Cost-Effective

Converting façade of existing high-rise buildings into multifunctional, energy gaining components

Newsletter
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Editorial

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***"Transforming facades into energy gaining components"* is the mission of the project Cost-Effective.**

The project wants to contribute to the development of a competitive industry in the fields of energy efficient construction processes, products and services, with the main purpose of reaching the goals of the EC set forth for 2020 and 2050 to address climate change issues and to contribute to improve EU energy independence. The transformation of the construction sector implies the necessity of dramatic changes in the near future. We are sure that these changes can not be avoided. We therefore expect a strongly increased activity in the building sector, especially in case of existing buildings. As we can see from the success story of the PV-industry, this also means a very good chance to develop sustainable industrial activities. This is the goal of the project.

The use of renewable energy in the building sector is today dominated by the application of solar domestic hot water and PV systems in single-family houses. In order to significantly increase the use of renewable energy in the building sector, concepts have to be developed for large buildings. In these buildings, high fractions of the energy demand can only be met with renewable energy sources, when the façade is used for energy conversion in addition to the roof. This is especially true for buildings with a small roof area compared to the floor area («high-rise buildings») and for existing buildings which generally have a higher energy demand than new buildings. Therefore the main focus of the project is to convert facades of existing high-rise buildings into multifunctional, energy gaining components. This goal will be achieved through:

- Development of new multi-functional façade components
- Development of new business and cost models
- Development of integrated building concepts

The project started at 1st of October 2008. In the first six moths the activities in the project where focused on the cross sectional analysis of the state of the art (work package 1):

- The collection of statistical information on existing and new high-rise buildings determined information on the geographical distribution and the corresponding characteristics of high-rise buildings in EU27, USA and China.
- Problems and opportunities regarding the use of innovative systems in existing high-rise buildings have been collected and classified with respect to the identified technologies for high-rise buildings. The status of innovative façade technologies, HVAC (heating, ventilation and cooling) systems, control systems and lighting systems has been reviewed in detail. In addition to that, the performance of 22 buildings in 7 countries (Greece, Germany, Austria, Slovenia, Switzerland, France and Spain) has been assessed, in some cases with detailed user questionnaires.
- A cross-sectional analysis of the performance of the various state-of-the-art energy and environmental technologies applied allows to compare the energy saving potential of the different technologies.

A scientific synthesis report of the results will soon be available from the project website http://www.cost-effective-renewables.eu.

Low & renewable energy systems in high rise buildings: installation, problems and opportunities

Theoni Karlessi, MSc Environmental Studies, NKUA -
Professor Mattheos Santamouris, NKUA

The development of new multifunctional components which combine conventional and innovative low energy features requires the identification of the problems and opportunities related to their installation. A major aspect for the implementation of this task is the determination and classification of the building characteristics in order to investigate the application of innovative systems in existing high-rise buildings.

In order to correlate the performance of the installed systems with the indoor conditions, building characteristics were analyzed and occupant's perception of the building conditions and controls was evaluated. For this reason data acquisition from high-rise buildings was performed by the completion of two questionnaires, an extended concerning building information and a short questionnaire for the occupants with information for indoor conditions and system controls.

Seven partners contributed to the collection of data on existing high-rise buildings from Germany, Greece, Austria, Slovenia, France, Switzerland and Spain.

The classification of the case buildings is based on the installation of renewable and low energy systems. The initial aim was the categorization according to the existing systems of this type, however not all the buildings had these systems installed. Thus the classification was completed with the buildings that have the potential for installing low energy systems according to the identified problems, as explained to their descriptions.
The categories concern systems of this type for the façade of the building, HVAC systems, controls (eg. automatic controls, BMS), ventilation and lighting systems.

High-rise buildings in numbers: creating a statistical basis

Bastian Wittstock, University of Stuttgart, Chair for Building Physics,
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The development of innovative technologies is important and provides one way to contribute to a sustainable development. A broad implementation however, requires technologies that are custom-tailored for the markets addressed. A statistical analysis of the building stock in Europe and overseas can provide a sound basis for the planned research.

A statistical analysis as the basis to identify the needs of the market and to highlight the requirements for technology development has been found to be the ideal starting point for the COST-EFFECTIVE project.

Ten partners collaborated to gather statistical data on high rise buildings in Europe, the United States of America and in China. One significant part of this collection is data on more than 18,000 individual buildings (assisted by the use of existing databases). In addition, secondary data from other studies, research projects, statistical publications, etc. was gathered.

One such result is the number of buildings – separated in low-rise buildings of up to 35 m of heigt, high-rise buildings of 35 to 100 m of height and skyscrapers of more than 100 m of height – given per decade of their construction (see Figure 1 for this graph).

The data covers all fields of interest, from general technical data on the buildings (height, gross floor area or number of floors, e.g.), to data on the façade system and material, to data on the energetic and economic situation and performance of the building, all the way to climatic data of different locations.

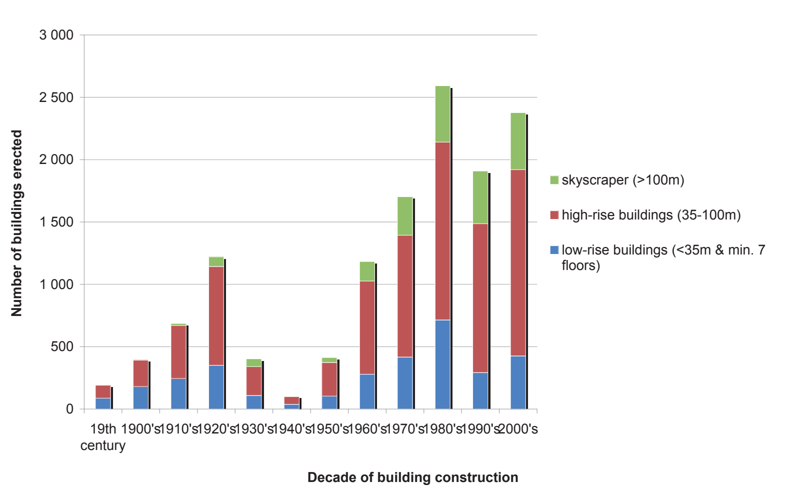

Figure 1 - Example of the statistical evaluation: construction activity in Europe, the USA and China for the last century.

The collection of a consistent set of statistical data for all countries however, proved to be a true challenge, as the type of data that was identified as most useful to the project is generally not recorded statistically and only rarely documented for buildings. Also, this kind of data has been subject to previous research to a very limited extent only.

Accordingly, not every question that might arise within the project will be answered with statistical data and the researchers will figure out alternative means of identifying their special area of interest.

Review of energy-efficient technologies adapted to high-rise buildings

Dominique Caccavelli – Carol Buscarlet, CSTB

Buildings are responsible for at least 40% of energy use in most countries. The absolute figure is rising fast, as construction booms, especially in countries such as China and India.

Commercial building encompasses a diverse mix of structures and purposes – from small retail establishments to high-rise office buildings, from neighbourhood schools to universities. Despite their differences, commercial buildings share a large and growing appetite for energy. They account for 30% of the primary energy consumption for building in Europe.

A large number of energy-efficient technologies exist that could curtail this increase. In recent years, improvements have contributed to reducing energy use. Hundreds of other technology improvements have and will continue to improve the energy use in buildings. While many technologies are well understood and are gradually penetrating the market, more advanced technologies will be introduced in the future.

A state-of-the-art on advanced energy-efficient technologies has been performed. Twelve partners contributed to the documentation of thirty-three promising technologies selected for that purpose. They address the major areas of energy use in buildings: space conditioning, water heating, lighting and ventilation. Besides describing energy-using technologies, this state-of-the-art also presents building envelope technologies and building integrated solar components. Adaptation to existing high-rise buildings has been permanently considered. Focus on some of these technologies is given below.

High Performance Insulation Systems

Vacuum Insulation Panels are very space efficient (can significantly reduce material volumes) and energy efficient (up to 10 times better performing with respect to conventional insulation materials) but they are costly, vulnerable to mechanical damage (especially during installation) and to ageing (loss of vacuum over time). They seem suitable to existing high-rise building.

Solar walls with transparent insulation (TI) need massive storage walls – and do not work with light weight walls like porous concrete or insulated walls. For this reason they will be not suitable to existing high-rise building in most cases.

Daylighting with TI provides high thermal performance to glazing (less than 0.5 W/m2K), allows a wide range of total solar energy transmittance g (from 15 to 45%) and provides diffuse daylight to rooms without hard shades. They are suitable to existing high-rise building.

Building integrated solar components

In a high-rise building, façade areas are much larger than roof area. Then a logical way to implement solar components on such a building is to integrate them in the façade.

The solar components can be solar thermal collectors with air or water or photovoltaic modules. There are different types of solar thermal collectors: unglazed collectors, flat-plate collectors with plastic or glass plate, collectors with evacuated tubes. In each case the thermal fluid can be either air or water.

Due to the properties of air and water, for the same energy flow, the mass and volume flow of air has to be higher than with water. This leads to an increased auxiliary energy demand. On the other hand, air can be used directly for space heating.

When implementing solar collectors (thermal or PV cells) on (or in) a façade, several issues are raised such as visual harmony of the façade (see Figure 2) and hydraulic, aeraulic and/or electric connections behind a wall; connections require special attention and skills.

The annual yield of vertical collectors is usually lower than the one of tilted collectors. However the tilt angle may be different from 90° even on a façade. Anyway this issue will be investigated in the Cost-Effective project. An important issue is also shading, especially in a dense urban environment.

The gained energy from the photovoltaic cells or hybrid collectors is most often supplied in the main electricity network. The heat provided by the solar thermal or hybrid collectors is supplied to the HVAC system.

The performances of an integrated solar component are on one hand the solar energy recovered and on the other hand his performance as a building element, performances of the solar component considered as a building element are lighting performance (vision area, spandrel/wall opaque areas), shading effect if the solar component is used as shading device, air and water tightness, fire resistance etc…

Figure 2 -
BIPV – Hong Kong Science Park

Passive and active cooling systems

Passive systems are devices that can be integrated into the building to perform the function of heat transfer and storage with little or no assistance from electrical or other non-renewable energy sources. Passive cooling techniques can be classified in three main categories:

a) Solar and Heat Protection Techniques
b) Heat Modulation Techniques that deals with the thermal storage capacity of the building structure.
c) Heat dissipation techniques which deal with the potential for disposal of excess heat of the building to an environmental sink of lower temperature. The main processes of heat dissipation techniques are: **ground cooling** based on the use of the soil, and convective and **evaporative cooling** using the air as the sink, as well as water and **radiative cooling** using the sky as the heat sink.

When the above systems use various device to enhance the cooling mechanism they become active systems. However the main active cooling systems are the heat pumps, including the absorption systems.

The radiative cooling systems are not the best choice for high-rise buildings since there efficiency depends mainly on the roof area. In the dry locations, evaporative cooling offers remarkable saving potentials. In high humidity climates such as the Mediterranean, solar hybrid desiccant cooling could be a promising alternative to standard HVAC installations but the implementation of solar collectors for a cooling application in high-rise buildings (with a low tilt angle) may be problematic. The energy performances of ground cooling systems are usually expressed by unit of ground area. So those systems are not recommended when the available ground area is limited (high-rise buildings in urban environment). Solar absorption cooling systems require solar collectors preferably with a low tilt angle so it may be challenging with high-rise buildings. Thermally activated building mass cooling systems are good systems in terms of investment and exploitation costs. Ceiling cooling systems offer fast response times without an air based system. The possibility of using solar hybrid cooling systems and absorption cooling systems together with facade integrated collectors will be assessed during the Cost Effective project.

Information > All information and project results are published on the website: **www.cost-effective-renewables.eu**