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Sustainable renovation of non residential buildings, a response to lowering the environmental impact of the building sector in Europe

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Abstract

Building renovation is a real opportunity to meet current challenges of primary energy reduction and global warming. But it is not sufficient in terms of sustainable development and sustainable retrofitting of buildings.
Sustainable building renovation is primarily an opportunity to improve comfort, wellbeing and quality of life of users while lowering environmental impact of buildings. This contribution, studied in one of the subtasks in IEA SHC Task 47 - Solar Renovation of Non-Residential Buildings – Subtask D; "*Environmental and Health Impact Assessment* ", aims to broaden the vision of designers and building owners to other environmental and health issues in the context of advanced renovation of non-residential buildings.

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1. Introduction

To achieve a sustainable development, that meets the needs of the present without compromising the ability of future generations to meet their own needs, building sector in Europe has a main role to play. In fact, European buildings stock represents 25 billion of square meters built of which 25% are non-residential buildings. But this stock is quite old (40% were built before 1960) and require a lot of natural resources (50% of total natural resources depletion, 45% of total energy consumption and 16% of total water consumption). Therefore, this stock produce a lot of greenhouse gas emission and waste (40% of waste production and 30% of greenhouse gas emission). Moreover, these buildings do not offer the comfort and the quality of life expected by their users or their inhabitants.

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In order to achieve the international goals in terms of sustainability and energy requirements, substantial measures have to be done within the existing building stock of non-residential sector. So far there are few exemplary retrofitting projects in the countries contributing to the work in IEA SHC Task 47 – Solar Renovation of Non-Residential Buildings (January 2011-June 2014) [1].

With the objective to initiate a stronger focus on sustainability in the existing non-residential building stock, it is needed to define what a sustainable design for building renovation is, what the priorities for building renovation are and how to integrate them into the renovation process (design and building site). These issues are dealt with subtask D in this research project.

2. Introduction

Sustainable renovation of non-residential buildings is primarily based on the reduction of energy requirements (heating, cooling, ventilation, lighting, appliances...). However, to be considered as «sustainable», the renovation process must also correspond to the global concept defined by the Rio declaration (1992) and the 27 principles drafted in application of the definition of sustainable development proposed by Gro Harlem Brundtland [3].

These principles can be summarized into five major concepts that can be directly integrated into the design of a renovation project:

2.1. Principle of integrating environmental, social, economic and political dimensions

Environmental dimension includes the environment, including biological diversity and the reserves of natural resources, both non-renewable and renewable. Social dimension includes health, capacities, knowledge, know-how, training, culture, experience and the relationships that a society proposes to its members. Economic dimension includes financial capital as well as physical or material capital such as technical infrastructures, machines, buildings... Political dimension consists of customs, laws, and various categories of institutionalized organizations at different levels of power.

Sustainably renovated non-residential building has all the usual qualities of a building (functionality, performance, techniques...) but the conditions of its environmental, economic, and social impact are minimized in the long run:

- on all scales: from quality and comfort of indoor areas up to the planetary scale, including neighbouring and urban areas around the building;
- at all time: from extraction of raw materials to renovation works and demolition.

2.2. Principle of inter- and intra-generational equity

This principle means that we must consider the entire environment and the balance between the four dimensions defined above as an inheritance: we have the right to inherit them and consequently to enjoy them equitably within our generation, but we also have the obligation to transmit them to future generations without dilapidating them, and better still, having enriched them.

Sustainable renovation of non-residential buildings is renovation that will take account of today's comfort criteria, while maintaining the capacity to satisfy future needs (comfort and quality of life) without generating major environmental nuisance for current and future generations.

2.3. Principle of precaution

This principle means that hypothetical or potential risks must be limited. It goes beyond the idea of prevention that is restricted to limiting proven risks. In other words, we must think about the consequences of our actions – our responsibility is no longer retrospective, it becomes prospective.

Sustainable renovation of non-residential buildings is renovation that limits risks both as concerns the health of workers, users and the overall environment, and it takes into account the various phases of the life of a building: manufacture, construction site, use, renovation or rehabilitation, use and elimination.

2.4. Principle of commom responsability

This principle affirms our common responsibility with regard to the issues of sustainable development, while maintaining that, although this responsibility is common to all, there is differentiation nevertheless: Occidental countries have a greater responsibility for the deterioration of environmental and social capital and they have the economic and political capital most apt to reverse the trends.

Sustainable renovation of housing is renovation that takes account of the four dimensions listed above, of current and future needs, and of the various phases of the building life (design, construction, use, renovation or rehabilitation, use and end-of-life).

A responsible designer is a designer who also limits the impact of his/her renovation project, both on the local environment (biodiversity, water resources, waste production etc) and on the general or global environment (fossil energy consumption, pollutants emission etc.).

2.5. Principle of participation

Citizen participation (re)locates decisions on the scale of the milieu for which they thus become players. It facilitates taking account of local particularities; it allows for appropriation of choices that have become collective; it ensures multiple solutions and points of view.

Sustainable renovation of non-residential buildings can not function without the awareness and active participation of its occupants.This principle is a fundamental priority for schools renovation where teachers, parents and pupils should be made aware to the good functioning of the building in which they live each day and to the impact of their participation. They must also understand the basic priorities implemented in the building: what is a “passivhaus” renovation, how to ventilate a room or a building, how to avoid overheating...

3. Sustainable design definition and priorities for non residential building renovation

3.1. Definition of sustainable design for non residential building renovation

Sustainable design for building renovation [2] can be defined as a design that interacts strongly with the various contexts (environmental, social, economic, ...) in which it is integrated, while:

- **Benefiting from the advantages of those contexts:**

Contexts should be considered as climactic context (orientation, solar gains, ventilation, shade etc.), geological context (earth, soil, altitude etc.), hydric context (resource, treatment, distribution, conservation etc.), vegetation and plants (trees, crops etc.) but also institutions, infrastructure and networks, technologies, the organization of the social context (social mixity, diversity of functions etc.), economy, historical and cultural heritage (buildings, landscapes etc.).

- **Protecting against aggressions from those contexts:**

The building envelope provides protection against the external environment, both in hot weather than cold weather (cold, rain, heat, wind, sunshine...). Moreover, to be considered as sustainable, buildings must also provide protection against external and internal noise, outdoor and indoor pollution, the risk of burglary as well as insecurity, the lack of drinking water, the risk of flooding, the limitation to a single generation or a single function, the lack of public transport, harmful materials etc.

- **Giving the benefit of sustainable improvements to those contexts:**

Constructing a building which, if it were to disappear, would not take anything away from the environment in which it stands, is not erecting a sustainable building. Architecture should be part of a triple context: the past that it inherits, the present that it constructs, and the future that it transmits.

- **Protecting those contexts from the environmental, economical and social nuisances of the construction itself**

The health and environmental impact of the renovated building must be lowest as possible. These impacts include atmospheric and hydric pollution linked the manufacture of the component materials, the use of problematic materials, the production of waste (household waste, demolition etc.), the sound pollution, additional traffic, impermeabilization of the soil, ...

3.2. Priorities of sustainable design for non residential building renovation

The objective of the sustainable renovation process is to extend the lifespan of an existing building while improving comfort, quality of life and limiting its environmental impact. Therefore, the following priorities should be taken into account at each stage of the building life cycle:

- **Increasing the comfort, the well-being and the quality of life:**

This priority means improving the thermal comfort, the visual comfort, the acoustical comfort, the indoor air quality; but also improving the quality of life, especially in cities and urban context and increasing social interactions and social diversity.

In the context of sustainable renovation of schools, this priority puts the user at the heart of the renovation project and includes the specific needs of pupils and teachers. This priority is particularly important because the population attending schools is a large population, in terms of both pupils and teachers; because the physical and mental development of children is strongly influenced by contexts or environments in which they live, mainly school and housing and because school spaces, indoor and/or outdoor, are also a great source of learning.

There is still a complementary notion to the comfort; it is the quality of life of the human being that can be defined in a series of parameters related to the quality of its external environment (built and unbuilt) and relationships that human beings share with its environment. These parameters are the quality of the immediate external environment, the presence of collective spaces or meeting, public spaces and parks; the possibility and ease of moving by foot or by bike, securely; the presence of proximity services; the existence of a neighborhood life... These parameters will give to a district inhabitant or to a building user a sense of belonging and a sense of security necessary for the quality of life 'felt'.

- **Reducing the consumption of fossil energy resources:**

This priority means improving the performances of the buildings envelope (insulation) but also optimizing the systems (heating, collong, ventilation, applainces) and increasing the onsite renewable energy production.

In a world where the growth of population and the economy drove up, energy needs and where the emissions of greenhouse gases lead to global climate change, energy issues become crucial. Growth of needs raises the question of security of supply and climate change that the sustainability of the energy system. The world's primary energy demand is met in 2010 to over 80% by fossil fuels. Oil is the primary source of energy, providing 33% of the world, followed by coal (27%) and gas (21%). Renewable energy meet 13% of demand, 10% for hydraulic. The share of nuclear energy in primary energy consumption amounted to 6%.

The consumption of fossil fuels also has disastrous consequences on our environment, especially in terms of CO2, fine particules and other air pollutants emission but also on the health of living beings, on the viability of wildlife (biodiversity) and on old heritage buildings.

It is therefore urgent to consume LESS WELL AND OTHERWISE taking into account of the operation energy for the use of buildings (energy efficiency in buildings), embodied energy of building materials (environmental assessment) and energy for transportation of occupants/users (sof mobility t , travel plan).

- **Enriching natural resources stocks**

This priority means permanently enriching the "water" resource by reducing water consumption and allowing the infiltration of rainwater into the ground but also enriching land and raw materials resources by limiting land use, having a rational use of materials and enhancing biodiversity by protection, conservation and creation of green spaces and green roofs.

Concern for sustainable management of the "water" resource in the building sector is linked to two major issues. On the one hand, the massive use of water (average 150 liters/day per european inhabitant), this pressure on the resource consumption and the creation of diffuse pollution that require treatment more expensive and on the other hand, urban expansion and soil sealing leading to gridlock, increased flood risk and prevent the supply of groundwater. During the past 50 years, the amount of fresh water available on Earth has halved and many countries and regions have gone below the threshold of water vulnerability (2000m ³ / capita / year).

So it is urgent to preserve this fragile resource and its quality and to consume LESS WELL AND OTHERWISE, by reducing our consumption of drinking water and by using another source of water for the needs do not require drinking water.

Worldwide, increasingly important urbanization of cities, densification of built-up areas and increase in impermeable surfaces have resulted in change or destruction of the BALANCE between built spaces and green spaces with large effects on the management of rainwater. In addition, the loss of green spaces and permeable surfaces leads to a strong decrease in groundwater recharge.

It is therefore urgent to take simple and effective measures for a better management of rainwater.These include increasing permeability of the plot; developing the plot with retention and infiltration devices and choosing permeable coatings for outside ground.

The notion of territory is also linked to the exploitation of resources and landscape. In terms of resources, the construction industry in Europe uses 50% of all natural resources exploited. In 2005, all sectors consumed 58 billion tons of resources extracted and is expected for 2030 consumption of 100 billion tons, or an increase of 75% in 25 years. In Europe today each inhabitant consumes every average 45kg of resources.

The resources used are either mostly renewable and non-renewable materials.The exploitation of these resources can firstly have adverse environmental impacts (landscape quality, loss of biodiversity, loss of existing ecosystems ...) and also have disastrous social consequences. So it is urgent to preserve our virgin spaces, ecosystems, our resources and landscapes by working on both a concept of compact cities, a concept of compact building (in renovation as well as in new construction) and by a good selection of building materials and processes.

- **Reducing the production of waste**

This priority means reducing pollution of air, water or soil, limiting and managing production of construction waste by promoting construction waste and exploiting stocks secondary resources from recycling of waste; controling and managing production of operation (domestic) waste and recycling or purifying waste water.

While most of people agree on raw materials and energy resources depletion, the construction sector is a major producer of waste (40% of total european production of waste).

Most of those wastes, despite a real potential for recycling are, by lack of infrastructure, information or adequate legislation, treated in traditional fields, namely landfilling or incineration plant.These fields generate significant nuisance both on the environment and on the health of living beings but are increasingly regulated, controlled and expensive and which locations will be increasingly limited in Europe.

Therefore, there remains, in terms of sustainable development only three alternatives: produce a minimum of waste,
sort waste more at source (directlyon building site) so that they can be easely exploited and recycled and use more materials produced from recycled materials.

The integration of these priorities in professional practice is a necessary step to achieve sustainable building renovation. These priorities are also the “red line” of the different environmental assessment methods such as BREEAM [4] (England), LEED [6] (US), HQE (France), DGNB [7] (Germany), Total Quality Building (Austria)...

4. Methodology

Subtask D aims to develop a guidebook for designers and planners that could be used in high ambition energy and sustainable retrofitting projects, especially for school renovation. Schools renovation is a common objective for most of European countries. It is also a real opportunities to improve environmental and energgy awareness of people, especially children and pupils and to motivate them to take action to improve their living environment and the places where they live and work.

Based on the priorities described above, the guidebook develops a holistic approach for non-residential building renovation based on environmental, urban infrastructure, comfort and health impacts.

The guidebook offers guidelines to be followed in the design phase and during the renovation works. It tries to raise awareness of environmental issues by providing to designers sufficient knowledge and tools adapted to their professional practice.

The structure of the booklet is as follows:

- **An introduction**

This introduction reminds of the challenges of sustainable development, of the definition and the priorities of sustainable renovation. It also presents the specificities of school buildings and renovation priorities for this type of building. It offers an overvieuw of the european energy legislation,of other energy standards and of various environmental assessment methods for building renovation.

- **The main content**

The four priorities are then discussed in different chapters. Each chapter consists of several parts or sections:

- Presentation of the theoretical basics necessary to good understanding of physical, hygrothermal, acoustic phenomena in building,...
- Proposals and tools for the evaluation of different problems (or environemental energy) met in the building and for the identification of the origin of these problems,
- Solutions or recommendations to improve and optimize the envelope, to optimize existing systems and / or implement new systems or measures.

These recommendations cover both the design of the renovation project, the implementation during the building site but also focus on the participatory process of users during all the steps of the renovation project.

Throughout these chapters, many tools (design and evaluation) and a bibliography are presented in order to facilitate the work of the designer.

The guidebook will be illustrated by a lot of comprehensive figures, graphs, pictures and also by good exemplary projects from the Subtask A. By April 2013 four exemplary projects have been analyzed in terms of comfort improvement, waste management, indoor air quality and heritage value. The analysis of exemplary projects will be continued until the end of the research project in order to highlight innovative, successful or replicable concepts.

At the end of each chapter, for each priority, a linking with BREEAM certification is achieved. This allows both to promote and support reflection or recommendations included in each chapter but also raise awareness of any designer or owner to the interest of a certification.

5. Further works

IEA SHC Task 47 will conclude it research by June 2014. The work in subtask D will result in a booklet on sustainable and advanced renovation of non-residential building, especially renovation of schools and a analysis of innovative concepts through the exemplary projects presented in Subtask A.

Acknowledgements

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