

Sustainable and eco-efficient technologies Multi-dwelling Urban Building - MBJ2030



Michał Piasecki
Senior Researcher
ITB Building Research
Institute
Poland
m.piasecki@itb.pl

Summary

The aim of the article is to present a concept and the effects of MBJ2030 project including new technical and environmental solutions which can enhance sustainable way of living within the future urban buildings in Poland. All presented experiences were collected during 1 year of project realization.

Keywords: sustainable building, sustainable construction, innovative technologies, green design, OpenHouse

1. Introduction

Project Multi-dwelling Urban Building 2030 (MBJ2030) is carried out by industry companies: Mostostal Warszawa, Acciona Nieruchomości as well as research units: Building Research Institute and Civil engineering Dept. of Silesian University of Technology. RTD activities are partly supported by a governmental grant. Research activities are focused on new construction, material and system solutions allowing erecting energy-efficient, environmental friendly and user-friendly multi-dwelling buildings characterized by a high comfort of life. The project represents a holistic approach to the improvement of technical and functional performance of buildings enclosing cooperation of civil construction, acoustics, architecture, installation, renewable energy and building physics engineers and scientists.



Fig. 1 MBJ2030 logo [1]

A main MBJ2030 goal is to establish a multi-dwelling urban building standard of the future to support new national technical requirement evolution and city/urban development policies. Under the

project the exhibition building located in Warsaw incorporating the research results is being designed and will be erected soon. The building is planned to be ready in the year 2014. Multifamily residential building technology can be upgraded to yield significant energy savings and improved quality of life for residents. However, the complexity of the multifamily building as compared to the single family sector requires a special approach. This project is to provide a toolkit of mostly technical and financial resources to assist developer who pursue energy efficiency and sustainable upgrades to his building. Sustainability assessment methods supporting project and integration of research results are modified CASBEE procedure and OPENHOUSE model [2] developed under FP7 program.

MBJ2030 goals were selected to:

- Present most effective research results and technologies in/as a real exhibition building.
- Prepare procedure step by step that allow to implement sustainable solutions to construction process
- Determine environmental, social and economic benefits of building with innovative, ecologically sustainable building materials and systems as compared to conventional methods.
- Validate various sustainable building assessment methods on specific case study
- Maximize energy efficiencies through building design, specification of materials and methods, selection of systems, appliances and equipment, and design of the landscape.
- Minimize use of materials and finishes that generate hazardous to indoor air quality
- Minimize carbon footprint during designed building life cycle.
- Considering end of life and recycling strategies.
- Design responsive to external environmental factors by incorporating: PV panels, municipal heating, heat recovery, day-lighting, environmentally sound landscape design, and efficient rain water management.
- Design to end-user needs, considering quality of life: amenity, architecture, health, community, culture and aesthetics.
- Reduce the overall cost of sustainable housing.
- Compare the difference between theoretical values and real measurements.

Actual project stage is selected technology implementation to the architecture. The following features were chosen to be integrated:

- Solar panels on building elevations
- Thermo-acoustical optimized external walls
- Architectural solutions to gain a light during winter and protect during summer
- Heat recovery system from waste water integrated with solar panels system
- Low-Emissive argon-filled windows
- Efficient boiler system
- Insulations against thermal bridges
- Low-energy elevators and Energy Star appliances
- Compact fluorescent light fixtures
- Low-flow water fixtures
- A green landscaping architecture
- A rainwater harvesting system
- Outside comfort zones and bicycle use friendly solutions
- Recyclable and eco materials (LCA based approach)

2. MBJ2030 outcome

The primary outcome of this research is a building concept that addresses evolving human needs, economic viability, and issues of environmental impact. The final concept/model is referred as the polish urban building standard in 2030. For this project ITB assist in design and construction and evaluate sustainability measures to present the final results.

[1] www.MBJ2030.pl

[2] www.OPENHOUSE-FP7.eu

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2. Technical goals

For this project ITB assist in design and construction and evaluate sustainable, multifamily attached dwellings. The researchers' charge is the development of a cost-effective, environmentally-friendly building model that is innovative, responsive to the local environment, and sensitive to the needs of the end users. The project is led and implemented by an interdisciplinary team that set ambitious technical goals for future in accordance to the existing sustainability definition. In the initial stage of the project 18 main technical goals (table 1) were selected to prove sustainability of the MBJ2030 results and also about 80 different with less meaning.

Table 1 Technical goals for the MBJ2030 building

Nr	Category	MBJ2030 Expected value
1	Total Primary Energy Demand	$EP < 0,5 \cdot EP_{WT2008}$ kWh/(m ² rok)
2	Building Environmental Efficiency	BEE > 1,5
3	Building Sustainable Efficiency	SBE > 1,2
4	Heat loss factor calculated for 1 m ² of building shell	$H'_{tr} \max \leq 0,5$ W/(m ² K)
5	Renewable Primary Energy Demand	> 25%
6	Life cycle carbon footprint	1 Mg eq. CO ₂ /m ² 60years
8	Airborne acoustic insulation level of completed building walls and beams	R'A1 ≥ 53 dB
9	Normalized beams acoustic sound impact	L'n,w ≤ 46 dB
10	Emission of TVOC	< 0,15 mg/m ² h
11	Emission of formaldehyde	< 0,03 mg/m ² h
12	Emission of carcinogenic compounds IARC	< 0,002 mg/m ² h
13	Subjective reaction as classification of the comfort	>80% positive votes
14	Contamination levels of non-specific allergenic, pathogenic or toxic fungal spores	no more than 30% of the outdoor level during winter time
15	Indoor air quality and acoustic comfort	Category I in accordance to EN 15251
16	CO ₂ concentrations above outdoor level	Max. 400 ppm
17	DF - Daylight Factor	Min. 1,5%
18	Green area efficiency	Min. 75%

Through unique design technologies and features the MBJ2030 house can adapt to meet the evolving needs of the homeowners. All technical goals will be measured during the MBJ2030 building life stage.

3. Building Sustainability Assessment Methodology

For the sustainability performance check of the MBJ2030 standard and building 2 systems of the assessment were selected. One is CASBEE concept based and second is European System called OPENHOUSE that is under development in FP7 program.

3.1. CASBEE based modification

Since 2004 ITB has been developing the assessment/design tool for buildings which provide comfort for its inhabitants and do not increase their costs, do not affect the environment and consume much energy. Assessment criteria were established as a result of ITBs experts experiences and international both international and domestic (e.g. SB conferences, National Technical Requirements WT, LMI/EPBD/CPR works, CEN TC 350/351 participation, FP6/FP7 projects, SBA cooperation) and the way that results are presented conforms to the well recognized Japanese assessment method CASBEE [3]. In 2004 Japanese method was highlighted during SB04 conference organized by ITB in Warsaw. It was the mile stone point in the environmental assessment result presentation potentially better than all existing "environmentally orientated" one-dimensional systems. But it was not yet sustainability assessment. Next year CASBEE method was distributed for the scientific purposes to all SB05 participants in Tokyo. In accordance to the procedure the high comfort of the building should be done with environmental and energy consideration. This great way of thinking is called a building environmental efficiency BEE. This 2 dimensional system was a basis for a further ITBs research to set 3 dimensional system taking into consideration a third and most important pillar of sustainability that is a building life cost. ITB is to present benefits of this approach in a first scientific project of Sustainable Building Alliance SBA. This way of thinking can be called the sustainable efficiency SBE.

When employed adequately, the model can guide an architect step by step to design an approach which will influence the final “3-pillared” sustainability assessment of a building. This method combines various existing methods, standardization, design solutions with methods assessing how buildings affect the environment, e.g. an acoustic assessment, energy performance, an assessment of existing component cycle, a sanitary assessment, a geotechnical assessment, a comfort assessment, also cost assessment and assessment of conformity to relevant legislation in force. The final result is presented as a sum of constituent assessments of particular aspects of buildings (assessed on a 1 to 5 scale, where 3 is an average level in 2010), expressed as a performance index which says what environmental input is needed to ensure an adequate comfort of living with assessment of what cost we need to get this high performance. A software tool (that is still under development) for the procedure of sustainable performance is designed to assess residential and office buildings with regard to national technical and sustainable development requirements. The adopted method with a third dimension is adjusted to Polish current legislation in force and environmental design guidelines. It takes into consideration utilisation comfort and reduction of the impact that a building has on the environment and pays particular attention to the reduction of energy demand (EPBD implementation). The result of the final building assessment is expressed as a single index “sustainable efficiency”. The determined environmental performance, following the assessment method, makes it possible to obtain a desired result for MBJ2030 standard once the result is positive and the requirements of the procedure have been met (see table 1; BEE, SBE). Validation of the system is also a part of MBJ2030.

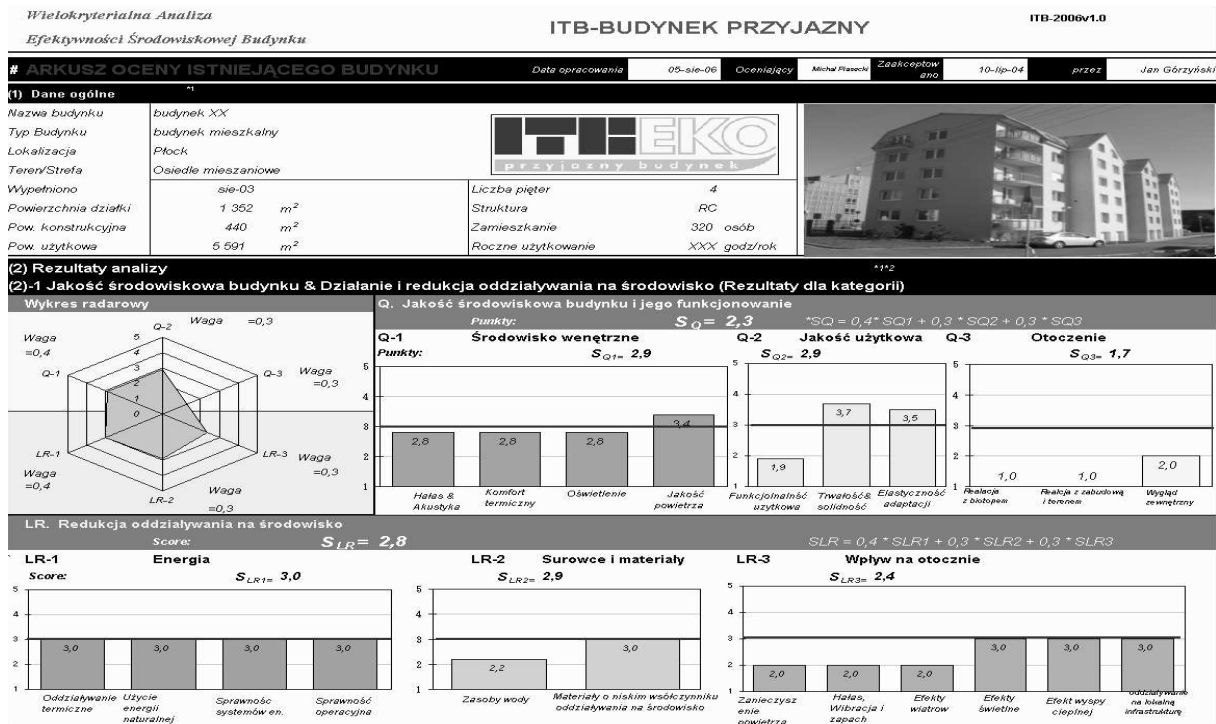


Fig. 2. A part of the environmental assessment of the national reference building

3.2. European OPEN HOUSE

OPEN HOUSE “Benchmarking and mainstreaming building sustainability in the EU based on transparency and openness (open source and availability) from model to implementation” is EC-funded Project, ENV-2009-244130, financed by the 7th Framework Program of the European Commission and started in February 2010 [2]. OPEN HOUSE partners are: Acciona, ACE, Apintech, Arup, BGH, Warsaw City, CCS, DAP, DGNB, EDF, ETH, Fraunhofer, ITB, Mostostal, SP, Visesa, ZRMK, FUNAB. Project objective is to develop and to implement a common European transparent building assessment methodology, complementing the existing ones, for planning and constructing sustainable buildings by means of an open approach and technical platform. Platform is being built up facilitating a pan EU effort towards a common view on building sustainability. OPEN

HOUSE baseline concept is going to be widely disseminated among stakeholders through its Platform. OPEN HOUSE basis is transparency, which has not yet been properly achieved in the building sustainability assessment tools existing at European level. Only EU wide discussion towards a common approach can produce an EU wide assessment methodology for sustainable buildings contributing to current activities on standardization of assessment methodologies at European level and also to a European potential related standard. The key reflection that OPEN HOUSE seeks to address is how to merge existing methodologies towards a common view, widely adopted, till it becomes the mainstream. Consequently, OPEN HOUSE should be an “open model” available for all stakeholders. Both transparency and openness may lead to radical progress; business interests can be safeguarded without the need to control or own the core model of building’s sustainability. The most solid advantage for stakeholders and OPEN HOUSE partners will be the follow up services of the implementation of this model (MBJ2030).

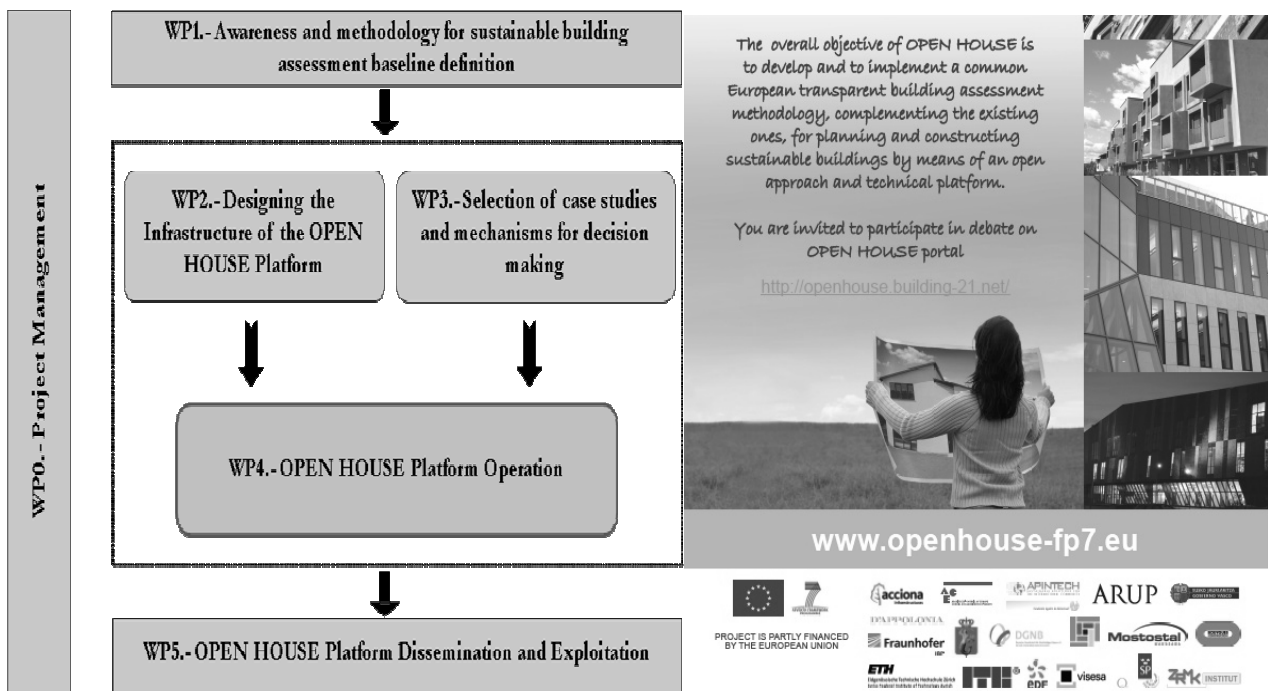


Fig.2. OPEN HOUSE work packages and information brochure view [2]

After 1 year of RTD cooperative works mostly all indicators are well described and ready to be used on real cases like MBJ2030. Environmental indicators are based on CEN TC 350 WG1 works (were ITB, EDF and DGNB partners are present). Thermal, acoustic and Indoor Air Quality indicator is based on the EN 15251. Economic and Social performance are based on the CEN TC 350 WG4 and WG5 works including experiences from SBtool, BREEAM system and DGNB. Core criteria are based on the SBA consensus.

Table 2 Building sustainable performance indicators by OpenHouse

Nr	Primary Aspect	Indicator (OPEN HOUSE full system) - draft	Indicator (OPEN HOUSE quick-check) draft
1.	Environmental	Global Warming Potential (GWP) Ozone Depletion Potential (ODP) Acidification Potential (AP) Eutrophication Potential (EP) Photochemical Ozone Creation Potential (POCP) Certified wood Non-Renewable Primary Energy Demands (PEne)	Global Warming Potential (GWP) Ozone Depletion Potential (ODP) Acidification Potential (AP) Eutrophication Potential (EP) Photochemical Ozone Creation Potential (POCP) Certified wood Non-Renewable Primary Energy Demands

	Total Primary Energy Demands Water and Waste Water Contamination of undisturbed areas Waste Responsible Material Sourcing Local Material Barrier-free Accessibility	Total Primary Energy Demands Water and Waste Water Contamination of undisturbed areas Waste Responsible Material Sourcing Local Material Barrier-free Accessibility
2. Social-functional	Thermal Comfort Indoor Air Quality Acoustic Comfort Visual Comfort Operation Comfort Electro Magnetic Pollution Public Accessibility Conversion Feasibility	Thermal Comfort Indoor Air Quality Acoustic Comfort Visual Comfort Operation Comfort Electro Magnetic Pollution Public Accessibility Conversion Feasibility
3. Economic	Bicycle Comfort Building-related Life Cycle Costs (LCC) Quality of the building shell Ease of Deconstruction, Recycling, and Dismantling	Bicycle Comfort Building-related Life Cycle Costs (LCC) Quality of the building shell Ease of Deconstruction, Recycling, and Dismantling
5. Process	Quality of the Project's Preparation Construction Site impact/ Construction Process Commissioning, Monitoring, Use and Operation	Quality of the Project's Preparation Construction Site impact/ Construction Process Commissioning, Monitoring, Use and Operation
6. Site	Risks at the Site Options for Transportation	Risks at the Site Transportation

3. Conclusions

The research and design of the MBJ2030 project determined that cooperation of the construction process actors and much progress in developing sustainable housing is possible. Designing low-cost, sustainable housing requires consideration of the site, building structure, and interior environment as a holistic and integrated system that's why sustainability assessment systems were very useful. The research part of MBJ2030 project have been completed, but construction of the exhibition building will be finished in 2014. As a result of the arising conclusions MBJ2030 will not be completed until the post-occupancy evaluations can be made to check all estimated parameters. More specific conclusions will be possible once the structures are built and these evaluations have been conducted and analyzed. All the research results can be the recommendation for the design and technical requirements development [4]. The primary outcome of this research is a building concept that addresses evolving human needs, economic viability, and issues of environmental impact. The final concept/model is referred as the polish urban building guideline code for 2030.

References

- [1] www.MBJ2030.pl
- [2] www.OPENHOUSE-FP7.eu
- [3] <http://www.ibec.or.jp/CASBEE/english/overviewE.htm>
- [4] CZARNECKI L.,M. KAPRON; Sustainable Construction as a Research Area, June 2010, Soc. Mater. Eng. Resour p.55-58, Japan