HOW TO SPEED UP ENERGY EFFICIENCY IN THE EU CONSTRUCTION THROUGH AN INTER-SECTOR COLLABORATION?

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INTRODUCTION

The article presents the major outcome of the European research project BUILDING UP "Multi-stakeholder, cross-sectorial, collaborative long term Research & Innovation Roadmap to overcome technological and non-technological barriers towards more energy-efficient buildings & districts"[1].
The construction industry has engaged with the European Commission in a Public Private Partnership concerning energy-efficient buildings, aiming amongst others to build a cross sectorial multiannual roadmap.
The background for developing the roadmap was a broad review of foresight studies and other relevant sources (EU-funded work and reports, research agendas from ETPs, and other national and multinational initiatives) served as a basis for the discussions, inventive sessions. The Building Up Roadmap[2] focuses its main targets in the short-medium term (up to 2020), with some suggested actions for longer terms (beyond 2020). In this framework, the Building Up Roadmap includes:

- **8 Cross-Platform (CP) collaboration areas** in research and innovation in the NMP field:

o CP1. Performance Based Approach for building components, including sustainable design, Life Cycle Analysis;
o CP2. Multi-materials and composites;
o CP3. Healthy and comfortable indoor environment (including air quality, ventilation, lighting, acoustic performance);
o CP4. Electricity generation and storage materials and systems (e.g. storage systems including building integrated energy technologies);
o CP5. Thermal generation and storage materials and systems (e.g. storage systems including building integrated energy technologies);
o CP6. Advanced thermal insulation construction materials for new buildings and existing buildings (e.g. aerogel, nanofoams, vacuum insulation panels);
o CP7. Building materials recyclability and re-use of components;
o CP8. Renewable resource-based products.

- A set of **cross-cutting targets** with considerations on broad non technological issues.

- The **overall social, environmental and economic impact**, adding specific examples on **target markets** and **expected benefits** of the proposed actions for each cross-platform areas.

The Building Up Roadmap aims to contribute addressing the 138 barriers identified by the project team and divided in two main groups: technological (68) and non-technological (70). Both groups have two categories each as shown in the figure 1.

[1] http://www.buildingup-e2b.eu/
[2] Energy Efficient Buildings (E2BA), BUILDING UP Deliverable D3.2 (2012): *Roadmap*, URL: http://www.buildingup-e2b.eu/

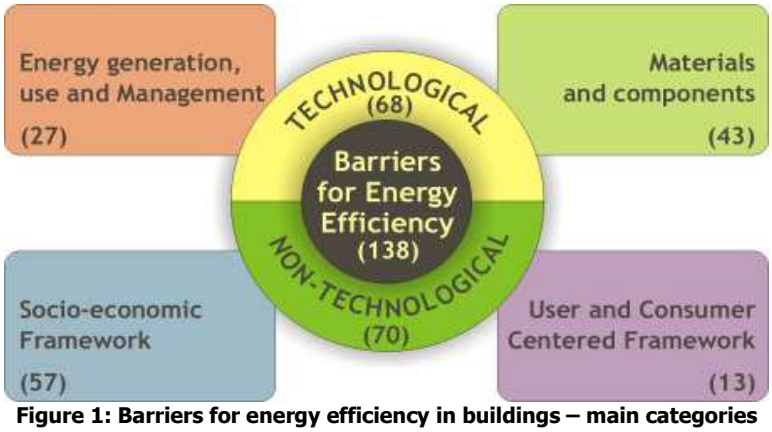

Figure 1: Barriers for energy efficiency in buildings – main categories

Furthermore there were defined six major sub-categories where barriers for energy efficiency in buildings occurred:

- costs / economic aspects (technological and non-technological barriers),
- innovation / communication (technological barriers),
- education / training (technological and non-technological barriers),
- technology (technological barriers),
- public and municipal steering mechanisms (non-technological barriers),
- culture, behaviour, lifestyle and the rebound effect (non-technological barriers).

The 8 cross-platform collaboration areas correspond to the major groups of identified barriers (fig. 2).

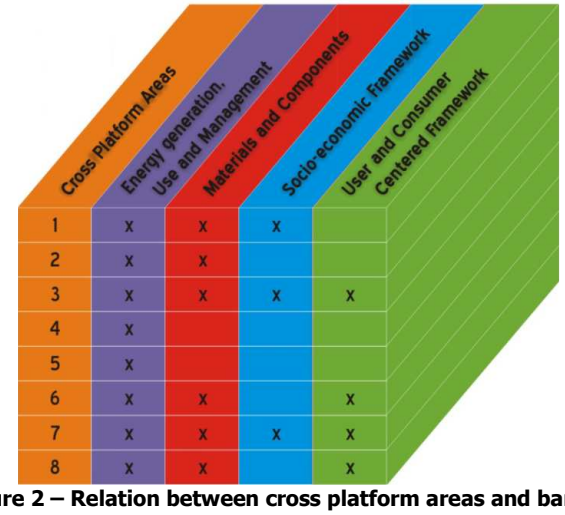

Figure 2 – Relation between cross platform areas and barriers

Table 1 A summary of targets and priorities for each of the Cross Platform Areas (CP)

TARGETS	PRIORITIES
CP1 Performance Based Approach for building components, including sustainable design, Life Cycle Analysis	
1) All building components meet an ecodesign approach (including LCA) covering the whole chain of the building life (material production, construction, use, recycling); 2) To assure higher energy efficiency and advanced building performance (e.g. acoustic, seismic, etc.).	• Agreement on common understanding (boundaries) and handing back to national standards; • Common methodology based on existing Life Cycle Analysis /LCA studies (CEN TC 350 based); • Systemic approach for all energy usages (energy, water…) taking into account their mutual interaction; • Link with future modifications of Ecodesign EU directive; • Design tools for optimization of buildings and building components; • Building design tools for architects allowing for real time building eco-design; • Development of new devices for reduction of water consumption.
CP2 Multi material and composites	

TARGETS	PRIORITIES
1) To provide multifunctional materials from: • Assembling of materials and/or components having different functions to obtain new elements enabling the exploitation of these different functionalities; • Producing composite materials enabling to exploit new functionalities; 2) To increase the use of building waste into recycled composites; 3) To develop composites consisting of renewable source matrix and fiber materials.	• Low-cost processing technologies for composite materials production and for components assembling; • New production processes for fibres - easy application methods; • Bio-mimetic technologies: need for better understanding of surface interaction on nano scale; Multi-scale modelling from atom to system; development of Chemical coupling agents and binders.
CP3 Healthy and comfortable indoor environment (including air quality, ventilation, lighting, acoustic, etc..)	
1) Availability of validated planning and measuring tools for Indoor Environmental Quality; 2) To improve comfort levels in buildings and houses, including historical buildings through highly energy-efficient and financially affordable internal components; 3) Active functions are integrated into the building; 4) All used materials have near zero harmful emissions (e.g. Reducing the Volatile Organic Compound (VOC) content of building materials).	• New and accurate IEQ assessment and planning tools; • Better understanding of VOC emittance. Better control over acoustics. Better control over moisture; • Empirical and reliable epidemiological data on correlation between buildings and human health; • Improved aesthetic room concept • Low-E insulating glazing, coatings, vacuum glazings and aerogel for reduced U value. Electrochromic, thermochromic or photochromic properties for G value control; • Multifuntional glazing; • Improvement of building material properties in order to maximize human comfort; • Establishing a methodological guide for the energetic rehabilitation of historic buildings; • Efficient, comfortable indoor lighting (Flexible Lighting based on LEDs – Development of LED integrated coated textiles); • Materials/systems with integrated failure warning; • Reducing the Volatile Organic Compound (VOC) content of building materials
CP4 Electric generation and storage materials and systems (e.g. storage systems including building integrated energy technologies)	
1) System and components need to be optimized (cost and energy) and their performance evaluated correctly. Tools for modeling new energy generating system performances need to be designed and developed; 2) Availability of new technologies and systems for electric energy storage and electric generation.	• New testing procedures, identification of new performances for new existing materials (e.g. with reference also to adaptive performances); • Holistic, intelligent & predictive energy control systems; • Fuel cells for static applications; • Smart grid solutions to fully enable distributed energy generation. Demand response solutions to fully exploit energy production at local level; • Building Integrated PV, producing energy to be stored in either batteries or hydrogen through electrolysis.
CP5 Thermal generation and storage materials and systems (e.g. storage systems including building integrated energy technologies)	
1) Advancement for total building integration (e.g. in plaster, windows, tiles, etc.): to increase aesthetics and integration flexibility, efficiency, cost, quality insurance, plug and play development. Market implementation 2) Availability of new technologies, systems and processes for energy storage and heating and cooling management 3) Further development of advanced nanotechnology	• Need for modeling behavior and properties of building integrated thermal technology (e.g. Development of flexible high efficiency solar thermal collectors); • Validation of thermal energy generation through advanced modeling tools; • To explore the potential for demand side management opportunities associated with the storage of energy in the thermal mass of buildings; • Research on new technologies for chemical composition of storage materials and efficient integration of existing ones.
CP6 Advanced thermal insulation construction materials for new buildings and existing buildings	
1) Availability of insulation materials with highly enhanced properties (λ < 0.03 W/m*k, fire safety, improved durability, low cost, recyclability) especially for retrofitting; 2) Availability of components with very high insulated materials, eco innovative, easy to install.	• Development of new cost-effective energy-efficient insulating materials from renewable sources or waste materials; • Development of materials that enable to create insulation materials with active properties; • Evolution of materials with λ < 0.03 W/m*k (e.g. nanofoams or silica aerogels); • Cost-effective large volume manufacturing • Cost-effective analysis on pilot test demonstration in public / administrative buildings • To determine the environmental tradeoffs between using insulation and sophisticated building techniques to control indoor climate in buildings with energy using heating / cooling and ventilation systems; • Integration of insulated materials in traditional products for large application; innovative solution for retrofit; thermal insulation, with good vapor permeability;

TARGETS	PRIORITIES
	• Improved material combinations in a layered and structured facade construction, IR absorption and reflection on demand in combination with insulation and switchable U-values.
CP7 Building materials recyclability and re-use of components	
1) Reduction of the amount of down cycling, considering cost and energy issues; 2) Design implementation of recycling and re-use of materials and techniques in construction; 3) Establishment of deconstruction processes and guidelines for existing buildings.	• Development of solutions to recycle and re-use the light part of construction materials, including thermal recycling; Increase the uptake by the manufacturing chain; • Research about the recyclability of different types of demolition products; • Better adhesives and other methods allowing disassembly of boded structures / assemblies; • Optimization of recyclability properties of materials for new buildings; • Building concepts with high fraction of material replacement where needed; clear separation of functionality layers in buildings; • Building concepts with very low resource input: low emissions recycling options; • Specific trainings to companies and end-users in order to improve recycling and re-using skills and techniques; • Information management and traceability.
CP8 Renewable resource-based products	
1) Availability of renewable (bio-based) construction materials and systems as alternatives to fossil and mineral based products for sheathings as well as advanced insulation products with improved performance and cost-effectiveness; 2) Availability of bio-based treatments such as paints, adhesives and modification for high performance renewable products.	• Creation of new value chains considering the complete life cycle (possibility of re-using etc.); • Optimization of natural fibers for insulations in order to ensure durability; • Advanced research on biotechnology and new bio-based materials such as plastics for barriers, pipes etc and foams for insulation; • Creation of new value chains.

CONCLUSIONS

The roadmap was released in October 2012. Its results will be adapted to the E2BA roadmap, which is considered as a basic document for the European Commission, to start working on their programmes.
Regarding the expected impact, BUILDING UP project promotes the European knowledge in the built environment and increases the industrial competiveness of the construction sector (in particular SMEs) and the inter-connected sectors.
Moreover, BUILDING UP contributes to tackle crucial challenges, which Europe is facing today of sufficient innovation, and several environmental and societal challenges. All the eight Cross-Platform Areas identified in the project focus and provide support particularly to the key priorities "Industrial leadership" and "Societal Challenges" in upcoming HORIZON 2020[3]:
- Industrial leadership in particular by developing technologies enabling energy-efficient buildings which will increase the technological competitiveness of EU industry and the involvement of a wide range of SMEs
- Societal Challenges focusing on "Health, demographic change and wellbeing", "Secure, clean and efficient energy", "Climate action, resource efficiency and raw materials", with the overarching objective of sustainable development.

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[3] HORIZON 2020 – The Framework Programme for Research and Innovation, http://ec.europa.eu/research/horizon2020/index_en.cfm