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Building Technologies Accelerator as a co-creation living laboratory concept

Autor: Carolina Mateo Cecilia

Institución: Instituto Valenciano de la Edificación (IVE)

Otros autores: Miriam Navarro Escudero (Instituto Valenciano de la Edificación); Jose María Peiró Silla (Universidad de Valencia); Malgorzata Kozusznik (Universidad de Valencia)

Resumen

El programa europeo "Building Technologies Acelerador (BTA)" surge como una solución estratégica de Climate KIC para acelerar la puesta en el mercado de nuevos productos, tecnologías y servicios que contribuyan a la mitigación y adaptación al cambio climático en el ámbito de la edificación. Con este fin, se ha creado una red de edificios habitados y experimentales que actúan como Living Labs, en los que testear y poner en práctica nuevos productos, tecnologías y servicios y ofrecer modelos de gestión de la energía, control de la calidad ambiental y gestión por parte del usuario en entornos reales, a la vez que los edificios se encuentran en pleno uso.

BTA está liderado por la Escuela Politécnica Federal de Zúrich (ETZH) y comenzó en 2014 con cuatro Living Lab ubicados en Holanda, Suecia, Suiza y España; liderados por la Universidad Tecnológica de Chalmers (CTH), la Universidad Técnica de Delft (TU Delft), el Laboratorio Federal Suizo de Ciencia y Tecnología de los Materiales (EMPA) y el Instituto Valenciano de la Edificación (IVE), y con el soporte de la consultora inmobiliaria internacional Knight Frank para la identificación del mercado.

El living lab español, denominado CIES Living Lab, se encuentra ubicado en Castellón y está centrado en la creación de fachadas y entornos de trabajo innovadores. En 2014, los proyectos desarrollados in situ son dos: NIR Reflective Façade System, cuyo fin es el desarrollo de una fachada ventilada que mejore el comportamiento térmico de la envolvente del edificio a través de placas cerámicas reflectivas de la radiación infrarroja; y Smart and Sustainable Offices, cuyo objetivo es establecer la correlación entre los parámetros medioambientales que se dan en el interior de las oficinas y las condiciones de salud, confort y productividad de los empleados que las ocupan.

Palabras clave: Calidad ambiental; Energía; Tecnología e innovación; Urbanismo y edificación, BTA

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Author:
Mateo Cecilia, Carolina[1]

Others: Navarro Escudero, Miriam[2]; Peiró Silla, Jose María[3]; Kozusznik, Malgorzata[4]

[1]Valencia Institute of Building (IVE), Valencia, Spain, cmateo@five.es
[2] Valencia Institute of Building (IVE), Valencia, Spain, mnavarro@five.es
[3] IDOCAL, University of Valencia, Valencia, Spain, Jose.M.Peiro@uv.es
[4]IDOCAL, University of Valencia, Valencia, Spain, Malgorzata.Kozusznik@uv.es

Note: Most of the contents of this communication have been carried out based on internal documentation of the project developed by the following partners: ETH Zurich, Chalmers University of Technology, TU Delft, Valencia Institute of Building, Knight Frank and EMPA - Swiss Federal Laboratories for Materials Science and Technology. In particular the proposal submitted in 2013 and the public brochure published and disseminated in 2014.

Abstract:

El programa europeo "Building Technologies Acelerador (BTA)" surge como una solución estratégica de Climate KIC para acelerar la puesta en el mercado de nuevos productos, tecnologías y servicios que contribuyan a la mitigación y adaptación al cambio climático en el ámbito de la edificación. Con este fin, se ha creado una red de edificios habitados y experimentales que actúan como Living Labs, en los que testear y poner en práctica nuevos productos, tecnologías y servicios y ofrecer modelos de gestión de la energía, control de la calidad ambiental y gestión por parte del usuario en entornos reales, a la vez que los edificios se encuentran en pleno uso.

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Calidad ambiental; Energía; Tecnología e innovación; Urbanismo y edificación, BTA

Abstract:

The Flagship project Building Technologies Accelerator emerges as a strategic solution of Climate KIC to speed up the dissemination of new products, technologies and services which contribute to the climate change adaptation and mitigation in the built environment. To reach this goal, BTA provides a network of the next generation Living Labs in which testing new products, technologies and services and offering new models for energy management, indoor environmental quality control and management of real environment by real users.

BTA is leaded by the ETH Zurich and accounts for several Living Labs located in the Netherlands, Sweden, Switzerland and Spain. These Living Labs are led by Delft University of Technology (TU Delft), Chalmers University of Technology (CTH), Swiss Federal Laboratories for Materials Science and Technology (EMPA) and Valencia Institute of Building (IVE) and are supported by the global leading property management company Knight Frank as an oriented business partner.

The Spanish Living Lab, CIES, is located in Castellón and is focused on the development of innovative façades as well as the creation of innovative work environments. In 2014, several projects are being developed in this context: NIR Reflective Façade System, whose goal is the development of a ventilated façade system that incorporates near infrared reflective tiles which will improve the thermal behavior of the building envelope; and Smart and Sustainable Offices, which aims to establish the correlation between indoor environmental quality parameters at offices and health, well being and productivity of employees.

Environmental quality; Energy; Technology and Innovation; Urban planning and Built Environment, BTA

Introduction

The project "Building Technologies Accelerator (BTA)" is one of the new flagship programmes that Climate KIC, the EU's main climate innovation initiative, is supporting in order to accelerate its efforts in climate change mitigation and adaptation. These flagships programmes are supported by a combination of Climate KIC, partners and external sources of funding.

BTA brings together multidisciplinary living labs teams, private, public and academic organizations, across Europe to address the climate impact of new building technologies and accelerate the potential of low carbon products, systems and services in the built environment.

BTA is leaded by ETH Zurich, in collaboration with other partners such as Delft University of Technology, EMPA – Swiss Federal Laboratories for Materials Science and technology, Chalmers University of Technology, Valencia Institute of Building and Knight Frank.

Rationale

The construction industry represents at European scale 10% of global Gross Domestic Product (GDP) and more than 7% of the total jobs. As a result, construction takes a significant position in the European economic output. This means there are a diverse and significant number of economic opportunities for transforming the built environment.

In this framework, buildings use 40% of total EU energy consumption and are responsible for 36 % of the total C02 emissions (EeB PPP, 2013)[1]. That is why sustainability depends heavily on buildings and its environment. New legislation is demanding a reduction in carbon emissions; this requires changes in several aspects of the construction sector, as in the design, management and operation of new buildings as well as in the refurbishment of existing buildings and renovation of urban areas.

As a result, it is an imperative to move towards innovative and sustainable construction field in order to get a low-carbon economy in Europe.

Despite this, the dissemination of new and sustainable building technologies into downstream sales channels is currently slow for both, new buildings and renovations. It's hard to stimulate investment in renewable energy when the current price for energy remains low. Research and development of new technologies often requires long-term investment. Stakeholders are often reluctant to do so due to uncertainty about the Return on Investment (ROI). Most of them prefer investing in new technologies with a proven track record. On top of this, potential buyers are often not even aware of new technological solutions. And even if they are, sometimes buyers such as builders lack the necessary expertise to implement new technology.

To enter the market, new technologies need to be scalable. So they have to be adapted to meet specific climate conditions, remove transformation barriers as well as meet various user needs of preferences.

[1] For further information visit "The Energy-efficienct Buildings PPP: research for low energy consumption buildings in the EU" – European Commission. http://ec.europa.eu/research/press/2013/pdf/ppp/eeb_factsheet.pdf

In this context, BTA's goal is to contribute to accelerate the route to the market of new sustainable building technologies and services in order to reduce CO_2 emissions and create new business and jobs in the European building sector.

BTA and its approach

To reach the objective established before, the approach of BTA is to provide an Open Innovation Ecosystem around several Living Labs and future test fields. The key for accelerating the knowledge dissemination and market development is to bring together all the actors involved in the built environment BTA provides such a platform as a facilitator for building technology innovations and dissemination.

BTA consists of three pillars:

- Living Lab infrastructures and network
- Real-world test beds in homes, offices and districts
- Markets and Urban society

Ideas and outcomes are created in each pillar and these will become inputs to provoke further activities in the other pillars. For example, insight studies to be conducted in the real-world test beds provide the innovation ideas that can be prototyped and tested in the Living Lab network. The products tested in the Living Labs network will be implemented into the market and their performance evaluated in the real world test bed. These results are shared in the markets and urban society in order to facilitate further dissemination. . This is a dynamic and exciting innovation platform where new technologies can enter the markets at all scales and, while maximizing the use of academic theory, the BTA will accelerate the development of solutions for refurbishment and new buildings alike.

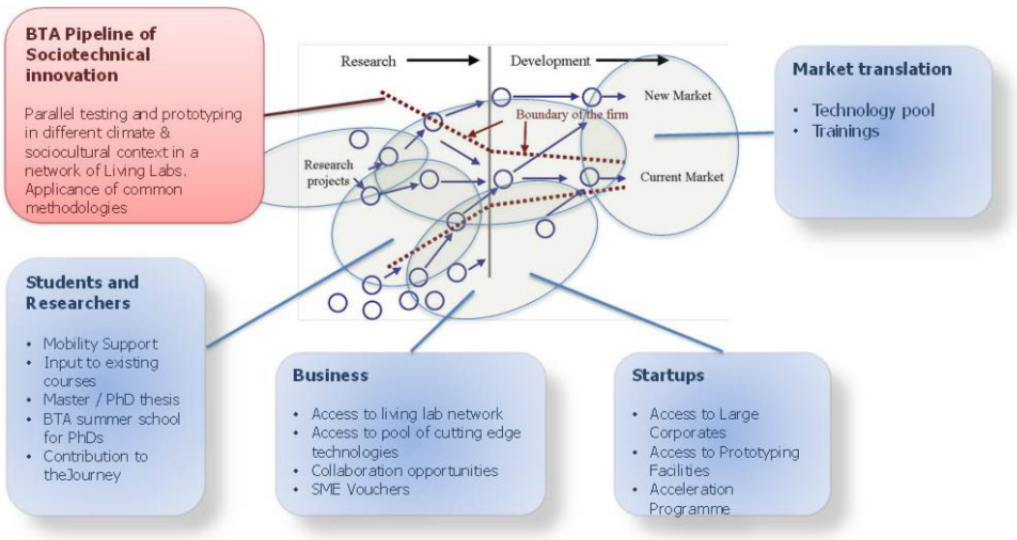

Figure 1. BTA approach. Source: BTA flagship proposal

BTA aims to achieve its goal by focusing mainly on four areas[2]:

- *Innovative Structures for Sustainable Buildings:* Structural elements comprise a significant percentage of the total material used in both office and residential multi-storey buildings. Choosing better materials and construction methods for these structures will help improve sustainability and the environmental footprint as a whole. As an example, wood is an alternative construction material that can be used to reduce energy waste. It is renewable and can store CO_2 for a long period of time.

- *Innovative Façade Systems:* The building façade acts as the boundary between interior and exterior environments. A wide range of technologies can be integrated within the façade. To determine whether the envelope is suitable for certain climate conditions, prototyping and testing has to be carried out. Living Labs can help establish whether an exterior envelope is the right choice for a specific building environment and climate conditions. Access to Living Lab's knowledge and facilities can save money and ensure high performance.

- *Energy Management Systems:* How consumers and residents respond to and interact with building technology plays a major role in its success. A user's behavior influences building technology performance. To optimize efficiency and a technology's effectiveness, users' living preferences and comfort criteria have to be taken into account. This is why understanding user behavior is essential when developing interfaces.

- *Innovative Work Environment:* The work environment also plays a significant role in the construction industry. A more efficient work environment can be developed by optimizing office buildings' hardware (the building and technical infrastructures), software (office devices such as remote communication), energy systems and work space. Progress in this field can be achieved by investigating user behavior and integrating appropriate technology to increase comfort and productivity of employees.

Network of Living Labs

BTA has consolidated a network of Living Labs along Europe that was set up in 2014 with Concept House Village and The Green Village in the Netherlands, HSB Living Lab in Sweden, House of Natural Resources and NEST in Switzerland and CIES Living Lab in Spain. BTA Living Labs are located in different zones in order to cover important climatic conditions: dry and Mediterranean, Scandinavian, mountainous and continental European.

[2] Building Technologies Accelerator Brochure. More information on: http://www.climate-kic.org/projects/building-technologies-accelerator

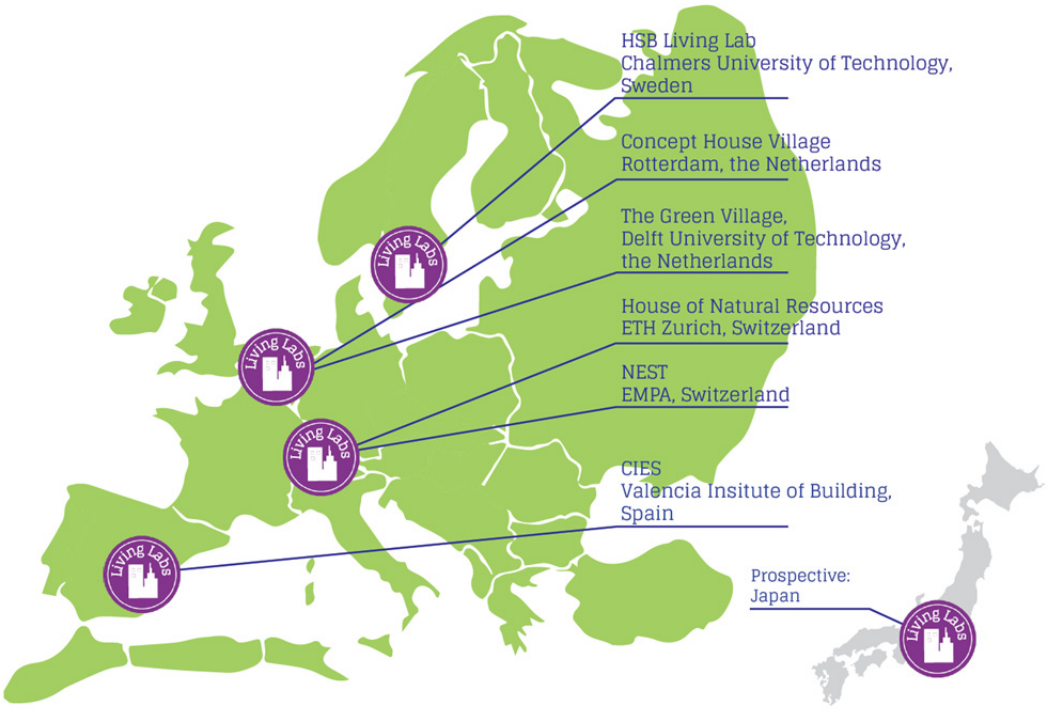

Figure 2. Network of Living Labs in BTA. Source: BTA brochure

BTA Living Labs are living laboratories. These are real-life buildings of home or work environments, not simulations. They are used for testing energy efficiency and sustainability. These labs are set up as real spaces where occupants use new products and technologies for a short or long period of time. They provide and ideal environment for testing new products, systems and processes. Participant feedback is collected and data analyzed, in order to improve the product, system or process taking into account this feedback coming from real users.

In this context, and focused on the four main areas defined above, several projects are being developed by the partners involved in BTA. BTA partners are developing products and services in real-life environments.

CIES Living Lab in Castellón

CIES is one of the Living Labs that BTA network. This experimentation center gathers the Technological Institute of Ceramics (AICE-ITC), the Castellón City Council and the Valencia Institute of Building (IVE) as main partners. CIES is an office building complex with a built area of 2700 m2 located at the City of Transport, the logistic and trade area of Castellón (SMEs and industrial area). The building houses 22 office rooms between 25 to 50 m2 each and 6 sheds of 150 m2 each.

The center becomes a real scenario of experimentation in which systems are subject to internal and external environmental conditions, and finally it is able to objectively evaluate their combined response through continuous monitoring.

Figure 3. CIES Living Lab in Castellón

Research innovation within the CIES Living Lab will focus on developing innovative façade systems and smart office concepts. CIES is the unique Living Lab in BTA that has been built with conventional building technologies. This brand-new building provides the opportunity to test new technologies and implement new services or process for new offices as well as for office refurbishment in Mediterranean climates. The main approach of CIES is to develop measures and methodologies for assessing smart office concepts in relation to human behavior, innovative products and building technologies.

Smart and Sustainable Offices (SSO): a case study

Smart and Sustainable Offices is one of the projects that will be tested at CIES Living Lab, in the framework of BTA and specifically, focused on the axis innovative work environment.

The objective of this project is to establish a correlation between indoor environment quality and health, well being and productivity, being the result the development of a tool for the design of new sustainable offices, as well as, for the conversion of old offices into sustainable offices in different climates.

The project is being carried out by several partners: Chalmers University of Technology in Sweden and Valencia Institute of Building and University of Valencia in Spain. The starting point of this project was a research developed by the School for Facility Management at the University Wädenswill (ZHAW) in Switzerland, and Chalmers University of Technology. They obtained a database of monitoring results for various indicators (lighting, relative humidity, temperature, CO2, air velocity, VOC, acoustics etc.) in 25 office buildings with rather homogeneous working situations but differing standards in orientation, envelope and housing services as well as energetic performance. At the same time the days of absences, the productivity and the wellbeing/satisfaction of the employees was assessed by personal interviews and more than 4000 questionnaires. The buildings ranged from old buildings over refurbished ones to state of the art new buildings with best environmental labels. This provided a worldwide unique basis to assess for the first time a possible correlation of well-being and productivity and inner room conditions.

Taking as starting point these monitoring results obtained in Switzerland, project partners are replicating the data collection in Spain and Sweden, in order to develop a sustainable office guideline for three different climates.

Many previous findings indicate that some factors of the office design used in sustainable-smart offices may positively affect health and well being of the office users (DeCroon et al., 2005; Vilnai-Yavetz et al., 2005). In turn, improving health and well being at office (e.g., job satisfaction, work engagement) may result in productivity gains (e.g., increased individual and team performance and decreased absenteeism), producing economic benefits for the organization.

In contrast, costs associated with health problems (e.g., in offices that do not ensure optimal conditions) can have significant costs for the organisation. Such costs can be associated with loss in productivity because of sickness absence, early retirement, increased staff turnover, and necessity for additional recruitment and training. Productivity can also be affected by a lower level of performance of employees who may suffer stress or other emotional problems. Research in this domain is potentially valuable because turnover costs U.S. businesses billions of dollars per year (Rosch, 2001), and practices that promote retention can save even small companies millions of dollars annually (Mathis & Jackson, 2003).

Simultaneously, it is also important to take into account a second way of influence on the financial outcomes – through the reduction of energy consumption – contributing to the sustainability of the office. It is necessary to underline that the reduction of energy consumption does not necessarily have to mean less comfort to maintain a good level of productivity; its challenge is to create an attractive work environment that fulfills ecological goals and is cost efficient decoupling the link between comfort and increase in energy consumption.

In this way, the office users' behaviors are an important factor, since decreased energy consumption depends to a great extent on their sustainable behavior. In turn, given that

behavior can be shaped by different psychological factors; whether office users will behave in an energy-efficient way is triggered by such psychological aspects as e.g., attitudes, values, and knowledge concerning energy-efficient behavior.

This project aims to test all these findings by providing empirical evidence on the existence of a link between building technologies, improved indoor environmental quality, and well being, health, productivity and financial benefits, by taking into account the human factor - the role of office users.

The research will be focused on two different phases. Firstly, relationship between IEQ attributes and health, well-being and productivity will be analyzed taking into account both secondary and primary data. Once this correlation has been defined and the IEQ attributes that determine optimal conditions for health, well-being and productivity have been set; the research will focus on finding the building technologies that meet these optimal ranges, establishing also a methodology to evaluate building technologies in each particular application depending on factors as type of building, climate conditions, cost justification, environmental impact and others.

As a basic premise of BTA, partners in SSO project are also working at the same time in the business modeling of SSO project, establishing different products and services that could be developed through the results obtained along the development or the project as well as analyzing the office building stock in order to meet its market needs.

The project accounts with the involvement of some real office buildings demonstrators (as shown in the following figure) that will be monitored in order to obtain primary data regarding indoor environmental quality (temperature, lighting, acoustics, workplaces ergonomics, furniture, materials, etc.) as well as indicators of health, well being, productivity and other psychological aspects of office users (comfort, absenteeism rate, values, attitudes, need for privacy, company incentives, goal achievement, quality of work, creativity, etc).

Figure 4. Real office buildings demonstrators for SSO project.

Conclusions

BTA is an initiative which promotes the transition to low-carbon buildings. In order to make it happens, it is necessary to develop new and sustainable products and services and accelerate its route to the market. BTA is a path to stimulate the development of these products and services and overcoming market barriers by raising decision makers' and beneficiaries' acceptance, and accelerating the upscaling possibilities in different markets.

The network of Living Labs is an open and dynamic network, whose prospective is to be scaled up by the involvement of new living labs focused on different areas. BTA Living Labs is actively looking for new partners, projects and technologies which can contribute to reach strategic goals.

BTA initiative is aligned with the strategic framework for European Research and Innovation Horizon 2020: supporting excellence in the science base, tackling societal challenges and securing industrial leadership:

- By dealing with societal challenges as Climate Action and Resource Efficiency on the built environment.
- By ensuring an excellent research and development system covering the gap between R&D&I and the market.
- By strengthening participation of industry and leveraging private sector investment through the involvement of industrial partners.

References

European Comission (2013). *The Energy-efficient Buildings PPP: research for low energy consumption buildings in the EU.* http://ec.europa.eu/research/press/2013/pdf/ppp/eeb_factsheet.pdf

De Croon, E.; Sluiter, J.; Kuijer, PP.; Frings-Dresen, M. (2005). *The effect of office concepts on worker health and performance: a systematic review of the literature.* Ergonomics 48 (2), 119-134.

Vilnai-Yavetz, I., Rafaeli, A., & Yaacov, C.S. (2005). *Instrumentality, aesthetics, and symbolism of office design.*. Environment and Behavior, 37(4), 533–51.

Rosch, P. J. (2001). *The quandary of job stress compensation*. Health and Stress, 3, 1–4

Mathis, R. L., & Jackson, J. H. (2003). *Human resource management (10th ed.)*. Mason, OH: Thompson/South-Western.

Windlinger, L.; Janser M.; Feige A.; Wallbaum H. (2012). *The role of office users in the sustainability of office buildings – an empirical investigation and implications for FM*. Conference Paper: 7th International Conference on Improving Energy Efficiency in Commercial Buildings (IEECB), At Frankfurt a.M., Germany.

Feige A.; Wallbaum H.; Windlinger, L.; Janser M. (2013). *Impact of sustainable office buildings an occupant's comfort and productivity.* Journal of Corporate Real Estate, Vol. 15 Iss: 1, pp.7 – 34.