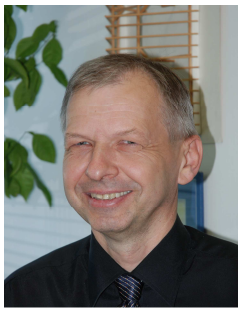
SUSTAINABLE BUILDING IN THE CZECH REPUBLIC – CHALLENGE AND OPPORTUNITY



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Summary

The paper brings an overview in sustainable building development in the Czech Republic. Specific natural, climatic and economy conditions for the development of sustainable buildings in CZ are shown, and influence of extensive economic transformation after 1990 is discussed. The paper shows selected examples of implemented sustainable approaches in the design and construction of buildings in the Czech conditions in last years. Research and education plays in the process of implementation of sustainable building ideas key role. Many research projects being solved on national as well as international level are focused to different aspects of sustainability. A new study programme directly focused to the problem of design of Sustainable buildings named Buildings and Environment will start at the Czech Technical University in Prague, Faculty of Civil Engineering in this fall. All these above mentioned aspects create challenge and opportunity for the Czech building industry for the forthcoming period.

Keywords: Sustainable building, integrated building design, low energy buildings, renewable energy, recycled waste, life cycle assessment

1 General context

Sustainable development is becoming a phenomenon of present which influences more or less all human activities. Buildings represent an essential element of the built environment created for preserving quality of human live. Construction and operation of buildings belong among the biggest consumers of primary materials and energy resources and environment pollutants as well. It is well known fact that buildings in highly developed countries, including Czech Republic are responsible for about 30 or 40 % of the total energy consumption and have the same share on production of carbon dioxide, waste and other pollutants. Developing of new technologies, using of new progressive materials and advanced construction solutions leading to quality improvement of buildings not only in the economical sense, but also in environmental and socio-cultural, represents a huge potential for sustainable society development. The population growth, depletion of primary

materials, energy and drinking water resources, deterioration off environment (including the consequences of global warming in form of higher frequency of natural disasters) necessarily lead to more intensive search for new environmentally suitable approaches and solutions. It is evident that without considering economic aspects there is no way to achieve improvements in environmental and social areas of sustainable development. The need for progress in economic development respecting all other sustainable issues is thus essential.

2 Specifics of the Czech Republic

2.1 Natural specifics

The Czech Republic is situated in the Central Europe in a moderate climatic zone. The country consists of the Bohemian Highlands surrounded by several mountain systems. Climate in Czech Republic is mixed, influenced by east continental and west oceanic climate. Predominant are west winds bringing relatively wet weather. Continental influences are marked by large fluctuations in both temperature and precipitation. In general, temperatures decrease with increasing altitude but are relatively uniform across the country at lower elevations. The periods with very low winter temperatures by -20 °C (January, February) and without significant sun radiation (typically January, February) must be considered. On the other hand, longer periods with very high continental summer temperatures (above 35 °C) must be taken into account, too. Such fluctuation in temperature and solar radiation require designing buildings to be well insulated for cold winter as well as to be ready to prevent overheating.

2.2 Czech Republic, Kyoto targets and further challenges

Kyoto target for the Czech Republic is – 8 % compared to 1990 reference year. In this year aggregate emissions of all considered GHGs equaled in the Czech Republic to approx 190 Mt of CO_2eq. Extensive economic transformation (mainly from heavy industry to light and service industries) after 1990 resulted in the decrease of GHG emissions by approximately 24 %. Future projections show further possible decrease of GHGs, depending on scenario considered (**Tab. 1**).

Tab. 1 GHG emission projections for reference and high scenarios. Projections have been constructed on the basis of the original value of the total emission balance for 1990. *Source:* Ministry of the Environment of the Czech Republic, OECD Economic Survey 2004, www.oecd.org

	1990	1995	2000	2005	2010	2015	2020
Reference scenario (Mt of CO_2 eq.)	187.5	142.7	141.8	126.4	128.3	123.8	121.2
High growth scenario (Mt of CO_2 eq.)	187.5	142.7	141.8	141.5	141.7	146.6	145.9

Although the total amount of CO_2 emissions is in the Czech Republic significantly lower than in the year 1990 the amount of released CO_2 per capita is in the Czech Republic much higher then in the most of other European countries – see **Fig. 1**. This creates necessity (more moral than legal) to make additional actions towards reduction of GHG emissions in the Czech Republic within the near future – in spite of the Kyoto targets has been already fulfilled. There is no more space to fulfill “automatically” (like during economy

transformation after 1990) more strict requirements, which are under discussion now at EU-level.

In the period 2007-2013 the Czech Republic has a unique opportunity to use EU – structural funds for substantial changes in infrastructure, including refurbishment of existing building stock, for systematic support of emerging technologies like passive buildings, solar and other renewable energy technologies etc.

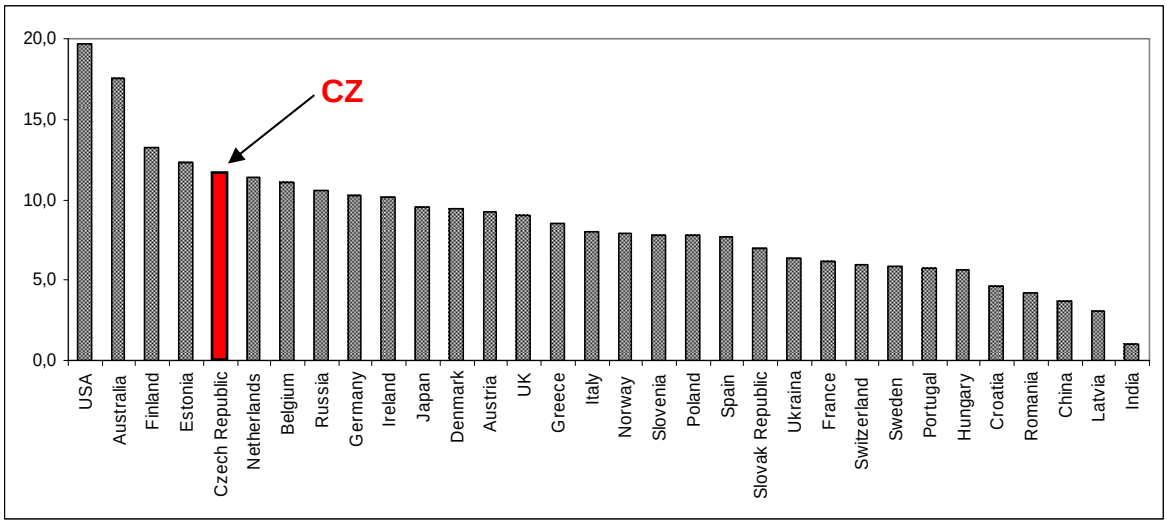

Fig. 1 Carbon dioxide production per capita in selected countries. Source: IEA Key indicators 2004

2.3 Changes in general attitude to sustainable principles

The understanding and accepting of sustainable principles, especially concerning built environment, is becoming to be more and more frequent by population, especially by younger people, at least in a declarative way. However, the acceptance by decision makers and is still not sufficient.

Concerning buildings, the low energy concepts including use of solar systems are more frequently asked at family houses. Some companies from building industry started to work with sustainable approach and first few results are already visible.

In the year 2006 has been established The Czech Sustainable Building Society – CSBS. CSBS iiSBE is an official representative of iiSBE in the Czech Republic. CSBS is a non-profit organization founded with the aim of promoting the ideas of sustainable building in the specific national conditions of Czech Republic. It manages the development and introduction of a building complex evaluation system, supports educational activities and the web information system SUBSTANCE related to sustainable built development (www.substance.cz).

There are several other groups and non-profit organizations dealing with particular problems of built sustainability, like Center for Passive Houses, Society for Environmental Engineering (STP), information web-portals focused on energy saving measures and technical services design and technologies, etc.

3 Sustainable building – challenge and opportunity

3.1 Life Cycle Approach and Integrated Design

Integrated environmental design represents a new approach integrating material, energy, structural and environmental aspects in one complex design and optimization process. This process should result in the development of energy and material efficient buildings throughout entire life cycle. This should cover not only (1) energy for operation (heating, cooling, hot water supply, ventilation, lighting, cooking etc.) but also (2) energy associated with the use of construction materials (embodied energy), (3) energy used in technology processes (construction, reconstruction and modernization) and (4) during demolition. It is essential that at present the energy needed in operation phase for heating and cooling represent for the most of current buildings the major part of energy used.

3.2 Energy efficient buildings

There is a potential for design and construction of 10 times and more energy effective and fully functional buildings in term of space heating in comparison to existing building stock. It is necessary to apply new techniques towards energy-optimized building. Energy optimization can be performed – up to zero-energy or energy-plus buildings (the building in which energy production of the building itself is larger than its annual total need).

Use of renewable energy systems in buildings has a large potential for further development. The technologies for particular systems are available, further improvements are possible and especially by photovoltaic (PV) highly expected. A systematic methodology and designer oriented tools are missing.

All such innovative buildings must be designed and built consequently, taking into account the best available technologies and components, knowledge in building physics, theories of technical systems (HVAC). New generation of information technique can be used for better building operation (intelligent buildings).

In general, a very effective source (and very frequent used source, mainly in electronic way) of examples of good practice are the information available by the "neighbors" – in Germany and Austria – with their fascinating development of passive houses, solar technologies, etc. The possibilities to compare different approaches in the countries with similar climatic condition and similar traditions are very valuable and can speed-up the implementation of new technologies.

General perception of low-energy strategies finally seems to be visibly changing in the Czech Republic. This is not just an evident result of growing energy prices and other negative expectations, but also stems from the dissemination of information on successful realizations. This positive trend needs to be further supported at the levels of applied research, pilot projects, promotion and other informational activities and education. The limits to applying progressive technologies and approaches more quickly create intellectual stereotypes that are too often more difficult to overcome than the technical barriers.

Fig. 2 illustrates a new housing development in Koberovy [1] – 13 passive houses with unified timber structure, only slightly differing in size and design of building envelope. **Fig. 3** presents the SEV Slunakov building. This education and ecological centre is in operation since January 2007 and the building itself could be used as a part of environmental oriented education. **Fig. 4** illustrates one of the larger PV-installations. The guaranteed prices for 15 years together with possible financial support or investments (up to 30 %) changed the situation within one year significantly in a positive way. A similar

successful tendency would be highly needed in the categories of “simple” energy refurbishment of buildings.

Czech technical standard on Thermal Protection of Buildings, Part 2: Requirements (CSN 73 0540-2 (2002, 2007)) was written partially in a new way, with certain professional overlap to enable the wider understanding of con-text of thermal protection of buildings, indoor comfort, HVAC-system and built sustainability. Even paragraphs and criteria from its informative only Annex A **Design instruction** are used by contractual parties, as a guideline for low-energy buildings.

Fig. 2 Passive houses in Koberovy – loadbearing structure, November 2007

Fig. 3 Education and ecological centre Slunakov. Low-energy building with passive house components covering the energy need from renewable sources (photo Projektil architekti)

Fig. 4 Part of PV installation at CTU campus building in Prague (2005). Several universities and high schools in the Czech Republic are equipped with PV systems for research and education. Financing was organized mainly from governmental sources.

3.3 Material efficient buildings

Non-renewable natural sources are irreplaceably exhaustible and regeneration ability of some renewable resources is limited. Thus, there is an undisputed need for reduction of consumption of primary non-renewable materials. The extraction of natural raw materials and manufacturing of products are associated with corresponding environmental impacts, including embodied GHG emissions.

The amount of embodied energy in construction materials is becoming more and more important criterion of sustainability of buildings and reduction of embodied energy and embodied CO_2 through optimization of material use is essential. The increasing use of renewable natural materials, recycled materials as well as high performance materials (like high performance concrete, new composites etc.) can thus increase the overall sustainability of the new building design concept.

Collection, sorting and recycling of municipal waste has been largely developed in the Czech Republic during last years. Since January 2002 new Law on Waste 185/2001 Sb is in force and all towns, villages and other settlements are responsible for collection, sorting and reuse of all waste.

Building construction typically uses large amounts of materials in relatively less demanding techniques. Therefore, there is a high potential for the use of secondary materials obtained from recycling of waste generated by other industry and from municipal waste. The main concern should be paid to those waste materials which are produced in

large amounts and just a small amount is recycled – like non-sorted waste plastic (from municipal waste yellow collecting containers) and laminated carton drink boxes. **Fig. 5** shows use of lightening installation fillers in the construction of Senior Centre in Moravany. More information about the use of recycled waste in building construction is available in [2], [3] and [4].

Use of renewable materials has been also increased in the last 15 years. Especially use of timber framed structures for family houses is becoming to be more popular. However, still the percentage of timber structures is in the Czech Republic much lower then in many European countries, although the potential is due to level of domestic wood production much higher. **Fig. 2** and **Fig. 3** show good examples of timber structures designed with the intention to be sustainable in the complex manner. In the building SEV Sluňakov on **Fig. 3** are also used walls from unburned clay bricks.

There is also a big potential for the use of high performance silicate materials (UHPC, HPFRC) to form ultra thin shell structures with higher reduction of the use of primary raw materials, and correspondent reduction of associated environmental impacts.

Fig. 5 Senior Centre in Moravany – composite RC flor slab with installation fillers from recycled municipal waste plastic, August 2000

3.4 Evaluation and labeling

The methodology for evaluation of energy performance is already standardized within EU. More precise level of estimation of all energy flows in building system should be developed, separately for different energy carriers, results in term of primary energy and equiv. carbon dioxide,...etc.

Several methods and tools have been already developed and are used for complex assessment of buildings from a range of issues of sustainability (GBTool/SBTool, BREEAM, LEED, GreenGlobe etc.). In the Czech Republic does not exist yet widely recognized and used specific Czech evaluation tool. In 2005 was finished translation of GBTool 2005 into Czech language, however, this toll has been used just for research and testing purposes. The development of specific Czech rating tool is now in progress (see next).

In 2007 the biggest new office building in the Czech Republic – CSOB Bank in Prague **Fig. 6** has been evaluated by US team Buro Happold using LEED rating system.

This is the first Czech building obtained LEED certification – silver. This building has been designed to be environmental friendly, with high emphasis on energy efficiency and high quality of internal environment for users. Flat roofs are covered by green roofs with trees and facades are prepared for creepers.

Fig. 6 CSOB building, Prague, Radlice. Design: AP Atelier, Arch. Josef Pleskot, Contractor: SKANSKA CZ, a. s., completed: December 2006

4 Research

Research priorities of several Czech grant agencies are mostly consistent with EU priorities. Thus many research projects are oriented to sustainable issues, including efficient use of materials, energy, development of high quality internal environment and others. The emphasis is on the implementation of research results directly into the practice.

In 2005 has been established research centre CIDEAS (Centre for Integrated DEsign of Advanced Structures). The centre is a research establishment for basic and applied research of new progressive structures which will meet a wide range of demands and comply with sustainable development principles. The initial concept was driven by the effort to facilitate cooperation of young research teams managed by top researchers at three largest civil engineering faculties in the Czech Republic, as well as specialists and staff involved in cooperate research in major Czech construction companies (SKANSKA CZ, Metrostav and SSZ). Research and development of techniques and tools for design and construction of sustainable buildings represent essential part of the research of the CIDEAS centre. Some topics recently being solved: Life cycle assessment and development of assessment tools, Low-energy and passive houses, Alternative materials, Possibilities of utilization of new earthen structures, Use of recycled materials, Earth-to-air heat exchangers and others.

Current trend is to develop EU standard and methodology for labeling of total quality of buildings. Research group from CIDEAS is also involved in FP6 EU project LEnSE. The goal is to propose the form of label showing the performance quality from environmental, social and economy issues point of view. Based on particular results of this project and based on participation on the Green/Sustainable Building process controlled by iiSBE, the Czech SBTool is being developed.

5 Education

Recently, some changes are visible in university education in the Czech Republic. The sustainability agenda is being introduced step-by-step in curricula of different study programs for future civil engineers and architects. New master study program Buildings and Environment has been recently introduced at Faculty of Civil Engineering at CTU in Prague. This study program is focused on principles of integrated design, life-cycle approach, sustainability assessments, buildings physics, material related issues, technical services etc.

Since 2006 courses on sustainable building are organized at CTU also for practicing architects and building engineers (www.substance.cz/kurzy). They are available in two forms – one week intensive course (5 full days of lectures and practical trainings) and electronic course available on internet. The preparation of these courses was financially supported by EU funds.

6 Conclusions

The high potential for improvement of technical, energy and environmental parameters of new designed and existing building stock in the Czech Republic is evident. However, up to present, in the Czech Republic was built only a small amount of buildings in the standard going near to the "sustainable" level. The step by step improvement of the average standard of the Czech building stock (from the sustainability point of view) is possible, but it is conditioned by (a) development of technical basis (know-how, database, product base, technology of production and construction etc), (b) development of legal support for implementation of sustainable principles in building practice and by (c) implementation of economy stimulation.

Energy related problems, already recognized by public can be effectively used as an introduction for increasing sensibility in broader agenda of sustainability of built environment. At the same time, wider perspectives and strong visions are needed to try to solve serious problems at urban scale. The problems of sub-urbanisation (urban sprawl) in areas around larger cities are substantial and should be solved in parallel with particular problems of buildings.

The role of building industry is essential on the way towards wider implementation of sustainable agenda into construction of buildings. Building industry should play in this process the leading role. From this perspective the participation of representatives of the Czech building industry together with researchers from Czech universities in the ECTP (European Construction Technology Platform) is very important.

Challenge and opportunity are clear and evident. It’s the time for sustainable building.

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