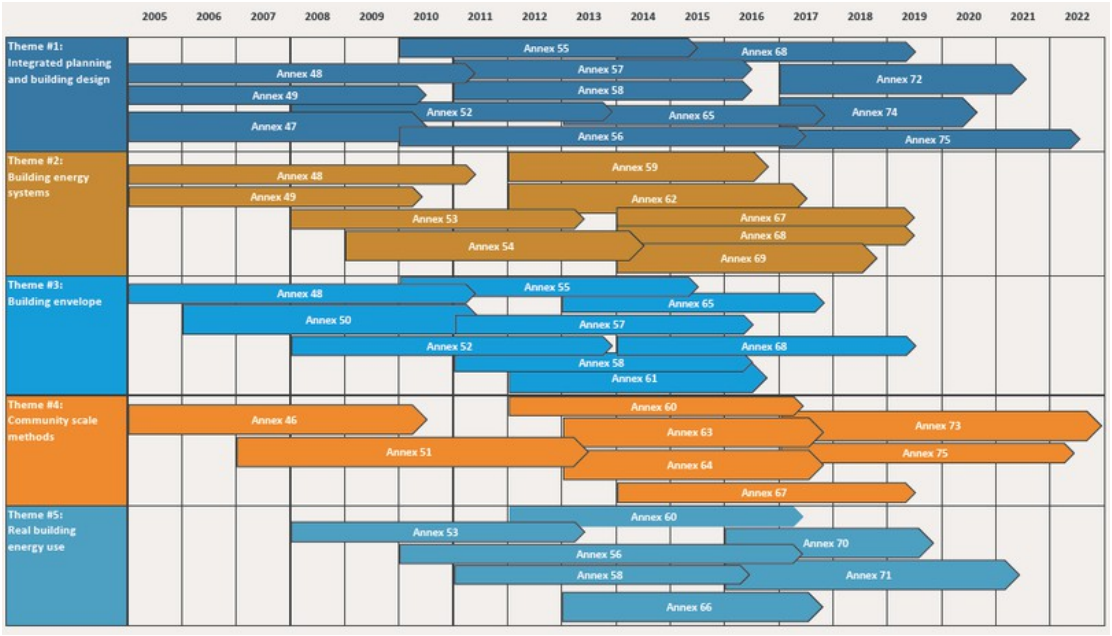

Figure 1 - IEA EBC Annexes 46-75 mapped to five research themes (Source: Rolf Moser)

To communicate IEA-EBC's R&D in buildings and communities to broader audience especially the academic and research communities, this special issue of Energy and Buildings highlights thirteen EBC Annexes. Operating agents and technical leads of the annexes contributed thirteen articles (Table 1), summarizing research problems, research methods, technical activities, and main outcomes, by drawing some content from the annex's technical reports, final reports, related journal articles and other publications.

Table 1 –Thirteen IEA EBC Annexes and Articles

No.	IEA EBC Annex	Authors	Manuscript Number	DOI
1	Annex 40 - Commissioning of Building HVAC Systems for Improved Energy Performance; Annex 47- Cost Effective Commissioning of Existing and Low Energy Buildings	Natascha M. Ferretti, Masato Miyata, Oliver Baumann	ENB_2017_1222_R1	10.1016/j.enbuild.2017.08.031
2	Annex 51 – Energy Efficient Communities	Reinhard Jank	ENB_2017_881_R1	10.1016/j.enbuild.2017.08.074
3	Annex 53 - Total Energy Use in Buildings: Analysis and Evaluation Methods	Hiroshi Yoshino, Tianzhen Hong, Natasa Nord	ENB_2017_1417	10.1016/j.enbuild.2017.07.038
4	Annex 55 - Reliability of Energy Efficient Building Retrofitting - Probability Assessment of Performance and Cost	Carl-Eric Hagentoft	ENB_2017_1890	10.1016/j.enbuild.2017.09.007
5	Annex 56 - Cost-Effective Energy and CO2 Emission Optimization in Building Renovation	Marco Ferreira, Manuela Almeida, Ana Rodrigues	ENB_2017_1323_R1	10.1016/j.enbuild.2017.07.066
6	Annex 57 - Evaluation of Embodied Energy and CO2 Equivalent Emissions for Building Construction	H. Birgisdottir, A. Moncaster, et al.	ENB_2017_820_R2	10.1016/j.enbuild.2017.08.030
7	Annex 58 - Reliable Building Energy Performance Characterisation Based on Full Scale Dynamic Measurements	Staf Roels, Peder Bacher, et al.	ENB_2017_1264_R1	10.1016/j.enbuild.2017.08.006
8	Annex 59 - High temperature cooling and low temperature heating in buildings	Xiaohua Liu, Yi Jiang, et al.	ENB_2017_88_R1	10.1016/j.enbuild.2017.04.036
9	Annex 63 - Implementation of energy strategies in communities	Helmut Strasser, J. Kimman, et al.	ENB_2017_1261_R2	10.1016/j.enbuild.2017.08.051
10	Annex 66 - Definition and Simulation of Occupant Behavior in Buildings	Da Yan, Tianzhen Hong, et al.	ENB_2017_1427_R1	10.1016/j.enbuild.2017.09.084
11	Annex 67 - Energy Flexible Buildings	Soren Jensen, Anna Marszal-Pomianowska, et al.	ENB_2017_1277_R1	10.1016/j.enbuild.2017.08.044
12	Annex 68 - Design and Operational Strategies for High IAQ in Low Energy Buildings	Louis C. R. Salis, Marc Abadie, et al.	ENB_2017_1249_R1	10.1016/j.enbuild.2017.07.054
13	Annex 70 - Building Energy Epidemiology: Analysis of Real Building Energy Use at Scale	Ian Hamilton, Alex Summerfield, et al.	ENB_2017_812_R2	10.1016/j.enbuild.2017.08.079

Annexes 40 and 47 focus on the building commissioning process to meet building design performance goals. Ferretti et al. [1] discussed research results and impact of building commissioning in four areas: 1) commissioning support software tools, 2) cost-benefit methodology, 3) guidelines and standards, and 4) industry associations and conferences. Annexes 51 and 63 focus on energy efficient communities. Jank [2] summarized the Guidebook on Successful Urban Energy Planning developed from 25 community energy case studies of the 10 participating countries, to directly address practical urban/energy planners and municipal decision makers. Strasser et al. [9] introduced procedures and best-practice examples to implement optimized energy strategies in communities, by using nine strategic measures to address the challenges. Annexes 53 and 66 focus on knowledge and tools to understand and calculate real energy use

in buildings. Yoshino et al. [3] highlights research results of six driving factors of real energy use in buildings including, climate, building envelope, building services and energy systems, building operation and maintenance, occupants' activities and behavior, and indoor environmental quality. Yan et al. [10] summarizes new data, modeling and simulation tools, and case studies developed to standardize representation and simulation of occupant behavior in buildings to enable the evaluation of its impact on adoption of building technologies as well as building performance during the building life cycle. Annexes 55 and 56 focus on building retrofit. Hagentoft [4] presents methods of risk management and probabilistic assessment used in Annex 55 to evaluate uncertainties of factors in the building retrofit process. Ferreira et al. [5] presented a method, developed in Annex 56, to integrate co-benefits in the evaluation of renovation scenarios towards both the nearly-zero emissions and the nearly-zero energy objectives. Birgisdottir et al. [6] introduced methods and database developed under Annex 57 enabling accounting of embodied energy and GHG emissions, together with the operational energy, as the life cycle energy and GHG emissions for building construction. Roels et al. [7] presents on-site testing and dynamic data analysis methods used in Annex 58 to characterize the actual thermal performance and energy efficiency of building components and whole buildings, using the case studies of the thermal characterization of a round robin test box. Liu et al. [8] presents a novel concept of entransy used in Annex 59 to characterize the mixing loss and transfer loss in the district energy systems, and introduces new processes and equipment that are key components of the advanced high-efficient low-temperature heating and high-temperature cooling district energy systems. Jensen et al. [11] introduces the concept of energy flexibility of buildings, in Annex 67, and various techniques that can be employed to improve the energy flexibility of buildings to meet needs such as demand response as well as challenges of variability of renewable energy generation from solar PV and wind. Salis et al. [12] introduces the scope and goals of Annex 68 which aims to develop an IAQ index that can be used to evaluate indoor air quality design and control in low energy residential buildings. Hamilton et al. [13] describes Annex 70 which draws on the health sciences to posit 'energy epidemiology' as a whole-system approach for empirical research that provides a methodological framework for building physicists, engineers, social scientists, and economists to engage in cross-disciplinary studies on energy performance of building stocks, through identification of user needs around energy demand in buildings and establishment of best practice methods and harmonized formats for data collection, analysis and modelling.

Overall these 13 annexes developed and employed new methods, tools, case studies, guidelines and policies, to support EBC's goals by providing insights and actionable information for a wide range of stakeholders to improve energy efficiency from individual buildings to communities.

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Contains articles from 15 June to 31 October, 2017.