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Vision of a Sustainable Smart-ECO Building in 2030 and Requirements

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Content

1 The vision developed by the SMART-ECO project (background & context)

1.1 The vision for sustainable European eco-buildings in 2030

A Smart Sustainable Eco (SSE) Building will:

1. Apply the general principles of sustainability;
2. Result from the involvement of all interested parties and be designed to meet its occupants' needs individually and collectively;
3. Be completely integrated into the relevant local building, town-planning or environmental–planning schemes and infrastructure;
4. Be designed or refurbished from a Life Cycle perspective;
5. Have its environmental impact minimized over the estimated or remaining service life;
6. Deliver economic value over time ;
7. Provide social and cultural value over time and for all;
8. Be healthy, comfortable, safe and accessible for all ;
9. Be designed or refurbished to be user-friendly, simple and cost effective in operation, with measurable technical and environmental performances over time;
10. Be designed or refurbished to be adaptable throughout its service life, with an end-of-life strategy;

1.2 What is the SMART ECO project?

The core of the Smart-ECO project was to establish a vision for sustainable European eco-buildings in 2030, giving due consideration to the requirements of all stakeholders' viewpoints and interests. Identifying a vision that is equally idealistic and ambitious whilst being pragmatic and applicable has been the main challenge. The community of stakeholders, who were involved throughout the project, have come together around a clear set of priorities in order to derive requirements from the vision. Technical as well as non-technical innovations have been evaluated on the basis of their potential in Smart-ECO vision priorities. Activities and policies are mapped to ensure even coverage and gaps are identified for focussing future efforts.

A consensual vision of what a sustainable building should be in the time period 2010 – 2030 is provided on the previous paragraph The objective of this document is to explain in detail how this vision was developed from the original starting point in 2008. The construction sector is facing important challenges, and the Sustainable Smart-Eco-Building, or SSE, as expressed in this vision, could be one key element to emerge.

A second document has established requirements to support the vision, and suggests tools for measuring how the requirements are being fulfilled. Both have been submitted to the stakeholders for comments, and they serve as a basis for the development of the evaluation of each innovation's potential.

The Smart-Eco project consisted of several work packages, as follows:

- **WP1: Project Management**
  - Ensure project coherence and coordination
- **WP2: Vision & Requirements**

- Develop a vision for sustainable development in building and construction, anchored with stakeholders and applicable for a time horizon 2010 – 2030 and identify requirements and indicators reflecting the vision.

- **WP3: Innovation**
    - Identify elements that are likely to provide significant contributions to delivering the vision, and can be understood as milestones on the route for the building and construction sector to meet the vision of sustainable building.
- **WP4: Evaluation**
    - Apply the vision as a reference point in order to analyse how the identified elements contribute to the vision.
- **WP5: Stakeholders**
    - Involve various relevant stakeholder groups in the establishment of the vision for sustainable building as well as in the assessment and evaluation of the elements that are identified as contributing to the development and delivery of the vision.
- **WP6: Dissemination**
    - Document and Disseminate the content of Smart-ECO.
- **WP7: Exploitation**
    - Bring the contents and results of Smart-ECO to a wide relevant international audience with the prospect of further development and ultimately application.

1.3 Methodology to develop the vision of a Sustainable Smart-Eco (SSE) Building in 2030

1.3.1 The General Framework of the Smart-Eco project

The vision, as described above in figure 1, is intrinsically tied to the other Work Packages (WP) of the Smart Eco project. An iterative process was employed, as follows:

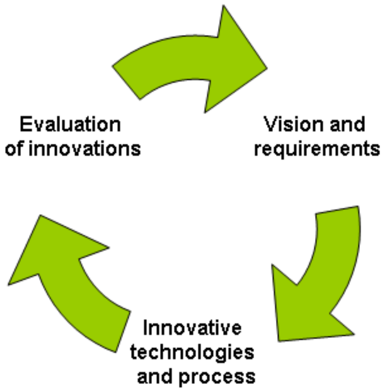

Figure 1 : Interactions between workpackages

The next figure (figure 2) illustrates the iterative project process and the methodology for feeding information into the process from WP3, Innovation, WP4, Evaluation, and Stakeholder engagement. The stakeholders were sent a questionnaire and a number took part in a workshop. Their inputs were significant in terms of form and content. A panel of stakeholders (researchers, architects, and other decision makers), was invited by the Smart-Eco project partners to comment on and to help improve the vision of a sustainable smart-eco building. As a result of this engagement the original 10 issues in the vision were revised, and summarised in a short standalone document, with brief explanations and illustrative examples for each issue.

This approach provided a way to identify the need for specific developments to deliver solutions where they are currently not available for priority questions and issues.

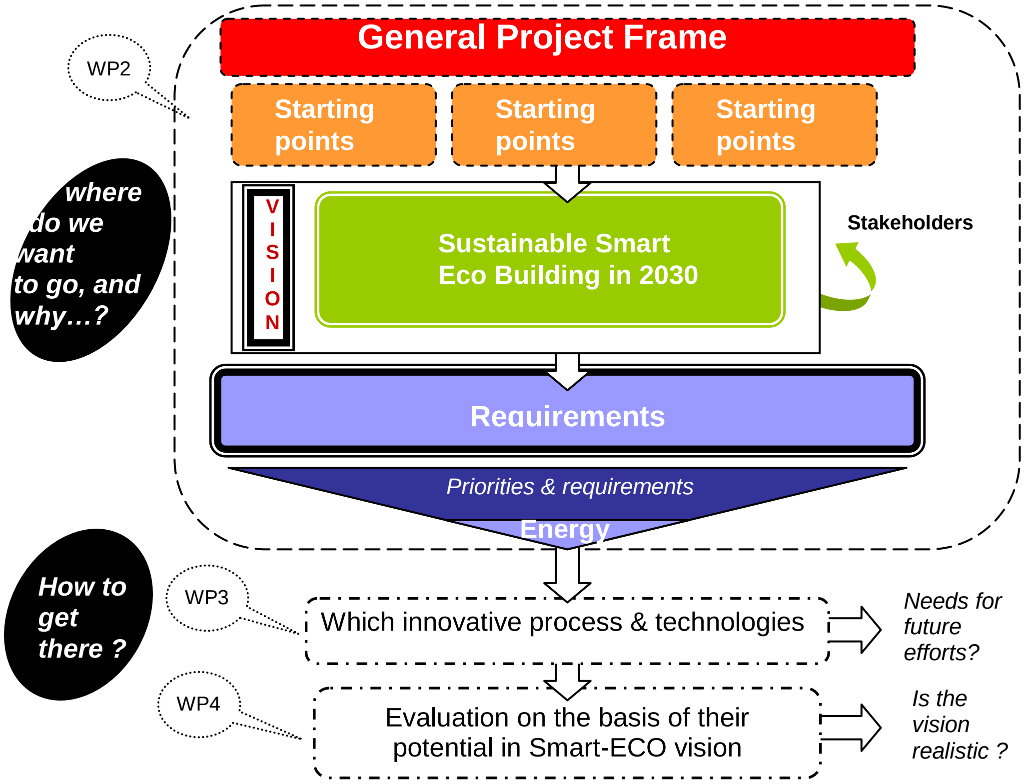

Figure 2: Process from the vision to the requirements and evaluation

1.3.2 Development of the vision statement

The figure 3 illustrates the progress of the project from the general framework to the first steps of the elaboration of the requirements.

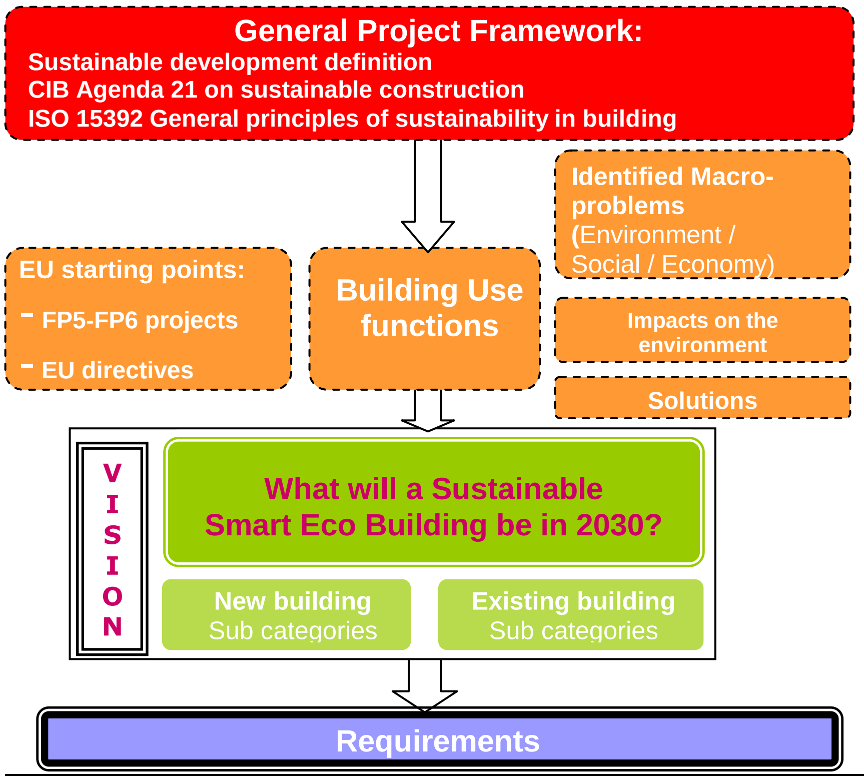

Figure 3 : To build the vision and requirements

The vision was methodically built up by applying a holistic approach based on the full life cycle of the building. Starting from the general framework, the work progressed by considering:

- The results of previous European projects
- The use functions of a building
- The EU starting points
- The standardization work in CEN and ISO
- Other standards documents

The final outcome is expressed as a solution to the macro-issues and their median scenarios.

For example, the general framework is aligned to the internationally agreed and harmonized basis for the thematic field of "sustainable building", including the Brundtland definition of sustainability, the "CIB Agenda 21 on sustainable construction", and ISO 15392: "General principles of sustainability in building construction".

The approach taken was to take the global reference points expressed in the framework documents, and to apply these to the specific requirements and context of the European building and construction sector. The global consideration of issues to be included in sustainability assertions, relating to internationally agreed concepts such as for instance life cycle and performance concepts, paired with the tasks and trends in European policy making and the state-of-the-art in building construction have been brought together in the draft vision document and used as the basis of an intensive discussion with stakeholders.

1.3.3 Stakeholders involvement

Through WP5, stakeholders were consulted over the life of the project, in order to validate and influence our work about the vision (as well as the development of the other work packages o innovation and solutions. The stakeholders were formally involved and engaged in task 2.1 "Establishment of the vision". They were drawn from the large number of actors involved in the process of construction, from the conception phase to the deconstruction or demolition phase through the operation phase. They included decision-makers and researchers working in the construction area, as well as , some stakeholders who were "external" to the planning process and construction, like investors, insurers, tenants, etc

First questionnaire

The first executive summary of the vision was circulated to stakeholders in the beginning of 2009 for their comments and feedback. A questionnaire - built by the WP2 and WP5 partners, formulated the key issues considered important for inclusion in an initial version of the Smart-ECO Vision. This questionnaire accompanied the executive summary, in order to identify stakeholder's priorities and their opinion about it at the early stage of development. The questions and issues the stakeholders raised were analysed in order to obtain a consensual vision

The questionnaire was designed by making particular statements and asking the Stakeholders to respond with their level of agreement or disagreement to the statement. For example one of the questions asked was: "Sustainable Smart-ECO buildings should be designed from a life-cycle perspective". Responses were requested on a five point scale as follows: 0: Strongly disagree /1: Disagree / 2: Neutral/ 3: Agree / 4: Strongly agree. In this way the level of agreement/disagreement was ascertained and by taking the averages of the full data it is possible to rank the issues in their importance as seen by the Stakeholders collectively. The results of this questionnaire (36 filled questionnaires) were considered valuable and gave a general way to orientate our work. These instantaneous opinions permitted to address some misunderstandings and identified new priorities. The vision was strengthened at some points (giving greater weight to life cycle aspects, for example), and the basic concept was validated. The responses also led to further development of other parts of the Vision, to cover aspects that could easily be overlooked.

In addition to the initial questionnaire, various Stakeholder events were held and a number of Stakeholders attended the different Smart-ECO project meetings.

Brussels Workshop

A panel of stakeholders was invited by the Smart-Eco project partners to comment on and to help improve the vision during the Brussels workshop in March 2009. After a detailed presentation of the process, methodology and result of the work to develop the Vision up to that time, a structured discussion took place, guided by 5 questions related to the methodology and the content. Firstly, the methodology developed to establish the vision was clearly approved by the stakeholders. Then the 14 stakeholders agreed that few modifications were needed to the 10 issues identified in the vision. Minor amendments were needed to address some key concerns. After this workshop, a “stand alone” document was produced, setting out the objective, scope and targeted users, the 10 revised issues and an extended description of each issue enabling a clear understanding of the terms, a list of aspects covered by the general concepts, and illustrative examples.

Tallinn Workshop
A further panel of stakeholders was invited to the Tallinn project meeting in order to take part in discussions about final improvements to the work packages. From the 15 stakeholders present, the main criticism was about the lack of appeal of the format of the vision as it was presented.. The ambitious character of the vision is only clearly visible to specialists, and is not obvious to more general readers or policy makers. As a result the vision may initially appear not to be ambitious enough, as none of the issues is a fundamental breakthrough point. As written, all the issues are realizable, if we remain at the conceptual, visionary scale. But the vision is very ambitious when it comes to addressing all the buildings in Europe by 2030, including existing ones, and bringing all the issues into practice at the same time, particularly with current economic and temporal constraints.

Further involvement
No specific and strong further involvement was initially planned. However, a number of Stakeholders have requested to receive the full Vision document so that they are able to make detailed comments in enhancing it. To meet the goal to develop a “stakeholder supported vision”, the drafts have been validated by the work package partners, the Smart-ECO partners and the stakeholders contacted by email in November 2008. Their points of view were actively considered during the workshops and their comments were always addressed in some measure. Hence the Smart-ECO Vision development has involved close and detailed involvement by the Stakeholders and is now nearing completion. However, the early decision by the consortium to keep the Vision documents as “living documents”, to update them throughout the project and only to print them at the conclusion of the entire project has allowed for additional refinement including inputs from stakeholders through the life of the project.

2 THE SSE BUILDING AS A RESULT OF SUSTAINABLE CONSTRUCTION, WITHIN THE GENERAL ISO AND CEN FRAMEWORK OF SUSTAINABILITY

The roots of the vision for “Sustainable Smart-Eco Buildings in 2030” lie in the general definition of the sustainability concept and make reference to standardisation work.

2.1 Background and definitions of Sustainability

Several definitions of Sustainable Development can be extracted from the literature, but the consensus starting point for the definition of sustainability is: "*Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs*", first set out by Mrs Gro Harlem Brundtland, and included in the report “Our Common Future”, [1987].

The Earth Summit in Rio de Janeiro in 1992 constituted a turning point in man’s attitude to the environment. The 1997 Kyoto conference which resulted in the Kyoto protocol was the first international agreement to set goals for reduction of greenhouse gas emissions.

Sustainability is not a fractal concept: an internal sustainability does not involve necessarily an external sustainability or the sum of different sustainable initiatives is not obviously sustainable in global. “***Think global, act local***”. A balance must be found for each action to find the best global compromise.

Moreover, a sustainable approach for a specific project (like a building) is different from a sustainable approach for a local area (city scale), or national projects (regional scale). Thus, adapting sustainability in buildings and other construction works includes a specific interpretation of sustainable development in terms of its three primary aspects, economic, environmental, and social, whilst also addressing the technical requirements and functional performance of the whole construction works within the context of the locality. Finally, sustainability in the building sector is strongly dependant on the social, political and economical climates. The construction industry also has a significant responsibility in a society where behaviours are influenced by the available facilities and infrastructure.

Since the year 2000, International Standards for sustainable construction have been under development. Now, in 2008, as a result of these efforts, ISO TC 59 on Building Construction has published several standards through its Sub-Committee 17, “Sustainability in Building Construction”. These standards are also the basis of new European Standards currently being drafted by CEN Technical Committee 350 in response to mandate 350 of the Directorate General “Enterprise”, entitled “Sustainability of Construction works”.

2.1.1 General principles of Sustainability in Building Construction

Many initiatives deal with how the construction industry should respond to the sustainable development agenda. In particular ISO 15392 on the "General Principles of Sustainability in Building Construction" identifies the following aspects:

- ✓ Continual improvement,
- ✓ Equity,
- ✓ Global thinking and local action,
- ✓ Holistic approach,
- ✓ Involvement of interested parties,
- ✓ Long term consideration,
- ✓ Precaution and risk,
- ✓ Responsibility,
- ✓ Transparency.

2.1.2 Building use functions.

The first objective of any construction project is to meet the functional or operational requirements or needs expressed by the future owner and/or user. The sustainability of a building depends not only on the process of building but also on the final outcome of the process, the finished building or works. Moreover, a building is not only an object that can be sold but it becomes a sum of functions, with hopefully some assurance on the expected performance.

The main use functions of building works have been identified by CIB Commission W052 “Procurement systems” (1995) as follows:

- ✓ Provide space
- ✓ Provide an indoor climate
- ✓ Provide safety and security
- ✓ Allow the use of goods and tools
- ✓ Control the nearby relationship
- ✓ Take advantage from the site without damaging it
- ✓ Bring meaning (semiology)

2.2 EU-level starting point in terms of research, policies and existing know-how

2.2.1 EU Projects and Networks

The establishment of a vision, which, in terms of sustainable development, meets the European interests concerning innovation, technology, quality of life, etc, cannot be disconnected from its European context. The ‘state of the art’ is the precondition for describing a vision for smart, sustainable Eco-Buildings in the EU. This involves identifying the current status of knowledge within the EU, and relates to the starting point in terms of current policies, targets, technologies, market aspects and mechanisms, R&D projects and their exploitation. It needs to include requirements resulting explicitly or implicitly from previous R&D projects conducted under the EU FP5 and FP6 programs.

2.2.1.1 EU Projects about Sustainability, Sustainability in Building Construction and Sustainable Buildings

The following projects are relevant in this context:

FP5: Fifth Framework Programme

- CRISP – Building and city related sustainability indicators
- PRESCO – Practical Recommendations for Sustainable Construction
- IVESTIMMO - A decision-making tool for long-term efficient investment strategies in housing maintenance and refurbishment
- SUREURO - Sustainable Refurbishment Europe
- LIFETIME – Lifetime engineering for buildings and civil infrastructures
- PeBBu – Performance Based Buildings
- e-Core – European Construction Research Network
- HQE2R – Sustainable renovation of buildings for sustainable neighbourhood
- SHE – Sustainable Housing in Europe
- EUROLIFEFORM - Probabilistic approach for predicting life cycle costs and performance of buildings and civil infrastructure
- ENDOHOUSING - Endothermic technology for energy efficient housing in the EU

FP6: Sixth Framework Programme

- BRITA in PuBs - Bringing Retrofit Innovation to Application in Public Buildings
- DEMOHOUSE - DEMOHOUSE is focused on improving sustainable renovation of the existing housing stock in Europe.
- ECO-CULTURE
- SARA - Sustainable Architecture Applied to Replicable Public Access Buildings
- PHDC
- ECO-BUILD
- LENSE – Methodology Development towards a Label for Environmental, Social and Economic Buildings

2.2.1.2 CIB work

CIB is the International Council for Building Research, with membership drawn from the worldwide construction community.
"*CIB's unique position within the international construction community allowed it to initiate a specific sectorial response to the international agendas raised by Brundtland, Habitat II, Rio and Kyoto. CIB's recognition of the problems in establishing both a framework for sustainable development; how change within industry occurs, along with CIB's past, current and proposed activities meant that CIB was perfectly suited to respond to sustainable development. This CIB-led project resulted in global collaboration and co-ordination to specifically address sustainable development for the construction community. Situated between the broad international agendas and more local and sub-sectorial agendas, CIB's Agenda 21 is a conceptual framework that serves as an intermediary and provides for comparison and co-ordination. The three principal objectives are: to create a global framework and terminology that will add value to national, regional and sub-sectorial agendas; to create an agenda for CIB activities and for co-ordinating CIB with specialist partner organizations, and to provide a source document for definition of R&D activities*." (Christer Sjostrom; Wim Bakens)

2.2.2 European and National views

A clear picture of the current state of sustainability in construction in Europe, together with the main areas requiring action is needed to establish a realistic vision for SSE Buildings. European countries have focused on different issues: energy, materials, healthy indoor climate, wastes … etc. Even the methodology changes from one country to another: these approaches could be additive, transparent, holistic, or mono-criteria. The driving forces and building categories differ depending on the country. Nevertheless, a general drift is to reduce the sustainability concept to environmental aspects, and then to consider energy aspects or even further to single emissions linked to energy use, like CO2.

Sustainable construction has, nowadays, different approaches and different priorities in the whole of Europe. A more extended and detailed analysis, which is beyond the scope of the Smart ECO project, is required to give a more accurate map of the actual situation.

The current plan of the German government is to double the energy efficiency and productivity until 2020. In Germany all current EU standards and directives are implemented in residential and commercial appliances. In 2001 an Ordinance on Energy Conservation in buildings was established in Germany. The aim of this law is to reduce the energy demand in new buildings by 25 – 30 %.
In France, the Grenelle law requires new buildings to go to 50 kWh_{ep}/m^2.year by 2012, and, to be energy positive by 2020. For existing buildings the target is 40% less energy consumption by 2020.
In 1991 Italy established its National Energy Planto regulate efficient energy consumption. The plan includes building standards and performance of heating systems. Additionally a certification scheme for buildings was added in 2006 to implement the European Energy Performance of Buildings Directive. Furthermore the Energy Plan requires companies with annual energy consumption over a certain amount to employ an energy manager. Communities with a population of about 50.000 or more are advised to establish an energy plan, with an emphasis on renewable energies and efficiency. Gas and electricity suppliers with more than 100.000 consumers are also advised to help their customers to save energy. Alternatively, through trading, firms can buy White Certificates for Energy Efficiency Titles from other suppliers, where these have achieved them.
The 2004 UK Energy Act considers a range of EU requirements which are related to energy efficiency. This includes building and product standards. Furthermore an Energy Efficiency Action Plan was established to lay out the minimum energy standards for new houses. Additionally a Code for Sustainable Homes encourages house builders and developers to go beyond. compliance with minimum building regulations requirements. Energy Performance certificates (EPCs) were also introduced for the property trade in 2008. The gas and energy suppliers have been pleased to achieve significant energy savings by improvements in energy efficiency through measures provided to domestic consumers. The Carbon Reduction Commitment (CRC) is a similar instrument for industry and the public sector, which comes into effect on 1 April 2010 for organisations using more than 6,000 MWh a year.

A lot of European countries accept the challenge to save energy and to protect the environment, but this is just the beginning. There are a lot of possibilities which can be undertaken, not only for new buildings, but also for existing ones. The incipiencies have been done, but they have to be forcefully continued.

3 Problems and macro-issues: actual and future challenges for the construction sector

The establishment of the vision of what a sustainable building in 2030 needs to be requires assumptions about the **main variables** of societal and environmental evolution over the next 20 years: namely the evolution of the social, political, economic and environmental concerns. The following scenarios identify the macro-problems. These problems have some consequences on our environment and more precisely on our built environment that will be considered in the next paragraph.

3.1 Limited resources available and distribution (energy resource, material, labour, skills, water, land, money ...)

The basic assumption is the **finiteness of the world**: particularly its resources (energy resources and material resource), which are not infinite.
The case of energy resources is striking. Sooner or later, fossil fuels and fissile energy will be exhausted. Three institutes (BP Statistical Review, The United States Geological Survey –USGS- and the Oil and Gas Journal) provide roughly equivalent data about proved reserves that correspond to forty years consumption at the current rate. Now, the actual trend consists of increasing energy demand[1] because of economic growth and the increasing population[2].

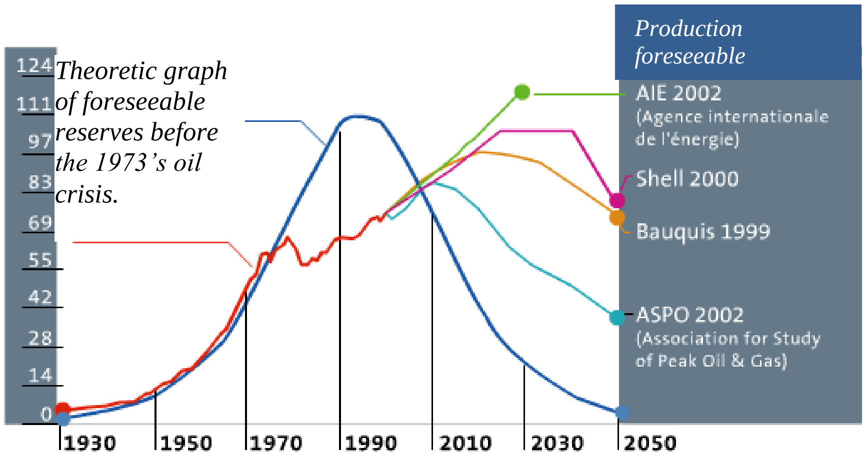

Figure 4 Optimists and Pessimists. Oil production forecast (millions of barrels per day); Source: Le Monde Infographie

The same phenomenon is true for raw materials. This is also a major indicator, as construction activities consume more raw materials by weight (as much as 50%) than any other industrial sector. But at the same time retrofitting can be anticipated as the main activity in the construction sector by 2030, with lower raw materials consumption (compared to new construction). The main resources addressed are cement, steel, aggregates and oil again for organic materials. Wood is also concerned, and its availability strongly depends on more sustainable growing and exploitation processes. The distribution of other resources, like labour, skills, and money, appears more and more unequal among the population needs.

[1] AIE predictions give a increasing of the energy demand of 60% over the newt 30 years. The demand should be concentrated in countries as China, India Brazil and Russia, the so-called BRIC economies. The main increases should be in the transport sector, petrol-dependant, due to increasing mobility and the democratization of car access.
2 World population will have more than double between 1970 and 2030: from 3,7 to 8 billions.

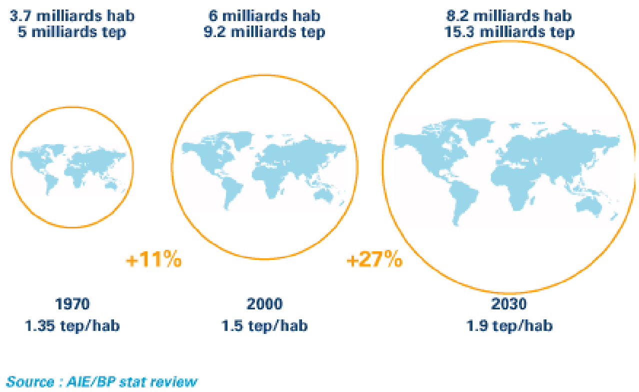

Figure 5: Increasing of the energy demand. 1 Tep = 7,2 bep (barils équivalents pétrole). Hab = Inhabitant. Source: IFP (French Petroleum Institute) web site

3.2 Climate change / environment

The primary ecological concerns are the speed of climate change and the consequential pressure on biodiversity. The built environment accounts for the largest share of greenhouse gas emissions (about 40% in Europe) in terms of energy end usage. Our median scenario is based on the most recent report published by the Intergovernmental Panel on Climate Change (IPCC), which suggests that the average temperature of the Earth's atmosphere is set to rise by between 1.5 and 6°C by the end of the century.

3.3 Demography and people movement

There were 6 billion inhabitants on earth in 1999 and there will be 7 billion in 2011 or 2012, with a forecast of 9 billion by 2050.

When considering the growth curve, 2030 seems to be the inflexion point. But until that date, the growth rate will remain very high.
A population of 8 billions in 2030 appears as the median scenario.

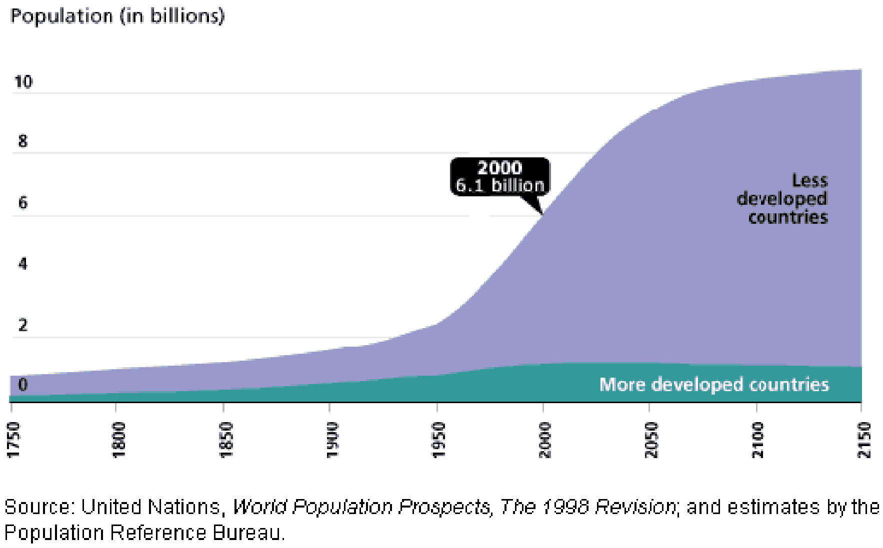

Figure 6: World population growth, 1750 – 2150 population, in billons

An historical overview of **migratory movements** that have occurred for tens of thousands of years and continue to the present day, suggests that major movements will have to occur in the next few decades. Migratory movements could have many origins and factors, for example: the local demography and environment (the search for more and better resources, or a move from rising sea levels), economic, cultural, or political (the search for freedom from war and conflict, and religious and ideological toleration). These group and individual movements have shaped and structured societies, cultures, technologies and landscapes.

3.4 People's awareness

The **individual awareness** and a modification of habitual ways of thinking about environmental and social concerns will be required and will be more painful the longer it is delayed. As we saw, in order not to accentuate the crisis, society will need to decrease its energy and material needs. In all human activities, a trend is growing towards an approach based on the identification of the accurate needs, in order to find the best balance between the required performance and the energy and material demand. At the individual level, the key issue is the acceptance of modifications to our way of life resulting from this approach.

But this aspect may be altered by another key point, resulting from the points above: the economic and social climate may deteriorate in the coming years, with increased social disparities, and so environmental concerns may become less of a priority.

3.5 Lack of coordinated policy making, market distortion

In relation to **political aspects**, the concern is to know if national governments in Europe will be in a position to push or regulate the whole economy in the way of sustainability in order to postpone and reduce the scale of the impending energy supply and social crises which threaten over the next 20 years. Despite the real difficulty of sending such electoral messages, a real political will should take shape to initiate some sober trends and national (indeed regional) energy independence.

3.5.1 European Directives

As a result of a consensus between the European countries, mainly focused on energy performance and reduction of CO_2 emissions, several decisions have been taken recently, each resulting in the formulation or revision of a Directive:
- EPBD (recast awaiting decision and adoption by the European Council)
- CPD (revision)
- Energy Services Directive
- Energy related products Framework Directive

In its Action Plan for Energy Efficiency (2007–12), the EU has laid out a comprehensive set of measures aimed at achieving a 20% reduction in energy consumption by 2020. Various directives and regulations following from the Action Plan have established minimum standards and labelling requirements for different sectors. The most important pieces of legislation include the Eco-Design Directive enacting minimum standards to improve the energy yield of 14 groups of products; the mandatory labelling rules for household appliances which aim at harmonization of European energy efficiency labels; and the minimum performance standards and building energy certification required for new and renovated buildings put in place by the Energy Performance of Buildings Directive.

3.5.2 Nations

More than 30 % of the energy used in Europe is accounted for by households, with over 70% of that energy used for space heating. Consumption of energy will rise in the next years, because of larger buildings and more residential homes. Furthermore, increasing numbers of electrical appliances are used. Governments need to try to find different solutions to save energy and to make energy saving more attractive to the owners of buildings. It starts with tax benefits or information brochures with the advantages of new and energy saving technologies. Additionally the governments from different countries ask energy and gas suppliers to inform their consumers about the benefits of new energy saving technologies. . Another possibility is to pass a new law to "force" firms and builders of new houses to save energy. These laws are generally valid only in one country and not in the whole EU. Minimum standards have been established in different countries, but they differ from country to country. They are aimed at different nations and situations and they are not fully transferable to other countries.

4 Impacts of these macro-issues on human society and on the construction sector

The impacts of each “macro-issue” are multiple, and are described in turn below.

4.1 The impacts of limited resources available and distribution (energy resource, material, labour, skills, water, land, money ...)

Limited supply (people and materials)
The available resources for consumption are decreasing due to increasing demand within as well as outside the EU. The short term availability of resources such as refined oil causes rapid changes in prices of food, energy and raw materials). Consequently, there are economic limits to the supply of these goods. Additionally, the infrastructure needed to supply some of these materials or goods is at the limits of its capacity. An increasing item of concern is the availability of people with the right skills to provide the required services or to perform the desired works.

Interruptions
The increasing density of technical equipment also leads to a stronger dependency on the availability of services and infrastructure. Problems in the distribution networks are a concern, as back-up systems often are not available or are only available at a capacity that does not meet the demand over longer time-periods. Shortages in delivery with e.g. energy can lead to significant deficiencies in building performance, ultimately leading to the disruption of building equipment. Many elements of the built environment depend on a constant and secure provision of energy.
The function of buildings may also be disrupted by maintenance and refurbishment activities. Unplanned interruptions disrupt business, with economic consequences. For the duration of the interruption, alternative solutions, including moving of the provided services, need to be found.

Conflict
Conflicts over resources are one global threat related to the current consumption patterns associated with the assumed future development.
On a lower and more local scale, conflicts of interests between different stakeholders can also slow the required redevelopment of the building stock, or can significantly delay necessary strengthening of infrastructure. Routines for early resolution of potential conflicts consequently become a core concern.

Higher Cost
Increasing requirements leading to increasing demands for volume, space, equipment, energy and material, coupled with decreasing availability of required resources naturally lead to increasing prices. The cost of construction and operation of the built environment therefore needs to be assumed to be rising. More efficient buildings can balance the rising price level.

Delays
Shortages in the available resources, both concerning resources and labour, and in combination with rising prices, may lead to increasing delays between the demand and investment decisions and the possibility to perform the decided construction work. Such delays may have significant impact on the functionality of buildings and infrastructure, naturally depending on the kind of construction project that is being delayed. Delays in maintenance of buildings in operation may lead to reduced building performance, reduced efficiency or increased deterioration, with negative economic consequences.

Availability of buildings
Unavailable economic, energetic, material or human resources may make appropriate building operation impossible, leading to the disruption of the services provided by the building in question. On a lower scale, higher prices for e.g. energy may force the building users to operate the building with reduced efforts. Thinking about heating, cooling and ventilation, this may lead to problematic hydrothermal conditions in the building, potentially leading to health impacts on people using the building, or leading to humidity related physical building problems.

4.2 The impacts of climate change

More cooling load and increasing solar irradiation (gains)
The likely future change in the global climate is impossible to predict in accurate terms, and likely regional variations need to be considered. A global increase of average temperature will lead to an average decrease in heating demand while increasing the average cooling demand, supposing that the extremes will move in the same direction as the average. The likely occurrence of stronger storms and more frequent extreme weather conditions, however, indicate the difficulty of making assumptions about future extremes. Apparently however, both energy gains and losses are increasing and the spread of conditions in which buildings need to operate appears to be widening. Increasing solar irradiation not only causes thermal gains but also affects the deterioration of building materials.

More water run-off
Climate change is likely to lead to more frequent extreme weather conditions, including heavier rainfalls. These lead to a changing demand in the peak capacity of storm-water run-off systems in order to protect from overflows.

Flood protection needed
The increased water run-off, caused by faster melting of snow and increasing intensity of rainfalls, leads to an increasing demand for flood protection. In coastal zones, the combination of increased water run-off with increasing storms and higher sea levels suggests increasing water levels from inland and from the sea at the same time.

Impact on materials durability
Increasing solar irradiation not only causes thermal gains but also affects the deterioration of building materials. Likewise the changes in relative humidity or the increases in wind driven rainwater impact on materials and affect details in building designs. Changes in the temperature load on constructions may affect temperature related movements and may have negative effects on joints or composites. The changes of temperature and humidity may also bring e.g. insects affecting wooden materials into areas where they currently are not.

Adaptation of existing stock
The adaptation of the existing building stock to changing conditions of building operation may create a huge demand for renovation and adaptation processes, with a regional dependence on the nature and speed of changes in climate. The availability of know-how as well as technologies, products and labour as well as of economic resources may be a matter of concern.

Change of buildings performance
Changes in the performance of buildings due to changes in the exposure environment, including partial building failure, may cause significant losses of building efficiency, leading to increasing energy demands, or may lead to sudden disruptions in the cost of building operation, or may even lead to sudden building failures in extreme cases. Buildings may become obsolete unless significantly refurbished, causing increased demand for replacement.

Impacts on human health
Projected climate change-related exposures are likely to affect the health status of millions of people, particularly those with low adaptive capacity. Buildings may need to have their protective role strengthened (against mosquitoes, temperature amplitude, and extreme events).

4.3 The impacts of demography and people movement

More Buildings
With changes in the demographic structure of societies, the demand for buildings is changing. While some areas may show negative demographic development, other regions show increases. In any case, the demographic distribution as well as the social distribution is changing. These changes usually lead to changing requirements to be met by the buildings, causing the demand for redevelopment, redefinition of functions, replacement, additions or partial deconstruction.
The resulting demand for more buildings can be seen as a problem due to the increasing demand for land, infrastructure, materials and energy needed to plan, construct and operate these buildings.

Different Building uses
Changes in demography and in the people using the buildings naturally lead to (slight) changes in the demand for the buildings themselves as well as for the functions provided. Further aspects leading to the demand for different buildings are changes in what people expect from buildings, especially relating to size and style of apartments and offices for instance. The demand for service buildings, hospitals, schools, supermarkets, etc depends directly on the regional population and their habits. The increasing demand for infrastructure and welfare facilities is linked to the ageing population, and the increase in the comfort requirements of building users in Europeans countries.

Ageing Population
An ageing population has demands that are significantly different from earlier populations. The adaptation to the demands of the elderly, including the functionality, size, and identity of buildings, as well as the possibility to provide the elderly, with their decreasing physical strength, with the services they need to remain "functional" is an essential task. The robustness of buildings to non-professional operation by people with decreasing understanding of technical innovation (easy to operate "smart" buildings), whilst, meanwhile, meeting increasing efficiency demands is another task. In general, cities will need to adapt to the specific demands of the elderly in the built infrastructure, as well as to changes in acceptable walking distances, easy access to public services, changes in the relative density of schools and services for the elderly, etc.

Demand adaptation
Where society and the distribution of "elements of society" change, the demands imposed on the built environment as such, as well as on individual buildings, will change. Buildings need to be adaptable to these changing demands. Currently, local and regional changes in population density and the social mix of people leads to situations where the building stock needs to be rapidly adapted to changing demands. Preparation for continued future adaptation to ongoing changes will reduce future demand for significant re-development, but requires an early anticipation of future developments.

Higher Resource Demand (to build and operate)
The generally increasing economic wealth of people leads to an increasing demand for space and functions provided by individual buildings and the whole building stock. This tendency is not likely to change unless people’s behaviour or the pattern of economic development changes significantly. Buildings providing higher levels of functionality are likely to require more resources, unless a significant increase in efficiency can be achieved.

4.4 The impacts of people’s (non) awareness

Inefficiency
Inefficiency has multiple causes:

(1) products and services used are themselves inefficient
(2) efficient products and services are used in an inefficient way
(3) the full capacity of products and services is not used
(4) products are regarded in terms of status rather than need, leading to superfluous consumption

The awareness of people, including their sensitivity to their own actions and their impact on the local as well as the global environment is a core issue of concern.

High Consumption / Waste
Current trends in consumption and waste disposal patterns lead to an increasing demand for energy and material intensive products and services. This demand in turn gives rise to increased demand in terms of resource extraction, production, process energy, transportation, energy in application and ultimately waste handling and treatment. Recycling strategies are an "end of the pipe" approach aimed at reclaiming and reusing resources, but do not reduce the total volume of material and energy used.

Lack of Know How
Lack of know-how is directly related to the problem of "inefficiency" above. Lack of know-how can lead to misapplication of products, to installation errors and incorrect operation, leading to early replacement, contradictory product applications (e.g. heating and cooling at the same time), inappropriate product application etc.

4.5 The impacts of lack of coordinated policy making, market distortion

Contradictory drivers

Measures applied to support various actions may, at their extremes, act in contradictory ways. Actions that are supported by one policy may be 'punished' by others. Punctual descriptive support actions may disregard the over-all performance and the desire to "collect" support may lead to building designs that are optimized not towards their overall performance, but to taxation, insurance or subsidies.

Drivers pushing in different directions lead to market confusion and distortion, as actors receive different signals about the desired direction of development.

Lack of confidence in the market

Lack of confidence in the market reduces incentives for long-term investment. However, many of the technologies aiming at increased building efficiency and the use of locally available renewable energy rely on a long-term perspective. Changes in the application context, weather technological developments, economic developments or policy development, can be perceived as a problem or risk leading to conservative decisions.

Lack of sustainable technologies

Both incentives and regulation may help the development of sustainable technologies. But, if the decision-makers do not give the necessary impetus and if the market is waiting for a more favourable time, sustainable technologies which encourage people to use new technology, working methods and financial models, will develop too slowly. Specifically, sustainable technologies are not easily accessible due to their price, their scarcity and the shortage of competent people to implement them.

5 What are the strategies and challenges for the construction sector to bring solutions to these macro-problems?

5.1 The solutions for limited resources available and distribution (energy resource, material, labour, skills, water, land, money ...)

Engaged stakeholders

To establish the agenda for sustainable construction in the building and construction sector, it is necessary for all the relevant stakeholders to engage according to their respective capabilities and include sustainability considerations responsibly into their daily work. This includes their own decisions as well as their actions in their dialogues with suppliers and clients. Stakeholders will need to agree on a common understanding of the issues, the needs and the priorities for sustainable construction. The communication of sustainability aspects among relevant stakeholders is essential, both to communicate qualities, to discuss the effectiveness of approaches, as well as to balance diverging yet legitimate interests and to overcome conflicting targets.

The construction sector is made up of a very large number of actors, and so management and organisation is a key aspect of sustainable construction. To introduce a new model of work with fewer or lower barriers, new partnerships between different actors and new responsibilities (at local or national scale), and each stakeholder has to be engaged in a progressive way. It is an opportunity to put a new value on construction jobs, but they will have to deliver technological or process innovations (or both) even if the benefit is not financial or does not flow to them.

Training and education

The challenge of sustainable construction creates a large demand for knowledge intensive services. The integration of specific as well as broad and generic know-how of the problems and the solutions related to sustainable construction into decision making processes is a key concern. Training and education both of professionals and non-professionals aims to prepare actors as well as the public for the future challenge of building stock renovation and the efficient use of buildings and the services they provide. People will need to be trained about new management systems and integrate new knowledge into their everyday business and private decisions. Developing and disseminating knowledge is a key challenge. Today's education system needs to be oriented towards such challenges, e.g.: specialisation for some actors in specific market segments (rehabilitation, refurbishment etc.) should improve the efficiency of multi-skilled teams, whilst designers and construction engineers need an interdisciplinary education to advance together.

User-friendly solutions
Users must be enabled to operate innovative solutions in the intended way, otherwise these solutions will not reach their potential. This in turn may lead to inefficiency, mis-application, or to early failure A building's overall performance is strongly dependant on the users' behaviour. Every user of the building should therefore be enabled to understand the features of a building in order to enable and support the buildings functionality and to support its efficiency. User-friendly, intuitive solutions should be put in place in order to give a sense of responsibility to each user.

Building operation logbook
Complete documentation of buildings is a precondition of understanding the development of performance over time and to enable appropriate corrective or preventive measures. There is a significant risk of losing significant experience and information about a building when ownership or facilities managers change. This relates both to information about the physical properties of a building (built in materials / products / systems) as well as to their condition and performance or operation. A logbook concept that makes information and experience traceable supports efficient building operation as well as prevention of premature failure or the taking of inappropriate decisions or the risk of "surprises" in renovation and dismantling.

Enforcing measures
Whist pro-active approaches by decision takers are a promising and positive-minded route, sustainability aspects need to be addressed by the market in its full breadth. Assuming that not all actors can or are willing to take a pro-active approach, even when sufficient incentives are in place, the combination of incentives to promote pro-active adoption of sustainability along with reasonable enforcing measures will be needed to ensure that all actors move in the desired direction. Enforcing measures however need to be chosen carefully in order not to replace functioning market mechanisms and to promote a sensible holistic benefit rather than immediate 'hot-spot' impulses.

Responsibility
Responsibility is one core element of sustainability. This relates to peoples responsibility for their own actions, towards their own as well as to other peoples and other generations concerns. Sustainability itself must be understood as a shared responsibility, and to reach significant enhancement co-operation towards common targets and partnerships are vital.

Peer pressure
Peer pressure, concurrence and market evolution are key elements of a general improvement.

5.2 The solutions for climate change / environment

The solutions for that item could be divided into two different aspects:

Adaptation to consequences
Buildings have to be designed to be flexible, in order to operate in a wider range of conditions and to increase their resilience against climate actions. The changing conditions could be social, economical or environmental.

Reduce contribution to the problems
Buildings as systems are important actors in the battle to reduce carbon emissions and reduce resource demand. The solutions could be technological innovations (e.g. renewable energy systems, etc), methodologies for analysis and assessment (e.g. Life Cycle Assessment), management concepts and tools. These elements are described on the WP3 document "Report on innovation supporting the vision on sustainable building".

5.3 The solutions for demography and people movement

Solutions to address demographic change and people movement are complex and are long-term actions.

More flexibility to operate under a wider range of functions and requirements
In order to extend the lifetime through which user's requirements are fully met, buildings have to be designed to allow internal flexibility.

Make efficient use of existing buildings and space
To reduce land waste, a new approach to planning the management of land and human settlements has to be created. The objective is to improve the flexibility and adaptability of new buildings and land. Measures have to be adopted in order to counter countryside fragmentation and to fix urban growth boundaries.

High density
To reduce land waste, designers and town planners have to be encouraged to invent more compact, mixed-use neighbourhoods. They must create new urban forms that could curb urban sprawl.

Brownfield sites
To reduce land waste, brownfield sites have to call upon services: consequently, new soil cleaning technologies have to be developed and adopted. Consideration of the compatibility between land use (in terms of type of building for which activity) and levels of pollution is required.

Support development of regional centres
To stop urban sprawl and balance the growth of mega-cities and the drain on the countryside, regional centres have to be identified and strengthened.

Establish efficient infrastructure within and between metropolitan area
To meet the social needs for mobility without encouraging greater car use, infrastructure has to be improved.

5.4 The solutions for people's awareness

Reduce demand to reasonable supply levels
The aim is to reduce or optimize existing equipment and building. After optimization, new technologies could be introduced. In terms of energy, user behaviour has a huge impact especially when efforts have been made to improve thermal building and equipment performance. People have to be urged to defer energy loads such as washing machines, to limit peak consumption. A new tariff structure could be applied; the objective being to establish a rate structure that provides incentives for consumers to save energy.

Rely on secure supply sources
Improved diversification and energy resources; independency at a regional, local or individual level and reliability in energy supply will increase general supply security.

Create multi-functional environment
A multi-functional environment will – for example- help people to know their consumption and react to and change their own behaviour.

Attract people to natural sciences
People may become more sensitive to sustainability by raising awareness of the natural sciences, climate change, resource depletion and life cycle assessment, etc.

Attract investment capital to sustainable built environment
A tax system which takes account of environmental costs may contribute to raising people's awareness.

5.5 The solutions for lack of coordinated policy making, market distortion

Harmonized policies with clear common objectives
In order to improve information exchange (e.g. on toxic and environmental data) and to have more efficient results, the community (at the European and the national scale) has a responsibility to

harmonize their policies.

Identify drivers and blockers
The decision making process requires greater public participation.

Establish long-term incentives for stakeholders to act
The construction industry can transform the demand for sustainable development into an opportunity to create and access new markets for efficiency and performance guarantees.

Enable the market to communicate sustainability performance
Energy performance displays are now rather common. Authorities must engage building owners to communicate about environmental performances and about social and economical aspects.

Push the public sector to act as an example
At a professional level, public owners and designers (architects) are generally more aware than contractors, for example the lean building principle. Public authorities must continue to push the public sector: what is the rule for the public sector becomes a strong driver for the private sector.

6 Expression of the vision

Sustainable constructions adopt different shapes but are the result of the same approach. Designing a sustainable building implies a holistic approach to the whole life cycle (construction, operation and demolition) in order to reduce environmental impacts and resource depletion, without forgetting the objective to fulfil use functions and be consistent with the general principles of sustainability.

From the expression of the macro-problems, we identified the potential impacts onhuman society and more precisely on the construction sector. Then solutions or new challenges for the construction sector were made explicit. The vision of what should be a sustainable smart eco building includes:

New or existing buildings:
The number of new buildings produced during one year represents a small percentage of the building stock. In Europe the figure is 1%, maybe 1,5% in some countries, as a result of new social housing construction. This means that in 2030, the stock will include no more that 20 to 30% of new buildings, while 70 to 80 % will be buildings already existing now, and mainly built from 1950 to date. These figures demonstrate the challenge of making rapid progress in the sector. Thus, the vision must address existing building improvements.

Spatial boundaries:
Because a building is strongly dependant on its surrounding plot, the notion of a sustainable building will take into account the close environment and its connections to the various networks which contribute to the urban mesh. The vision must be global to European countries without erasing specific local variations due to climate, cultural habits, environmental concern, etc.

6.1 "The vision of a Sustainable Smart-eco Building in 2030"

A sustainable, smart eco-building (SSE building) results from the practical application, at all phases of the project of the general principles of sustainability set out in ISO 15392:2008. These are: Continual improvement, Equity, Global thinking and Local action, a Holistic approach, Involvement of interested parties, Long term consideration, Precaution and risk, Responsibility, Transparency. These general principles need to be applied in all decision making (planning, design, construction, operation, renovation, end of life), especially project planning phases, associated with the building life cycle.

An SSE building is a new or a renovated building designed as an answer to the needs expressed by the owner and/or future user, for fulfilling its main use functions[3]. These are to provide space, an indoor climate and safety and security, to allow the use of goods and tools, to control nearby relationships, take advantage of the site without damaging it, and to bring meaning (semiology). An

[3] [CIB W052 "Procurement systems" – 1995].

SSE building contributes to sustainable development when designed and operated to match the appropriate fitness for use, with minimum adverse environmental impacts, while encouraging improvements in economic, social and cultural aspects at local, regional and global levels.

A Smart Sustainable Eco (SSE) Building will:

1. Apply the general principles of sustainability;
2. Result from the involvement of all interested parties and be designed to meet its occupants' needs individually and collectively;
3. Be completely integrated into the relevant local building, town-planning or environmental–planning schemes and infrastructure;
4. Be designed or refurbished from a Life Cycle perspective;
5. Have its environmental impact minimized over the estimated or remaining service life;
6. Deliver economic value over time ;
7. Provide social and cultural value over time and for all;
8. Be healthy, comfortable, safe and accessible for all ;
9. Be designed or refurbished to be user-friendly, simple and cost effective in operation, with measurable technical and environmental performances over time;
10. Be designed or refurbished to be adaptable throughout its service life, with an end-of-life strategy;

According to local conditions (geography, climate, culture, density, etc.), the implementation of the SSE building may show different shapes. The vision must be timeless to ensure that it remains relevant over time and in different European cultures. All these aspects are part of the overall vision. They may be documented with quantified targets only when defined in detail and for individual categories of buildings.

To obtain a Smart Sustainable Eco Building, it may be necessary to aim beyond most current technical regulations. In particular, Smart Sustainable Eco Buildings need to address the following key considerations:

1. **Apply the general principles of sustainability** [ISO 15392:2008]: these are: Continual improvement, Equity, Global thinking and Local action, Holistic approach, Involvement of interested parties, Long-term consideration, Precaution and risk, Responsibility, Transparency.
2. **Result from the involvement of all interested parties and be designed to meet its occupants' needs individually and collectively.** The occupants' needs must be consistent with collective social ones.
3. **Be completely integrated into the relevant local building, town-planning or environmental–planning schemes and infrastructure.** The building must comply with the local laws applicable to it and connect into the existing services, networks and urban or suburban fabric of its environment.
4. **Be designed or refurbished from a Life Cycle perspective**. The life cycle covers planning, design, construction, operation and maintenance, renovation and end of life. Evaluation of performance at each phase includes taking into consideration all the other phases.
5. **Have its environmental impact minimized over the estimated or remaining service life.** This takes into consideration regional and global requirements, resource consumption (energy, material, and water) and waste and emissions (to air, water and soil) reduction.

6. **Deliver economic value over time.** To assess economic value over time requires a life cycle cost approach, taking account of future costs of operation, maintenance, refurbishment and disposal.
7. **Provide social and cultural value over time and for all.** A Smart sustainable Eco-building must provide a sense of place for its occupants (permanent or occasional), and be seen as a mean of work status improvement for the workers. A SSE building should relate to the local environment and wider regional culture. Moreover, a SSE building is one of the key points for the social affordability.
8. **Be healthy, comfortable, safe and accessible for all.** Health criteria include indoor air quality and comfort criteria include acoustic, thermal visual and olfactory comfort. Full access allows every one, to use the facilities of the building. A Smart sustainable Eco-building must allow safe working conditions to the workers during the construction and the service life. "For all" means for permanent and occasional, private and professional occupants.
9. **Be designed to be user-friendly, simple and cost effective in operation, with measurable technical and environmental performances over time.** A manual describing the operation and maintenance of the building must be available for both operators and occupants.
10. **Be designed or refurbished to be adaptable throughout the service life, with an end-of-life strategy.** The building allows adaptation to changing performance and functionality requirements, in accordance with new environmental constraints, and taking into account particular regional requirements.

Requirements, derived from this vision, will illustrate in full detail the meaning of each part of the vision.

7 Requirements

While the vision describes general expectations, the next step is to establish requirements implementing this vision and expressing it more precisely, to meet the demands of sustainable performance.

The vision for 2030 expresses its ambitions through tangible specific requirements and quantifiable targets.

These are no longer requirements in terms of means (e.g. in terms of type of equipment used) or restricted to user's specifications, but are expressed as performance requirements, defined in environmental, economic, social and health and comfort terms. Obviously, a sustainable building is a building whose technical performance must be seen as an answer to a social demand, and to the user needs. The designer's and builders' roles are to suggest technical solutions to meet the programme, but always considering the impacts of the technical choices on the three aspects of sustainability: environmental, economic and social/cultural. They are free to design the building and to choose equipment (consistent with the social demand) provided that the performance goals are reached. The expected performance must be measured or calculated at the final handing over or during its exploitation, according to indicators or characteristics at the building level. These requirements should form the skeleton of the project requirements, or brief.

These requirements are the practical and detailed expression of the vision and demonstrate the actual and futures challenges for the construction sector. These are described in the extended Vision document. The purpose of this document is not to quantify the expected performance: consequently, the requirements are expressed as single sentences. A sustainable building is the one for which the relevant questions addressing all the stages of its life cycle have been raised at the initial stage by the owner, and answered through the technical and process choices described in the brief.

The following pages present tables setting out the requirements derived from the vision, classified by:

- topics of requirements
- preoccupations/concerns

7.1 From the vision to the requirements

The ten point of the Vision covers different aspects that we can distinct with a little part of arbitrary on four topics of requirements: environmental, social, economical and heath and comfort aspects. In fact, to follow one specification of the vision, many requirements need to be expressed and reached. The following table express relations between the vision and the four topics of requirements.

	Vision	Topics of requirments	Thematic
1	Apply the general principles of sustainability;		
2	Result from the involvement of all interested parties and be designed to meet its occupants' needs individually and collectively;	Social attractiveness, User throughout satisfaction	Social
3	Be completely integrated into the relevant local building, town-planning or environmental-planning schemes and infrastructure;	Resources, User throughout satisfaction	Environment, Social
4	Be designed or refurbished from a Life Cycle perspective;	Life cycle approach, Cost performance and economic assessment, User throughout satisfaction, Climatic change	Environment, Economic, Social
5	Have its environmental impact minimized over the estimated or remaining service life;	Life cycle approach, Resources, Air, Climatic change, Water & soil, Waste	Environment
6	Deliver economic value over time ;	Cost performance and economic assessment, Economic attractiveness	Economic
7	Provide social and cultural value over time and for all;	Full access, Social attractiveness, User throughout satisfaction, Social accessibility	Social
8	Be healthy, comfortable, safe and accessible for all ;	Indoor Air Quality, Acoustic comfort, Thermal comfort, Olfactory comfort, Visual comfort, Internal comfort, Water quality, Social attractiveness, Full access	Health & Comfort
9	Be designed or refurbished to be user-friendly, simple and cost effective in operation, with measurable technical and environmental performances over time;	Economic attractiveness, User throughout satisfaction	Economic, Social
10	Be designed or refurbished to be adaptable throughout its service life, with an end-of-life strategy;	Cost performance and economic assessment, Economic attractiveness, User throughout satisfaction	Economic, Social

7.2 Environmental requirements

Requirement general Topics	Preoccupations		Requirements
Life cycle approach			Indicators applied to measure performance must reppresent full life cycle
Ressources	Consumption of energy resources	energy	Reduce energy consumption
		except energy	Reduce material consumption
	Land use		Reduce land use. Is integrated into town planning
	Water consuption	drinking water	Reduce water consumption
		non drinking water	
	Biodiversity	gene biodiversity conservation	Reduce impact on biodiversity
		Species conservation	
		Ecosystem conservation	
Air	Atmospheric acidification		Reduce contribution to air pollution
	Formation of photochemical ozone		
	Air pollution		
Climatic change	Climatic Change		Reduce contribution to climatic change
	Adaptation to climate change		Adapt to environmental changes
Water & Soil	Soil & Water pollution	Eco-toxicity terrestrial	Reduce impact on biodiversity
		Eco-toxicité aquatic	
		Eutrophication	
Waste	Eliminated solid waste	Non hazardous	Reduce waste production
		hazardous	
		radioactive waste	
		inert waste	

An SSE Building is not only designed to meet the initial requirements on completion, but to be designed or refurbished from a Life Cycle perspective. The life cycle covers planning, design, construction, operation and maintenance, renovation and end of life. Evaluation of performance at each phase includes taking into consideration all the other phases.

An SSE building has not only an energy focus on efficient systems or carbon emission reduction, but it has all its environmental impacts minimized over the estimated or remaining service life and takes a major role in the reduction of carbon emissions. This takes into consideration regional and global requirements, resource consumption (energy, material, and water) and waste and emissions (to air, water and soil) reduction. The ultimate vision requirement for an SSE building is the combination of: zero energy, zero net resource use and zero impact.

7.3 Requirements for the economy

General topic of requirement	Preoccupation	Requirements derived from the vision
Cost performance and economic assessment	Life cycle cost performance	Be economically efficient before the use stage
		Be economically efficient in the use stage
		Be economically efficient in the end of life stage
Economic attractiveness	Adaptability	Be adapt to change in use
		Be adapte to change in fuctions
		Be adapte to new legislation
	Efficient support for activity	Be functionnal

An SSE Building not only provides a good profit margin to the investor but also delivers economic value over time. To assess economic value over time requires a life cycle cost approach, taking account of future costs of operation, maintenance, refurbishment and disposal.

An SSE building is economically efficient before the use stage. This means that the analysis must include the cost of the land on which the building stands, the costs of products incorporated into it the costs of construction -excluding products- and the costs of professional fees and other payments associated with the building during the before use phase.

But an SSE building is also economically efficient in the use stage. This efficiency covers the costs of operation and maintenance, operational energy and water use, refurbishment, rent, taxes, regulatory costs, incomes, grants and other liabilities

An SSE building is economically efficient in the end of life stage. The end of life cost is associated with the removal of the building and clearance of the site ready for further use

An SSE building is adapted to change in use. The design, the structure of the building, the HVAC design, the location of structural elements, of building systems, of fire separations, are designed with the consideration of future possible changes. Moreover it is possible to change the energy/heat supply and to upgrade the building automation/management system.

7.4 Social requirements

General topic of requirement	Preoccupation	Requirements
Full access	Disabled friendly living space	Allow flexible usages for every one (physical, mental or sensorial handicap)
	Age-based living space	Be adaptable of the living space
Social attractiveness	Life quality (comfort & security)	Be connected to the urban mesh. Integrated, multimodal transport plan. Optimise people flow and crowd circulation.
		Have a visual quality
		Be adaptable of the cultural background (Religion, social environment)
		Have a cultural value: Respect of cultural heritage and indentification
		Allows access to knowledge, culture, etc. Allows access to leisures and sportive activities
	Safety, Security & Privacy	Allows inhabitant to have the feeling to be safe (use fonction)
		Avoid danger for users (domestic danger : sliding, etc.)and workers (safe working conditions).
		Occupants are free to manage their relations with the neighbourhood
Users satisfaction	Satisfaction of the user	Adapted to the present and futures owners requirements
		Be user-friendly
		Have a cultural value: Patrimonial approach
	Satisfaction of the local residents	Local residents are satisfatied with the building presence. Loadings on and benefits for neighbourhood.
		Promote governance : communication and participation.
Social accessibility	Social accessibility	Have a responsability in the social mixity plan. Promote solidarity and integration.
		Inhabitant can afford to pay the services charges

An SSE Building is not so sophisticated that nobody is able to use it properly and its performance cannot therefore be achieved, but be designed to be user-friendly, simple and cost effective in operation, with measurable technical and environmental performances over time. A manual describing the operation and maintenance of the building must be available for both operators and occupants

7.5 Requirements about health and comfort

General topic of requirement	Preoccupation		Requirements derived from the vision
Indoor Air Quality	General interior air quality		Be healthy for its occupants. Minimise indoor air polluants. Reduce equipement and material contribution to interior air pollution. Control fresh air renewal. Minimise radiative pollution
	VOC & Formaldehyde		
	Fungi & bacterial growth		
	Radioactive emissions		
	Fibres & particules Emissions from		
	Presence of allergenic matters		
Acoustic comfort	Noise from outside		Be comfortable for its occupants. Reduce nuisances and elimination of unwanted frequencies. Minimise noise pollution and vibration. Noise from equipment, neighbourough and facilities.
	Noise within the building		
	Acoustic quality of room		
Thermal comfort	Ambient temperature		Be comfortable for its occupants. Reduce thermal deperditions.
	Use of Inertia		
	Level of humidity		
	Air movment		
Olfactory comfort	Odour nuisance from the neighbourhood		Be comfortable for its occupants. clean compartment air
	Materials odours		
Visual comfort	User comfort	Natural luminosity on the building	Be comfortable for its occupants. Reduce incomfort layout, dazzle, dark room, etc. Optimise daylight usage.
		Artificial light	
	Neighbourough comfort		
Internal comfort	Dust	anti-static properties of the materials used	Minimize allergenic potential
		anti-static environment created by the facilities	
	Magnetic field		Have limited magnetic field inside
Water quality	general water quality in internal water supply		Have safe water supply

8 Conclusions

It is easy to expect the vision of the sustainable smart-eco building to be iconic, futuristic and technically advanced. In practice, sustainable smart-eco buildings will be diverse and varied: some of them will look very similar to buildings we are familiar with today.

Our work with stakeholders has set out a consensus vision of the key principles that determine whether our buildings are sustainable, smart, and ecological:

They will follow the agreed standards for sustainable building, based on the work of ISO TC59 and CEN TC350.

They will be low or zero energy, low or zero environmental impact and resource use, and they will be built so as to deliver the desired performance over their whole life cycle.

They will be healthy, comfortable, safe accessible, user friendly, and have social and cultural value in their own right, and within the local area.

They will be adaptable, readily refurbished, and can be demolished and reused at the end of their life.

None of these conclusions alone is particularly striking, novel, or innovative. But there is a huge challenge facing the construction sector within Europe, which is to deliver buildings that achieve all of these objectives, routinely, so that the smart-eco building is considered the norm, whatever its form.

Achieving this vision undoubtedly requires more specific and ambitious targets, and not just for "zero carbon". But the targets must be dynamic, and evolve as construction evolves towards a more sustainable market sector. And the targets must not be technologically focussed, but must focus on outcomes. This will require innovations in people, in processes and in products, as we move towards truly sustainable, smart-eco buildings in the future.

Achieving this vision requires technical innovation. But it requires fundamental innovation in the way we design, deliver and operate our buildings. And above all, it requires innovation in the way the construction sector itself operates, so that the sector is focussed on working together to deliver buildings like this. Those who know the sector well know that this is in reality a hugely challenging vision, demanding leadership at the highest levels of industry and society if it is to be delivered.