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WORKING GROUP SUSTAINABLE CONSTRUCTION METHODS & TECHNIQUES

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0. CHAPTER 0 - EXECUTIVE SUMMARY

The Directorate-General Environment of the European Commission is responsible for drafting the **Urban Thematic Strategy** of the European Commission's 6th Environment Action Programme. In order to offer advice to the Commission, the EU Expert Group on the Urban Environment established four working groups, including the working group **SUSTAINABLE CONSTRUCTION METHODS AND TECHNIQUES.** This is chaired by Livia Tirone and co-ordinated by the Architects' Council of Europe.

This working group is due to submit the final report by 16th January 2004, which will cover the following questions relating to Sustainable Construction:

- What is the state of the art of more sustainable construction in Europe?
- What barriers are preventing the mainstreaming of pockets of good practice?
- What are the recommendations (policies and tools) to overcome these barriers?
- What kind of quantitative and qualitative targets can be proposed?

The aim of the working group is to define a clear set of priority actions in every relevant area of construction, in order to make the use and application of sustainable methods and techniques in construction common practice across Europe.

0.1 On the State of the Art:

Sustainable construction has come a long way in recent years and there is no question as to the success of the best practice examples of sustainable construction that have become part of our European built environment.

In many European cities sustainable construction is gaining visibility. Nonetheless, the political message does not yet point the market clearly towards a more sustainable construction, as it is generally neither coherent nor clear[1].

Factors that constrain the use and application of sustainable methods and techniques in construction are:

- Economic constraints - whether perceived or actual, there is a limit as to how far one can go as the law of diminishing returns comes into play;
- Best available techniques are constrained by available technologies and products offered by manufacturers as well as by the process of integrating them into the design. This is particularly relevant in the context of energy use and conservation. Burning hydrocarbons remains the predominant source of heating and cooling that most buildings rely on. Although technologies for renewable energies and their integration in the building envelope and architecture exist, they are not always readily or economically available;

[1] Example of the message neither being clear nor coherent: In some EU Member States the VAT tax on electricity is lower than the VAT tax on insulation materials;

- There are gaps in research, which need to be identified and communicated to the European Commission;
- Major non-technical barriers stand in the way of mainstreaming the introduction of more sustainable construction.

The working group concluded that there are relevant positive aspects that characterise the state of the art:

- The dissemination efforts in respect of sustainable construction have resulted in relevant applications;
- A considerable amount of quality literature is available on the subject of sustainable construction;
- The relevance of the construction sector in the context of sustainable development has been understood;
- There is widespread popular support for the idea of promoting sustainability;
- A trend towards integrated solutions seems to be in motion;
- Cultural heritage has been acknowledged as a determining factor (already in FP5) in enhancing the quality of life of people.

Since there is no doubt that methods and techniques are available to move towards more sustainable construction, persuading the relevant actors in the construction sector to implement them in their day-to-day practice, may rely predominantly on how they are trained and on how effectively they can be motivated to take on the liability / risk associated with change.

0.2 On Recommendations Listed in Order of Priority

The Urban Thematic Strategy addresses the various sectors of governance in Europe in an attempt to increase the effectiveness of the resulting legislation and its impact in the day-to-day life of citizens. This integrated approach reflects vision on the part of the EC and constitutes an opportunity, which this WG welcomed and embraced.

The present report attempts to reflect the reality of the construction sector, in as much as it covers a very large spectrum of stakeholders / actors and that it has such a persuasive impact on our society. The far-reaching dimension of the construction sector is apparent in Annex 1, where barriers and recommendations are listed per actor.

Rather than a finite goal, the present report looks at sustainable construction as a continuously redefined direction, which needs to be aimed for with an integrated approach. Further the report builds on the fact that mainstreaming sustainable construction cannot be based on individual practices and good examples. It will require a clear and coherent top-down message (expressed in a set of EU common goals) and it will also require a multitude of committed bottom-up actions. It has become clear that achieving the mainstreaming of more sustainable construction relies on a significant effort on behalf of some of the main stakeholders / actors in the construction sector.

Although individual good examples are clearly not the solution, it is very important that MS express a clear top-down message. Therefore, the Resolution on Architectural Quality in the Urban and Rural Environments

adopted on 12 February 2001 (OJEC, 2001/C73/04), the Council of the European Union, is encouraging the MS to promote architectural quality by means of exemplary public building policies. Furthermore, the resolution has called on the Commission to ensure that architectural quality is taken into consideration in all its policies, measures and programmes, e.g. in relation to the implementation of the Structural Funds.

A summary of the most relevant recommendations included in this report and its Annex 1:

- The top-down political message has to come across to the market as clearly and coherently as possible – therefore:
  - Public bodies must support the MS to comply with their share of the responsibility of the Kyoto Protocol commitment.
  - All public money will therefore be spent on projects that respect the quantified (measurable) requirements of more sustainable construction to fulfil objective targets. Funds and subsidies will set requirements in line with more sustainable construction. Publicly owned buildings and public procurement should set an example in terms of calling for more sustainable construction expressed in objective targets. Further it is relevant that targets for “Environmental Performance Indicators” are displayed in new buildings open to the public.
  - The Commission should be encouraged to proceed with a standardisation mandate addressed to CEN for the “Development of Horizontal Standardised Methods for the Assessment of the Integrated Environmental Performance of Buildings”. In addition to establishing an assessment method for the construction and operation of complete buildings, the draft mandate for this proposed European standard also provides for the introduction of a voluntary system of “Environmental Product Declarations” (EPD). Develop a common European recognised methodology for the estimation of life cycle costs of built facilities. It is suggested that the existing ISO standards could form the basis of such a methodology and should include a system for estimating LCC indicators.
  - More sustainable construction does have a positive impact on the environment, but this added value can have an extra cost that the market is not yet willing to pay for. Taxes and all other regulatory mechanisms at global, regional and local political levels need to be adapted (transformed into incentives) and used to help motivate the stakeholders / actors in contributing to achieve more sustainable construction. Contributing to reduce the extra cost of sustainable measures and to encourage the necessary research and development;
  - Urban planning instruments must make room for more sustainable construction, encourage it and even make it a condition for the award of construction permits;
  - Monitoring (post occupancy evaluation) of built environments that comply with the quantified (measurable) requirements of more sustainable construction should be ongoing, namely in the context of the Directive for buildings energy efficiency certification, addressed below. The results of the monitoring process should be communicated to all relevant actors, establishing and maintaining a European database on building performance, divided up by reason as between design, construction, products, misuse, etc.

- Education and awareness raising campaigns must prepare all relevant actors for the necessary changes required to achieve a more sustainable built environment, including the encouragement towards a more efficient use of the built environment.

- Bottom-up market initiatives in favour of sustainable construction need to be just as committed to achieving the mainstreaming of more sustainable construction and must be accommodated and encouraged by local urban management – therefore:
  - Many of the qualities intrinsic to more sustainable construction can have direct cost reduction implications for the end-user as well as health enhancing positive implications. Raising the awareness of the end-user to the choices he / she has, includes the marketing / campaigning of relevant environmental information on: energy consumption in buildings (energy certification of buildings), on toxic emissions of materials and ventilation systems, impact on indoor air quality (could be included in the building certification if the scope of the 'passport'[2] can be widened), on waste separation and disposal, reduction of water consumption etc;
  - The use of resources (specifically waste disposal, energy and water supply) should become more sustainable by encouraging the implementation of utility run decentralised systems: for the recycling of grey water, for decentralised energy production, for decentralised waste collection;
  - Encouraging a shift in attitudes by all stakeholders / actors in the construction sector, in terms of education and continuous training which is an indirect but nonetheless relevant area of action;
  - Develop and make generally accessible tool kits and guidelines for architects, engineers and others actors involved in design activities that will assist them in developing more sustainable buildings with fewer design failures;
- In order to make more sustainable construction possible and feasible, having already determined that sustainability is evolutionary rather then an absolute goal, the direction which this evolution takes needs to be clearly identified, so that, starting with existing efforts of good practice, further efforts can be focussed efficiently and results can be attained in the short term – therefore:
  - It is important to define the holistic, environmental, common EU indicators and the respective quantified objectives (targets) within each indicator adapted to each MS, together with an adequate common EU assessment method, using a common language between all stakeholders in the construction sector;
  - There is a need to integrate principles of sustainability into the practice of design, construction, maintenance and management of buildings; Parameters that matter the most need to be identified in a language that is consistent with the issues typically addressed in the construction sector. As methodology:

[2] The building passport is an extension of the energy certification of buildings as introduced by the EU Directive on the Energy Performance of Buildings published on 4th January 2003, to incorporate beyond energy, other building performance parameters, such as indoor air quality (materials' and systems' emissions), comfort (thermal, visual and acoustic).

1. Identify what can be kept from current common practice integrating cultural and regional (climate) values (as valid for new buildings as it is obviously for retrofitting);
2. Identify what needs to be changed, new techniques and processes;
3. The resulting product must be assessed starting from the design phase in an integrated manner from the point of view of the fulfilment of the requirements and the environmental impact at all levels from the local, to the regional, to the global;

- Certification of construction must be “performance based” rather than “prescriptive”, in order to challenge the design team to find creative and diverse solutions leaving them the relevant flexibility to be inventive;
- Sustainable construction should be implemented through integrated approaches, and optimised solutions within the domain of each actor in the construction sector.

0.3 On Examples of Targets

There is a consensus among the experts of the Thematic Strategy Working Groups on Sustainable Urban Design and on Sustainable Construction Methods and Techniques that the following less quantifiable quality objectives will contribute to making the built environment more sustainable and should be included in the list of recommended urban design targets. As objectives these should be defined at local level as they are very culture-specific:

- Intensify the identity and character of the built environment as it stimulates the user’s sense of belonging and care;
- Introduce diversity and variety of texture, colour, form, typology, use and property;
- Introduce flexibility to cater for unknown future needs;
- Increase the life span of buildings and public spaces;
- Optimise orientation of buildings to benefit from climate conditions;
- Increase the attractiveness of the built environment;
- Guarantee accessibility[3] to all.
- Respond to demographic pressures by making settlements more compact, rather than turning to urban sprawl. Focus on retrofitting, refurbishment and renovation and use brown field as opposed to green field sites for new construction, as the latter is a valuable natural resource.

There is consensus among the experts of the Thematic Strategy Working Groups on Sustainable Urban Design and on Sustainable Construction Methods and Techniques on the following more quantifiable quality objectives that contribute to making construction more sustainable. These quality objectives have an impact on the user’s sense of well-being, increased productivity and reduced absenteeism. As objectives these

[3] "Accessibility" means providing buildings and places which are designed and managed to be safe, healthy, convenient and enjoyable to use by all members of society. It implies that buildings should be accessible for all (for instance with level or ramped entrance), that they should be really "usable" from ground floor to the top, and that adequate means of autonomous exit (for instance, a lift providing evacuation in the event of fire) should be provided.

should be defined at the European institutions level and adapted to each member state's reality in terms of climate, for example:

- Improve indoor and outdoor air quality;
- Improve indoor and outdoor comfort conditions (thermal, acoustic and visual);
- Improve the energy efficiency of buildings by implementing appropriate construction methods and techniques (passive solar design) internalising the best of the local climate conditions;
- Reduce CO_2 emissions per capita and per sector;
- Integrate renewable energy systems (active solar and wind) and energy management systems for permanent monitoring;
- Specify systems to maximise efficiency in operation, making room for flexible performance (foresee changes in uses);
- Reduce waste and facilitate waste separation;
- Reduce water demand and implement grey water recycling systems at the local level;
- Reduce running and maintenance costs;
- If no alternative or feasible choice, use non-renewable resources rationally (materials, energy), taking into consideration the life cycle of materials and their re-use and recycling potential (up stream and down stream);
- Minimise impact on bio-diversity.

These objectives all aim to support and consolidate sustainable communities, offering the highest possible quality of life to the users.

Conclusion:

There are relevant examples of sustainable construction all over the EU, but it is far from being a "stream" and much less a "mainstream".

There is no unique / single realistic recommendation to mainstream more sustainable construction. Although the scope and intensity of the barriers is as far-reaching as the impact of the construction sector on our society, they can be collectively and individually addressed and overcome. Annex 1 breaks down each barrier per actor in the construction sector and points out recommendations to overcome these barriers. It is nonetheless clear that mainstreaming more sustainable construction relies on the dynamic inputs of each individual actor in the construction sector and of the construction sector as a whole.

If the road towards more sustainable construction is about offering the capacity for choice then, in order to have sustainable construction chosen as the alternative for tomorrow, it has to be promoted today as a viable alternative for the future.

Similarly, as important as it remains to intervene in already badly performing built environments, it is even more important to focus on prevention. If present and future construction can be more sustainable, then the resources invested in correcting previous mistakes can be saved.

1. CHAPTER 1 – INTRODUCTION AND BACKGROUND

Since the first oil shock of 1973, Europe has become conscious of its strong dependency on non-renewable fossil fuels. With the Brundtland Report[4] a new dimension of human activities on this planet was disclosed – that of their local and global environmental impact on the planet and therefore a new responsibility was articulated: protection of the heritage of future generations'. This is how the notion of sustainability was born.

This new dimension was consolidated and expanded with the Rio de Janeiro conference in 1992[5], which launched Agenda 21[6] and the Kyoto Protocol in 1997. The latter set clear targets that were transformed into the "burden sharing agreement" for the reduction of greenhouse gas[7] emissions in the EU member states. Although the Kyoto Protocol is a global / world initiative, Europe is trying to set a good example with a commitment to a 8% reduction in CO_2 emissions in relation to 1990 levels within the agreement period 2010-2012.

The effective and real goals required in order to comply with the Kyoto Protocol commitment imply an 80% CO_2 emission reduction in Western countries. The sustainable CO_2 emission rate is estimated to be about 2.72 to 3.3 tons per person per year.[8]

The European Climate Change Programme started the policy process, obliging each member state to put a National Climate Change Programme in place, in order to achieve the commitments to the Kyoto Protocol. Other policies have followed, encouraging energy efficiency in the building and transport sectors as well as promoting the use of renewable energies.

There have been other key events and there is a number of other key multi-lateral Environmental Agreements of direct relevance such as, for example the UN Millennium Development Goals, the United Nations Conference on Human Settlements – Habitat Agenda and, most recently, the World Summit on Sustainable Development (whereby the Plan of Implementation makes direct reference to construction).

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[4] The World Commission on Environment and Development report 'Our Common Future' presented to the UN General Assembly in 1987;

[5] The United Nations Conference on Environment and Development (UNCED) held in Rio in 1992;

[6] The framework action plan for sustainable development - Local Agenda 21 grew out of Agenda 21, Chapter 28;

[7] Most notably carbon dioxide (CO2);

8 At the 1990 level of the world population. Thus, as world population increases, the sustainable CO2 emission rate necessary falls. Source: John Byrne, Equity and Sustainability in the Greenhouse. Reclaiming our Atmospheric Commons. 1997

1.1 Key Issues:

The context, as we know it in the EU, can be characterised in the following way:

- In the EU, 80% of the population lives in cities - ensuring a well-functioning built environment is therefore very important;
- In the EU, people spend almost 90% of their time in buildings - ensuring healthy indoor environment conditions is therefore very important[9];
- In the countries of the Organisation for Economic Co-operation and Development (OECD), 40% of the energy that is produced is consumed in operating buildings. This is just the energy used by a completed building (heating, lighting, running lifts etc), and does neither take into account construction activities, nor the manufacture and transport of building materials, which represents another 10%[10];
- Buildings are responsible for a considerable amount of the world's waste production, although most of this waste is inert and increasingly re-used and recycled;
- The construction sector accounts for approximately 50% by weight of all material taken from the Earth's crust, and in a few instances natural, non-renewable resources are being depleted beyond sustainable levels[11]; It is not the case in non-metallic minerals, which are classified as "non-renewable" but as "non-extinguishable', as they are recoverable[12];
- The built environment represents a substantial and relatively stable environmental resource. Most buildings survive for several decades, and very many survive for centuries. As the community's principal physical asset, getting good value requires that the building's full life cycle be considered, avoiding short-sighted attempts to merely minimise initial cost. A strategy on sustainable development will seek to prolong the life of existing structures, and indeed to prolong the utilisation of the materials with which they were originally constructed. Adaptation is usually preferable to new building, and upgrading of performance often represents an efficient deployment of resources;
- The initial construction cost of buildings is equivalent to the average buildings' running cost for between 7 to 20 years; Since the lifetime of buildings can average 100 years, buildings can cost up to ten times more to run during their life time, in comparison with their initial construction cost.

These simple facts underline the responsibility of the EU in the process of mainstreaming more sustainable construction, and setting an example for other nations.

This WG's task is to establish how the introduction, promotion and implementation of more sustainable construction methods and techniques can become part of the 'business as usual' scenario of all the relevant actors, within the framework of EU and national legislation in the context of present and future market circumstances.

[9] Source: OECD, Environmentally Sustainable Buildings: Challenges and Policies, 2003;

[10] Source: OECD, Environmentally Sustainable Buildings: Challenges and Policies, 2003;

[11] Source for Germany: World Resources Institute, 1997;

[12] Source: DG Environment in its background document "Towards a European Strategy for the Sustainable Use of Natural Resources" 10 April 2002;

The aim is to increase sustainability across the whole construction sector, implementing on-going improvement in terms of their accessibility to all, their promotion of indoor and outdoor health and comfort, their protection of the environment by performing efficiently and their rational use of natural non-renewable resources.

1.2 Vision

Whether to mark our territory, as shelter from the elements or to celebrate our achievements and beliefs, construction has been one of the oldest expressions of human intervention on the planet, and not always on friendly terms with the environment. Today's challenge lies in including construction into the integrated cycle of the environment, while achieving attained levels of quality of life (comfort) social, economical and cultural values and thus protecting the heritage of future generations.

Without claiming to be an absolute truth, rather a direction or evolution, more sustainable construction aims to respond to this challenge, by introducing, in a holistic manner the dimension of buildings' environmental performance into the whole cycle of construction – from inception to construction, demolition and re-use.

Therefore, in order to create the context for sustainable construction to evolve into a "mainstream consideration", a new set of holistic, integrated and far-reaching values and criteria have to be assimilated covering health, comfort, energy, materials and ultimately creating a new culture among all the actors of the construction sector.

There is a need for a common set of indicators, goals, evaluation criteria and assessment methods in the EU, in order to make the top-down political message clear and coherent and this will be the first step to help motivate the relevant actors to move in the right direction.

If the European institutions, member states, local authorities and other public bodies intend to mainstream sustainable construction, then public procurement needs to set an example for the sector to follow at the rhythm necessary for it to act as an instrument to ensure the widespread adoption and implementation of sustainable construction methods and techniques.

2. CHAPTER 2 – STATE OF THE ART

What is the state of the art of sustainable construction in Europe today?

Increasing sustainability in construction is a trend that is here to stay.

There are pockets of good practice across Europe demonstrating that more sustainable construction is a viable proposition. Nonetheless and solely on the basis of their own merits, these pockets of good practice have not succeeded to motivate the mainstreaming of more sustainable construction.

2.1 Key Issues:

The state of the art, as we know it in the EU, can be characterised in the following way:

- There are successful examples of more sustainable construction in most EU member states, largely more prominent in the new buildings sector[13] than in the refurbishment sector, in which, due to the longevity of buildings, more focus is needed in order to have a shorter term and wider impact in the built environment;
- As much as 50% of construction activity in many member states consists of refurbishment activities and this segment continues to grow;
- With the best available and proven technologies, methods and techniques it is possible to refurbish, design and construct or refurbish buildings to make them more sustainable, although there is not one single, universal recipe for achieving more sustainable construction, as these techniques are related to, and influenced by use, culture, climate and available resources;
- Information on the positive potential of sustainable architecture is not generally and widely available and professional education and training do not provide students with a profound understanding of sustainability in construction nor always integrate the tools that are relevant to promote more sustainable construction;
- Sustainability in buildings is measured through performance that is associated with a set of quantifiable targets for sustainability indicators;
- Many of the parameters for assessing sustainability are adequately quantifiable: indoor thermal comfort, indoor air quality, energy consumption and resulting CO_2 emissions, water consumption, materials in terms of their whole life cycle, environmental foot-print and toxicity, rational use of resources;
- But other performance parameters and qualities in making construction more sustainable, which are also of critical importance to the quality of life of people, are not so easy to quantify: cultural expression and cultural identity, integration into the existing urban and natural context, attractiveness, are all factors which can motivate people to care for their built environment and further: diversity of volume, colour, texture, typology and property, flexibility to adapt to unknown future needs;
- Making construction more sustainable as a performance based concept, is free of any architectural style. This is as much a responsibility during the creative process as it is a freedom of expression;
- Many of the performance parameters addressed above are determined by decisions at the urban policy and urban planning level, therefore requiring an holistic and integrated up and down stream approach.

[13] Representing annually between 0,5% and 2,0% of the total building stock;

2.2 Context

The concept of sustainable development is becoming a priority in local agenda across the EU and the scope is becoming wider. Nonetheless the application of this concept has not yet overcome the initial inertia. One particular reason for this is that there are many dimensions to sustainable development, including the environmental, technical, economic, social and cultural, all of which are mostly local aspects. These and other considerations must be taken into account in any attempt to move closer to sustainability and this requires an integrated approach based on practical knowledge of the development process, its implementation and its impact in all areas of human concern. Application of sustainable methods and techniques in construction faces further challenges related to the diversity of this area of activity which is involved in the creation, management, maintenance and renewal of the built environment. There are many different components of the built environment including residential buildings (houses, apartments, etc.) and non-residential buildings (offices, factories, shops, schools, hospitals, etc.), and all their associated infrastructure such as transport facilities (roads, railways, canals, airports, etc.) and utility networks (electricity, natural gas and district heating grids, water supply, treatment and disposal systems, etc.). In terms of environmental sustainability, the function of the built environment is to provide appropriate, efficient and pleasant communities in which humans can live, work and socialise whilst avoiding irreparable damage to the natural and built environment which supports all life and belongs to future generations. Adaptation to local aspects such as climate, culture, policies and priorities is therefore essential for successful implementation. Hence, sustainability in construction is a process that embraces qualitative as well as quantitative issues and human satisfaction as well as environmental protection.

2.3 Research

There has been extensive research into sustainable construction methods and techniques for new buildings, especially residential property, schools, offices and public buildings. As regards new buildings, many of the major issues of sustainability have been examined, particularly the enhancement of comfort for occupants (good thermal, visual and air quality conditions for the internal environment), energy saving design (insulation improvements, addition of thermal mass, passive and active solar energy systems), water collection, re-use and on-site treatment, and selection of low-environmental impact materials. In terms of infrastructure, most attention seems to have been paid to the design and implementation of sustainable urban drainage systems. In contrast, only sporadic research efforts appear to have been undertaken on specific topics related to transport infrastructure (such as recycling of road materials) and utility networks (such as integration of planning and construction).

Considerably less research has been directed at sustainable construction methods and techniques for retrofitting, refurbishment and renovation. This is an important concern since, in most areas of the EU, the annual rate of new building activity represents a rate of replacement or net increase of between 0.5% and 2.0% of the total building stock. Consequently, if reliance is placed only on new buildings at these rates to improve the sustainability of the built environment, then it will take many decades or even centuries to have a significant impact. The limited research that has been conducted on retrofitting, refurbishment and

renovation appears to concern mainly residential and office property. Much less research has been performed on the remainder of the non-residential building stock which includes diverse yet important building types such as factories, shops, schools, hospitals, etc. Independently of new or retrofit activities, further research into building functions, construction systems and materials is also relevant.

Diversity within the built environment is a challenge for research on sustainable construction methods and techniques. The nature and implications of this inherent diversity does not seem to be widely understood and appreciated. One particular reason for this is that essential information on the composition of the total building stock, and its consumption of energy and water varies greatly between different EU member states. Such information is important because it is needed in order to devise and target relevant sustainable construction methods and techniques for particular types of building. The diversity of the building stock is a significant consideration as it leads to large differences in energy and water consumption within and between different building types. Similarly, information on the performance of the construction sector, in terms of energy consumption, materials usage and waste generation, is collected on an inconsistent basis across the EU. Some member states have quite detailed information which is updated regularly, whilst others have little or no information and monitoring.

A significant amount of research has been performed on the development of design principles to make construction more sustainable. However, such design principles chiefly concentrate on new residential buildings so that there is much less coverage of new non-residential buildings, retrofitting, refurbishment and renovation for all buildings, and the construction and maintenance of infrastructure. Apart from the basic diversity of the built environment, there are a number of important reasons for the lack of widespread and practical design principles. In particular, the process of designing for sustainability requires effective integration between many different actors including architects, engineers, builders, clients, promoters, financiers, owners and occupiers. Only limited research appears to have been conducted on such integration. Additionally, there can be no universal approach to design for more sustainable construction since essential local factors, such as climate, culture, resources, regulations, laws, markets, finance, etc., must be taken into account. Furthermore, design for sustainability in retrofitting, refurbishment and renovation is intrinsically more difficult than for new build due to the building-specific nature (location, orientation, nature of the existing building etc.) of such activities.

Considerable research effort is required to provide suitable design tools and skills, which can be used with confidence and ease by the whole design team over the wide range of possibilities available to raise the level of sustainability in construction. Such tools and skills must be reinforced by robust and acceptable integrated methods for predicting, evaluating and monitoring performance in more sustainable solutions. Although notable progress has been made with a number of these methods, their application is constrained by various considerations including their relevance to specific types of building and countries. However, the fundamental challenge for all methods is the lack of clear definition and interpretation of sustainability. Most practical research in this area addresses this problem by concentrating on apparently agreed major issues, such as natural resource depletion, global climate change, etc. As such, there is recognition that, due to the

complexity of the topic, the best outcomes, which can currently be achieved, are measures of comparative sustainability. Whilst this may not be ideal, it represents a balance between progress and practicality.
There is debate as to which issues to address at the building level and which issues to address further up in the supply chain, for example product declarations at the level of the building component and material manufacturers. The debate is raised due to the need to keep decision makers with a clear overview of the assessment methods used during the design process.

Prominent amongst the techniques, which can support the promotion of increasingly sustainable construction is life cycle assessment (LCA)[14]. This technique is founded on a background of general research, which has been conducted over a number of years.

This has resulted in the publication and dissemination of the International Standard EN ISO 14040 Series on life cycle assessment, which has enabled its application to become more routine so that both practitioners and their clients are using it with relative confidence. Additionally, a collection of software tools has been produced for practitioners and these tools often contain important databases. The availability of relevant and reliable data is essential to the application of life cycle assessment and for client confidence in results. Unfortunately, such databases are still limited due to the extensive range of materials, products and services for which life cycle assessment data are required. These databases are also country-specific. Apart from the time and resources required to collect and analyse such data, some databases are proprietary. Such data limitations affect the transparency of life cycle assessments, which undermines their use in decision-making in making buildings more sustainable. Additionally, lack of data restricts the development of environmental product declaration systems necessary for "green" certification schemes.

2.4 Publication

It is apparent that there has been progress with research on more sustainable construction methods and techniques in certain areas, especially with new residential buildings. Although this research needs to be extended to embrace all aspects of the creation, maintenance and renewal of the built environment, it is clear that a range of basic components, technologies, methods and techniques are already available for application in making construction more sustainable. However, there is an important gap between current knowledge and actual application, which must be addressed by dissemination, initially in the form of publication but also in the form of awareness raising. Numerous individual studies, reports, papers, articles, books, catalogues and databases of sustainable construction methods and techniques have been produced. Despite this, there appear to be problems with access to this information by all the relevant actors in the construction, management and use of the built environment. This may be partly due to the integrated approach needed to achieve more sustainable construction. It may also be due to the fact that the construction methods and techniques need to be adapted to local factors, such as the cultural and climatic context, before they become applicable. Hence, whereas publications may exist for individual specialists and specific cultural / climatic contexts, relevant material has to be assembled from various sources addressing

[14] LCA is further addressed in Chapter 3 and Chapter 4;

the whole design and development team, which is engaged in making construction more sustainable and adapted to the different and specific cultural / climatic contexts. Consequently, apart from improving access to publications for all actors in the built environment, it is necessary to communicate integrated and interdisciplinary approaches in professional education and training, and to address the lack of co-ordination of assessment methods and standardisation of products. But above all, the process of raising awareness needs to take shape and be supported by a clear political message, addressing all the sub-sectors of the construction sector.

2.5 Demonstration

Demonstration is an important means of disseminating concepts, ideas and solutions to promote the acceptance, implementation and replication of sustainable construction methods and techniques, predominantly within the local context of the building. There are numerous examples of new zero–heating, low-energy and zero-energy residential buildings. However, whilst these can be influential within the relevant professions of the design team, especially architects and engineers, they may not be as effective amongst all actors dealing with the built environment. This is mainly because such examples must appeal to the different perceptions of different people. First, examples are needed for all aspects of the built environment, which include new residential buildings but also non-residential buildings, retrofitting, refurbishment and renovation, and infrastructure. If we follow this intention, this means that a considerable number of demonstration projects are required across the EU to achieve effective dissemination and this requires a large investment. DG TREN and DG Environment have made a considerable effort in the dissemination of demonstration projects. Second, the type and nature of demonstration is important. For example, architects, engineers and some developers might be inspired by novel and unusual solutions to make construction more sustainable. This may conflict with the needs of most developers, owners and occupiers who just want reliable yet commonplace solutions which happen to be sustainable. This presents a major challenge to those who wish to demonstrate sustainable construction methods and techniques to a broad audience so that they can be disseminated and replicated widely and successfully. This involves achieving a balance between the inspiration of novelty and the acceptability of the mundane.

Demonstration projects are intended as references that prove that the construction methods and techniques live up to their promises, but they have not yet reached the desired impact in the market context. One of the main reasons for this failure may be that relevant dimensions of the built environment have not been taken into account in the selection of demonstration projects: such as the cultural and aesthetic dimension. Although this dimension is very difficult to measure, it is easily perceived by local actors and the lack of appropriateness can make or break the success of a building. The result is that the very objective of creating a positive reference for the construction sector, is inverted and the building becomes a reference of what not to do.

The associated legal and financial frameworks, which support making construction more sustainable, need to be addressed and communicated, as they are critical for the successful implementation of the measures.

3. CHAPTER 3 – BARRIERS AND RECOMMENDATIONS

What barriers are preventing the mainstreaming of more sustainable construction?
What are the recommendations to overcome the barriers?

The construction sector is labour intensive and has a very large spectrum of stakeholders / actors, deeply linked to geography and cultural roots. Each actor is of critical importance for the completion of the construction chain and needs to be addressed individually and as an integral part of the team, if more sustainable construction is to be mainstreamed. In this chapter, the barriers that stand in the way of mainstreaming sustainable construction and the recommendations to overcome them, will be addressed from the perspective of each actor, in the case of new buildings and in the case of retrofitting, refurbishment and renovation.

3.1 Key Issues

The barriers and recommendations, as we know them in the EU, can be characterised in the following way:

- The political top down message has to be as coherent and clear as the Kyoto Protocol commitment is serious and the links between economy and the environment need to become more direct and transparent;
- Many of the barriers that stand in the way of mainstreaming more sustainable construction are culture and value related, thus requiring actions to increase public awareness;
- Construction methods and techniques are deeply rooted and form part of established processes that service / supply local markets – changing them requires integrated actions involving all relevant actors, helping them to work together and towards the same goals;
- There is a need for international co-operation in the development of guidelines for strategies and performance targets for the built environment;
- Research and development are required in refurbishment and renovation;
- An overly technical approach is perceived in the development scene; sustainability needs more human and comprehensible applications (social and cultural sustainability);
- Complexity of ecological factors and their causalities as a whole; there are insufficient methods to cope with these;
- There is a need to measure the progress, while moving to a more sustainable environment. A recognised system of benchmarking / assessment of the sustainability of buildings is needed;
- A market transformation approach is recommended in order to overcome market barriers that prevent more sustainable construction. Actions to improve the market impact of environmental impact data, indicators and reporting processes are necessary.

3.2 Context

Making construction more sustainable can contribute to a balanced existence between buildings, infrastructure and the environment, simultaneously supporting sustainable communities. As a quality issue in building projects, making construction projects more sustainable, has developed over the last 10 years in a number of European countries and also outside Europe, e.g. in USA, Canada, Japan. The background to

more sustainable construction in Europe is the concept of 'sustainable development' with its three pillars: economic, social and environmental. In the context of the United Nations Brundtland report, 'Sustainable Construction' is the integration of sustainable development principles into decisions about the built environment.

Given the fact that there are many successful examples of more sustainable construction across the whole of the EU, serving the respective communities, while reducing the impact of buildings on the environment, the main reason these are not common practice must be other than technical. Identifying the barriers that stand in the way of mainstreaming more sustainable construction and finding the actions that will help overcome them is the objective of this working group.

Nevertheless knowledge and access to information, will support the process of changes in attitudes.
Within the framework of this quest, it will be necessary to address what different incentives and penalties are necessary to motivate each actor to invest in and implement the necessary change - for each actor and within the context of each climatic / cultural region.

Overcoming the barriers will imply a considerable effort on behalf of the actors involved in the construction sector, as they will have to adapt the way they design and build in their everyday practice to a new set of values and quality criteria. The fact that an effort is essential to overcome the status quo, probably constitutes the dominant cause, why change is not forthcoming in spite of the fact that results of good practice are convincing. The need for co-operation among the different professions and actors, in order to create sustainable and efficient buildings, also requires changes in the current work methodology in many EU MS.

It is important to be aware of the fact that, across the EU, traditional construction methods have, in the past, been much more environmentally friendly than they have become since the industrial revolution (motivated by production) and in more recent years (motivated by short term economic thinking). Values have changed, along with cultural evolution and aggressively marketed fashions and trends have not infrequently taken over from native, common sense. Many of the measures to make construction more sustainable can be discovered in traditional European construction, some of which still retain value and can inspire contemporary construction techniques although it is essential to adapt these to current needs.

The scope of building quality issues has widened from the building itself (indoor climate, building physics) to the impact of buildings on environmental resources (upstream data) and the whole life cycle of buildings, including their total or partial re-use and demolition strategies.

Making construction more sustainable combines a focus on the quality of life of the users with the long term (life cycle) economic value / benefit, while retaining a balance in the use of resources, making sure that the environment as a whole does not get overloaded or over-exploited. It introduces life cycle thinking on all

aspects of a building: architecture, construction methods and structural engineering, mechanical and electrical installations.

The process of making construction more sustainable needs to involve all participants in the building sector, stay closely related to user demands and to regulatory requirements that, in their turn, need to become more and more performance based.

During the design phase, when the buildings and related infrastructure are being defined, and unless there are divergences during the construction period, the design determines the performance of the resulting building on the long term. Many of the relevant performance based quality objectives of more sustainable construction can be quantified, but there are less quantifiable objectives and values in more sustainable construction that are no less important and often upstream in relation to the quantifiable ones. The use-value and cultural identity are essential. Adaptability and flexibility are key aspects in achieving more sustainable buildings and more sustainable communities.

3.3 Barriers and Recommendations Listed per Actor

In order to be able to respond to the main task given to this working group – that of recommending the relevant actions that will promote the mainstreaming of more sustainable construction – all the actors involved in the construction sector were separately identified and addressed individually in Annex 1 to this report. As the list is extensive and the aim is to define clear and effective actions, these actors were then clustered according to their similarity in motivation.
The actors in the construction sector are identified and listed below, organised in five clusters:

Cluster 1: Ownership-related actors:

- Property management companies
- Owner (not end user)
- Real estate agent and valuer

Cluster 2: Production-related actors:

- Promoter (including the maître d'ouvrage)
- Design team
- Contractor
- Manufacturer of building components / products / materials
- Labour force
- Utilities (including waste disposal companies)

Cluster 3: Policy-related actors:

- Urban planner
- Municipality / Local authority

- Health and well-being
- Member states
- Inter-governmental organisations
- European institutions

Cluster 4: Market-related actors – Consumer /Communication / Information / Education:

- Occupier
- Education and training
- Research
- NGOs, local opinion groups and neighbourhoods
- Media

Cluster 5: Finance-related actors:

- Insurance companies
- Banks / mortgage institutions

The input of each of these actors is by no means similar in quality, quantity or relevance. Some actors are listed mainly because of the barriers they pose, others because their potential beneficial role could be relevant to mainstreaming good practice. The Annex 1 lists for each of the above actors in the vertical chain of action of the construction process, the barriers they experience and create and the recommended actions each can assume, to overcome those barriers.

3.4 Barriers and Recommendations Listed in Order of Priority

The Urban Thematic Strategy reaches across the different sectors of governance in Europe in an attempt to increase the effectiveness of the resulting legislation (directives / recommendations) and their impact on the day to day life of citizens. This integrated approach reflects vision on behalf of the EC and constitutes an opportunity, which this WG welcomes and embraces.

The present report attempts to reflect the reality of the construction sector, in as much as it covers a very large spectrum of stakeholders / actors and that it has such a diverse and far-reaching impact on our society. The far-reaching dimension of the construction sector is apparent in Annex 1, where barriers and recommendations are listed per actor. Although Annex 1 details all the main barriers and recommendations that were identified by the working group, this chapter places the barriers and recommendations into the global context.

On the basis of all that has been stated in the previous chapters, it is clear that making construction more sustainable is not a finite goal. It is a continuously redefined evolutionary and dynamic process requiring clarity and coherence in the top-down political message (expressed in a set of EU common goals) in order that mainstreaming of more sustainable construction can be promoted and initiated.

Some of the main barriers are:

- The **long term benefits** of more sustainable construction are **not easy to perceive** and to value by actors who have a **short-term involvement** with buildings, such as most developers and contractors.
- **Lack of flexibility to improve** habitual methods of construction, due to the complex nature of the construction sector, its very labour intensive and non-harmonious composition, and its very wide spectrum of levels of skill.
- A **universal method to assess the environmental performance of buildings is not yet available**, thus making it difficult to reward more sustainable construction with tax benefits and other incentives.
- **Public procurement does not lead by example** in the construction sector, producing some of the buildings with the highest energy consumption and running costs and thus contributing to an unclear top-down message to the market.
- **Simple guidelines for planners and design teams** to make sustainable choices **are not yet easily accessible to all** and most actors can't afford time-consuming research and development work.
- At best, in **professional education sustainability is a vertical subject**, making the approach to sustainability an isolated rather than an integrated one.
- Although not the case in all EU member states, cultural characteristics **don't encourage multi-disciplinary teams to work together** towards a common goal, from an early stage of design.

It should be a priority to encourage the reduction of buildings' reliance on active energy systems to perform effectively (demand side management), notwithstanding short term energy consumption promoting policies.

All actors, but primarily promoters, whether public or private, must take on their share of the responsibility of achieving sustainability goals. Achieving these goals will require a significant effort on behalf of all of the main actors in the construction sector.

Some of the main recommendations are (in brackets the actor the recommendation is aimed at):

- The top-down political message has to come across to the market as clearly and coherently as possible – therefore:
  - **Public bodies** must support the MS to **comply with their share of the responsibility of the Kyoto Protocol commitment**. (Member states, Municipalities, Public Bodies)
  - All **public money will therefore be spent on** projects that respect the quantified (measurable) requirements of **more sustainable construction** to fulfil objective targets. Funds and subsidies will set requirements in line with more sustainable construction, expressed in objective targets. Publicly owned buildings and public procurement should set an example in terms of calling for more sustainable construction. Further it is relevant that targets for "Environmental Performance Indicators" are displayed in new buildings open to the public. (Member states, Municipalities, Public Bodies, European institutions)
  - The Commission should be encouraged to proceed with a standardisation mandate addressed to CEN for the "**Development of Horizontal Standardised Methods for the Assessment of the Integrated Environmental Performance of Buildings**". In addition to establishing an assessment

method for the construction and operation of complete buildings, the draft mandate for this proposed European Standard also provides for the introduction of a voluntary system of "Environmental Product Declarations" (EPD). Develop a common European recognised methodology for the estimation of life cycle costs of built facilities. It is suggested that the existing ISO standards could form the basis of such a methodology and should include a system for estimating LCC indicators. (European institutions)

- **Certification of construction must be "performance based"** rather than "prescriptive", in order to challenge the design team to find creative and diverse solutions leaving them the relevant flexibility to be inventive and creative. The above-recommended building passport that is an extension of the energy certification of buildings as introduced by the EU Directive on the Energy Performance of Buildings published on 4th January 2003, may be the most effective way to generalise building certification. It is proposed that the building passport should incorporate beyond energy certification, other building performance parameters, such as indoor air quality (materials' and systems' emissions) and comfort (thermal, visual and acoustic). (European institutions)
- **Life Cycle Assessment (LCA) is a powerful tool for the systematic evaluation** of the environmental aspects of a product or service system through all stages of its life cycle. LCA provides a standardised methodology for environmental decision support.[15] With such data, actors in the building sector will have information on which to make informed choices. Also such data can form the basis for performance targets. (European institutions, Member states, Municipalities, Promoter, Design team, Manufacturer…)
- More sustainable construction does have a positive impact on the environment, but this added value can have an extra cost that the market is not yet willing to pay for. **Taxes and all other regulatory mechanisms** at global, regional and local political levels need to be adapted (transformed into incentives) and **used to help motivate the actors in contributing to achieve more sustainable construction**. These measures will contribute to reduce the extra cost of sustainable measures and will encourage the necessary research and development. (European institutions, Member states, Municipalities)
- **Urban planning instruments must make room for more sustainable construction**, encourage it and even make it a condition for the award of construction permits. (Urban planner)
- **Education and awareness raising campaigns** must prepare all relevant actors for the necessary changes required to achieve a more sustainable built environment, including the encouragement towards a more efficient use of the built environment. Among many other awareness raising measures described in Annex 1, sustainability achievements should also be included and rewarded in all prizes addressing the built environment. (Education and training)
- **Monitoring** (post occupancy evaluation) of built environments that comply with the quantified (measurable) requirements of more sustainable construction **should be ongoing** and the results **communicated to all relevant actors**, establishing and maintaining a European database on building performance, divided up by reason as between design, construction, products, misuse, etc. There needs to be **regular assessment of building performance** and publication of these

[15] Source: UNEP definition of Life Cycle Assessment;

assessments, similar as the EU Directive on the Energy Performance of Buildings[16] also recommends. (European institutions, Member states, Municipalities, Promoters, Property Management Companies, Utilities…)

- Bottom-up market initiatives in favour of sustainable construction need to be just as committed to achieving the mainstreaming of more sustainable construction and must be accommodated and encouraged by local urban management – therefore:
  - Many of the qualities intrinsic to **more sustainable construction can have direct cost reduction** implications for the end-user as well as health enhancing positive implications. **Raising the awareness of the end-user** to the choices he / she has, included in the marketing campaign of relevant environmental information on: energy consumption in buildings (energy certification of buildings), on toxic emissions of materials and ventilation systems, impact on indoor air quality (could be included in the building certification if the scope of the 'passport'[17] can be widened), on waste separation and disposal, reduction of water consumption etc. (Member states, Municipalities, Promoters, Media, NGOs …)
  - The **use of resources** (specifically waste disposal, energy and water supply) should become more **sustainable** by encouraging the implementation of utility run decentralised systems: for the recycling of grey water, for decentralised energy production, for decentralised waste collection. (Member states, Utilities, Media, NGOs …)
  - **Encouraging a shift in attitudes** by all actors in the construction sector, in terms of education and **continuous training** which is an indirect but nonetheless relevant area of action; (Education and training, Design team, NGOs …)
  - Develop and make generally **accessible tool kits and guidelines for the design team** and other actors involved in design activities that will assist them in developing more sustainable buildings with fewer design failures. (Design team)
- In order to make more sustainable construction possible and feasible, having already determined that sustainability is evolutionary rather then an absolute goal, the direction which this evolution takes needs to be clearly identified, so that, starting with existing efforts of good practice, further efforts can be focussed efficiently and results can be attained in the short term – therefore:
  - It is important to define the **holistic, environmental, common EU indicators** and the respective quantified objectives (targets) within each indicator adapted to each MS, together with an adequate

[16] The EU Directive on the Energy Performance of Buildings adopted on 4 January 2003 foresees such measures as a methodology for calculating the energy performance of buildings and certification schemes for buildings. MS are required to implement the Directive by 4 January 2006.

[17] The building passport is another recommendation, working as an extension of the energy certification of buildings, which was introduced by the EU Directive on the Energy Performance of Buildings published on 4th January 2003, to incorporate beyond energy, other building performance parameters, such as indoor air quality (materials' and systems' emissions), comfort (thermal, visual and acoustic).

common EU assessment method, using a common language between all stakeholders in the construction sector. (European institutions)

- There is a need to **integrate principles of sustainability into the practice of design, construction, maintenance and management of buildings**; Parameters that matter the most need to be identified in a language that is consistent with the issues typically addressed in the construction sector. As methodology: (Contractor, Design team …)
  1. Identify what can be kept from current common practice integrating cultural and regional (climate) values (as valid for new buildings as it is obviously for retrofitting);
  2. Identify what needs to be changed, new techniques and processes;
  3. The resulting product must be assessed starting from the design phase in an integrated manner from the point of view of the fulfilment of the requirements and the environmental impact at all levels from the local, to the regional, to the global;
- Sustainable construction should be **implemented through integrated approaches**, and optimised solutions within the domain of each actor in the construction sector. Dialogue and co-operation between the relevant actors working towards the same goal - a more sustainable construction – is clearly the framework within which more sustainable construction can be mainstreamed. (All actors)

These recommendations addressing most of the actors in the construction sector need to be put into practice simultaneously, in order to succeed in mainstreaming more sustainable construction.

4. CHAPTER 4 – EXAMPLES OF TARGETS FOR ASSESSING SUSTAINABILITY

4.1 Key Issues:

What kind of quantitative and qualitative targets can be proposed?

There is a consensus among the experts of the Thematic Strategy Working Groups on Sustainable Urban Design and on Sustainable Construction Methods and Techniques that the following less quantifiable quality objectives will contribute to making the built environment more sustainable and should be included in the list of recommended urban design targets. As objectives these should be defined at local level as they are very culture-specific:

- Intensify the identity and character of the built environment as it stimulates the user's sense of belonging and care;
- Introduce diversity and variety of texture, colour, form, typology, use and property;
- Introduce flexibility to cater for unknown future needs;
- Increase the life span of buildings and public spaces;
- Optimise orientation of buildings to benefit from climate conditions;
- Increase the attractiveness of the built environment;
- Guarantee accessibility[18] to all;
- Respond to demographic pressures by making settlements more compact, rather than turning to urban sprawl. Focus on retrofitting, refurbishment and renovation and use brown field as opposed to green field sites for new construction, as the latter is a valuable natural resource.

There is consensus among the experts of the Thematic Strategy Working Groups on Sustainable Urban Design and on Sustainable Construction Methods and Techniques on the following more quantifiable quality objectives that contribute to making construction more sustainable. These quality objectives have an impact on the user's sense of well-being, increased productivity and reduced absenteeism. As objectives these should be defined at the European institutions level and adapted to each member state's reality in terms of climate, for example:

- Improve indoor and outdoor air quality;
- Improve indoor and outdoor comfort conditions (thermal, acoustic and visual);
- Improve the energy efficiency of buildings by implementing appropriate construction methods and techniques (passive solar design) internalising the best of the local climate conditions;
- Reduce CO_2 emissions per capita and per sector;
- Integrate renewable energy systems (active solar and wind) and energy management systems for permanent monitoring;

[18] "Accessibility" means providing buildings and places which are designed and managed to be safe, healthy, convenient and enjoyable to use by all members of society. It implies that buildings should be accessible for all (for instance with level or ramped entrance), that they should be really "usable" from ground floor to the top, and that adequate means of autonomous exit (for instance, a lift providing evacuation in the event of fire) should be provided.

- Specify systems to maximise efficiency in operation, making room for flexible performance (foresee changes in uses);
- Reduce waste and facilitate waste separation;
- Reduce water demand and implement grey water recycling systems at the local level;
- Reduce running and maintenance costs;
- If no alternative or feasible choice, use non-renewable resources rationally (materials, energy), taking into consideration the life cycle of materials and their re-use and recycling potential (up stream and down stream);
- Minimise impact on bio-diversity.

These objectives all aim to support and consolidate sustainable communities, offering the highest possible quality of life to the users.

Globally, nationally, regionally, and locally relevant environmental targets must be addressed to economic sectors, including the construction sector. These should be short, medium and long-term environmental targets. Ideally these targets should be agreed between major players in a sector.
The working group SCMT is aware that in order to retain the full qualitative input of every actor of the building sector it is important to set targets as opposed to prescribing solutions. This methodology allows us to increase the diversity of the built environment, while its performance undergoes continuous improvement.

4.2 Targets and "Required Assessments"

To select a set of targets, the WG must return to some of the fundamental aims of pursuing more sustainable construction. The working group also notes that targets alone will miss some key areas of sustainable construction. Therefore another type of measure, one that requires the regular assessment of building performance and publication of these assessments, similar to the EU Directive on the Energy Performance of Buildings[19] is also recommended. As these targets are performance based, actors are then left to interpret these overall targets and required assessments in their design functions and other actions, permitting a considerable degree of freedom and flexibility, that will result in more diverse built environments.
Overall the requirements focus on a reduction in the use of key resources and in the pressure on the environment through emissions, while maintaining or improving comfort of the indoor and outdoor environments. Furthermore required assessments are simple, workable, generic measures that are amenable to measurement, such as volume for liquids, weight for solids and floor area for buildings, in order to satisfy the EC's request for effective legislation.

[19] The EU Directive on the Energy Performance of Buildings adopted on 4 January 2003 foresees such measures as a methodology for calculating the energy performance of buildings and certification schemes for buildings. MS are required to implement the Directive by 4 January 2006.

Life Cycle Assessment (LCA) is a powerful tool for the systematic evaluation of the environmental aspects of a product or service system through all stages of its life cycle. LCA provides a standardised methodology for environmental decision support.[20] With such data, actors in the building sector will have information on which to make informed choices. Also such data can form the basis for targets. However the WG recognises that LCA methodology and data currently lack transparency and agreement on allocation rules but, together with environmental product declarations, they are very promising areas for future application.

One approach to analysing the impact of a building project recognises four distinct phases over its entire life: design, construction, occupation and end of life. For simplicity in this report, the list of measures has been divided into just two groups: pre- and post-occupancy (before and after commissioning). The point between construction and occupation was chosen because this is when all aspects of a building's "value" are encapsulated into its market price, thus a driving force to reduce pre-occupancy costs and maximise value as perceived by the property market. For post-occupancy energy issues, new buildings were distinguished from overall buildings, the latter including both new and existing. Although the targets refer to timings during and after construction, the measures that permit achieving them apply to the brief definition and the design phases.

The measures (targets and required assessments) that are workable have been summarised below and will have the desired impact. In the sections that follow, the suggestions of possible units for their measurement and example values are detailed:

- Pre-occupancy (construction phase)
    - Targets to reduce use of energy
    - Targets to reduce use of water
    - Target to reduce use of packaging
    - Targets to reduce transport movements
    - Targets to reduce waste leaving a site
- Post-occupancy (occupied phase)
    - Target to reduce use of energy for new buildings
    - Requirement to assess use of energy of all buildings[21]
    - Target to reduce use of water
    - Requirement to assess the quality of indoor conditions

In the list of post-occupancy targets, note that the energy target excludes existing buildings. The target is for new build in order to create a driver during the design stage[22]. Existing buildings are excluded from the

[20] Source: UNEP definition of Life Cycle Assessment;

[21] Under the EU Directive on the Energy Performance of Buildings, "occupancy rating" is the energy use calculated by the building owner or occupant according to actual use of the building (as distinct from energy use calculated during the design phase when details of occupancy are unknown).

[22] Under the EU Directive on the Energy Performance of Buildings, "asset rating" is an energy use calculation performed at the end of the design phase. Its introduction for designers ensures that energy use by the building during occupation is taken into consideration at this stage. Furthermore, the asset rating must comply with local building regulations as another condition that must be met for the design to be accepted.

target because they will have greater difficulty complying with a simple energy target or would need a complicated range of energy targets. Instead, existing buildings are covered by the required assessment.

4.3 Details of Units for Targets

This section develops the concepts in these targets with specific measurable quantities. Selection of the type of unit and its point of measure are important and produces some surprising choices in some cases. For instance, a target concerning transport might be thought to include distance travelled whereas the measure detailed here simply concerns movements on and off site. The working group is keen to identify pragmatic measures drawn from experience of what works in practice. In this case, the targets listed are based on measures and units used to provide benchmarking services to organisations in the construction industry[23]. Benchmarking involves both collation of data from the industry to define the benchmarks and working with users of these services to ensure relevance and ease of application to their activities.

The choice of measure for energy targets needs some explanation. Rather than targeting energy use through units of energy or power (kWh or kW), current thinking emphasises the relationship of energy use to the specific fossil fuels used through the ultimate CO_2 emissions of each fuel. It is relevant to note that the "carbon intensity" (relationship of CO_2 emissions to primary energy sources) varies between different countries but it is well defined so still workable and appropriate. The nuclear component of electricity generation will need special handling since an increase in radioactive waste would be an undesirable side effect in sustainability terms of targeting CO_2 emissions alone[24]. On the basis of this way of thinking, the universal assessment unit for energy being CO_2 emissions, each MS's real energy supply mix (renewable vv fossil fuels) will be taken into account while setting a target. Thus, a MS with a high renewable energy source component in the energy supply, will be able to set slightly less demanding targets of energy performance of the construction sector, than a MS with a lower renewable energy source component. The proposed targets use units that aim to favour efficiency in the use of natural resources while reducing the ecological footprint[25].

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[23] Benchmarking services in the UK are provided through the Construction Industry Key Performance Indicators (CI KPIs) first developed in 1999.

[24] The effects of fossil fuels and nuclear power could be combined onto the same scale and one method under consideration is calculation of social cost. For CO2 emissions from fossil fuels, a social cost can be derived for the effects of climate change on sea level rise, extreme weather effects, impact on agriculture, etc. Similarly for nuclear power, a social cost can be derived for a possible power station explosion and an accidental leak of radioactive waste.

[25] For pre-occupancy targets, CO2 emissions relate to the energy used by factories and other manufacturing plant for construction materials. For post-occupancy targets, CO2 emissions relate to the energy used within the buildings themselves through the activity of their occupation.

Possible units for all the targets are summarised as follows:

- **Pre-occupancy – During Construction**
  - Energy targets:
    - Calculated kg CO_2 emissions per m^2 of construction products per year, taking into account the building use;
  - Water targets:
    - Calculated m^3 volume of mains-supplied and abstracted water per m^2 of construction products per year, taking into account the building use;
  - Packaging target:
    - Weight of packaging used for containment, protection and presentation of goods as a percentage of weight of total production output.
  - Transport targets:
    - Number of transport movements (via road, rail, water or other) leaving production site of quarries and manufacturers per m^2 of production output;
  - Waste targets:
    - Weight of waste leaving the production facility of quarries and manufacturers as a percentage of m^2 of production output;
- **Post-occupancy**
  - Energy target for new buildings:
    - Monitored kg CO_2 emissions per m^2 floor area per year, taking into account building use achieved indoor comfort levels;
  - Water target:
    - Measured m^3 volume of mains-supplied and abstracted water per m^2 floor area per year.

Naturally it will be necessary to adapt the measurement units to the building use – for example:

- In the housing sector, the CO_2 emissions could be assessed per dwelling unit and per year, taking into account the indoor comfort levels;
- In the case of hotels, CO_2 emissions could be assessed per guest per night;
- In the case of hospitals, CO_2 emissions could be assessed per patient per day.

At this stage, there is consensus on these above described targets. Naturally there are many other targets that will in the future need to be set for indoor conditions, for example and in order to guarantee adequate levels of indoor air quality, it will be necessary to address materials' emissions and air handling systems.
These targets and others like waste targets for post-occupancy need to be set over the near future.
The quantification of the targets set above, needs to be developed carefully and needs to bear in mind the building typology or use and the regional / local conditions (climate and culture).

4.4 Details of "Required Assessments"

In "required assessments" the WG sees another powerful mechanism to guide the awareness of the market towards more sustainable construction, although it is more subtle than the targets.

Under post-occupancy the requirement for assessment of energy performance and the quality of indoor conditions are listed.

Although assessments may lack teeth, the power of information, through the taking of measurements and public availability of the results, should not be under-estimated. One advantage of assessments over targets is that they permit flexibility in design response and allow this category of measurement to evolve and mature over time.

An important requirement for publicising the results is to set them in context according to the type, age and use of the building. For energy, categories of efficient and profligate use will become clear for stakeholders and other players to note and respond to as they choose. For example, energy performance certificates required under the new EU Directive must be produced whenever a building is sold or rented out.

The energy assessment we propose should include recording actual energy use over a year. This will be compared to current legal standards and benchmarks[26]. Other measurements should include density and duration of occupancy. A useful figure to derive from these measurements will be CO_2 emissions equivalent per capita for the building. In the case of new build, these measurements should be compared to the original design values.

The assessment of indoor environmental quality is about putting people at the heart of a building's function and applying modern thinking to what constitutes health and a feeling of well-being. This is the rapidly developing area of "post-occupancy evaluations" (POE) or workplace performance design.

There are many physical measurements that can be made on the indoor environment. We have listed here a few indices known to have a significant impact on the thermal and air quality:

- air temperature;
- radiation temperature;
- relative humidity;
- air velocity;
- rate of air changes;

The first four above are the most important for thermal comfort based on the well-established comfort model developed by Fanger[27] and already included in the new EU Directive[28]. The last ensures there is an

[26] The SAVE project, EUROPROSPER (www.europrosper.org), involving 7 MS is currently developing a method based on actual energy use and tailored benchmarks for a certified energy assessment of existing buildings.

[27] Ole Fanger developed the formal definition of "comfort" now in standard use by the mechanical services profession.

[28] The EU Directive on the Energy Performance of Buildings specifies that displayed information should include the range of indoor temperatures and, when local climatic conditions require it, other relevant climatic factors such as relative humidity. The Directive acknowledges that this will help to safeguard comfortable indoor climatic conditions (thermal comfort) in relation to the outside temperature.

adequate supply of clean, fresh air to clear away pollutants such as VOCs[29], particulates, body odours and cigarette smoke.

Other physical measures that affect the overall quality of environment include:

- amount of natural light;
- quality of artificial light;
- noise levels;

Additional factors to take into consideration for a balanced assessment of an occupant's environment include:

- degree of control occupants can exert over their conditions;
- outdoor conditions;

The interaction of all these factors must recognise the adaptive effect of occupants avoiding adherence to just a narrow set of physical measures, such as the comfort scales used to specify fully air-conditioned spaces in ISO 7730[30]. For example, mixed mode and naturally ventilated buildings are important developments in design for reducing energy demand, but they bring with them a variation of indoor environment according to outside conditions. This means their indoor conditions would not comply with current standards achieved by air conditioning. Nevertheless, the best building designs of this type appear to be preferred by occupants, an important observation that must be noted and developed in future.

4.5 Secondary effects on Objectives of Targets and Required Assessments

To illustrate the effect of these targets and assessments, the WG decided to look at them individually and how they relate to a list of design objectives produced by the working group.

- Improve indoor air quality and indoor thermal comfort conditions: post-occupancy required assessment of comfort conditions.
- Improve energy efficiency of buildings by implementing appropriate construction methods and techniques (passive solar design) internalising the best of the local climate conditions: pre- and post-occupancy energy targets; post-occupancy requirement to assess comfort conditions.
- Reduce CO_2 emissions per capita and per sector, pre- and post-occupancy energy targets; pre-occupancy transport target.
- Integrate renewable energy systems (active solar and wind) and energy management systems for permanent monitoring: post-occupancy energy targets; post-occupancy requirement to assess use of energy.

[29] VOC is the standard abbreviation for volatile organic compounds, a very broad range of substances whose indoor sources include building materials, cleaning agents and adhesives for furniture and carpets.

[30] The international standard ISO 7730 (1994) is based on the Fanger methods and provides a means to calculate the proportion of occupants expected to be satisfied with their thermal conditions. In addition to physical measurements on a space, it takes into account the type of clothing worn by occupants and level of occupant activity.

- Use non-renewable resources rationally (materials, energy), taking into consideration the life cycle of materials and their re-use and recycling potential (up stream and down stream): partially affected by pre-occupancy waste targets.
- Specify systems to maximise efficiency in operation, making room for flexible performance: post-occupancy energy targets; post-occupancy requirement to assess use of energy.
- Reduce waste and facilitate waste separation: pre-occupancy waste target.
- Reduce water demand and implement grey water recycling systems at the local level: pre- and post-occupancy water targets.
- Improve impact on biodiversity: pre-occupancy waste targets (in that they reduce the need to create more landfill sites).

5. CHAPTER 5 - OVERLAPS WITH THE OTHER URBAN THEMATIC STRATEGY WORKING GROUPS:

The most important outcome of the work of the SCMT working group is the definition of measures to be implemented at political and market level, which will bring sustainability into every decision of the complex process of creating and up-grading our European built environment.

On the working group's scope and thematic substance:
As more sustainable construction relies on a holistic approach in relation to all the relevant areas, there will be common ground with the related sectors, such as urban design and management and transport infrastructures.

The WG decided not to focus on the definition of the borderlines, rather to focus on the core of the thematic substance and work towards the related sectors.

Some areas of common concerns with the other WGs are nonetheless clear:

With sustainable urban design:
«A well designed urban context won't be damaged by bad architecture, but a badly designed one can't be saved even by good architecture»[31];
If sustainable development points towards the compact city as the solution for efficient use of urban infrastructure, there are measures that need room to be developed at the scale of the built environment:
Solar orientation and overshadowing, wind protection (enclosure) are defined at the urban design scale, and can prevent (or make possible) the creation of good and comfortable indoor and outdoor spaces.
It is therefore clear that more sustainable construction depends on sustainable urban design, so much so, that urban design can determine the performance of the built environment. Due to the diversity of activities and functions of urban areas, it is important to integrate both perspectives' visions and ideas in order to allow such diversity to co-exist without impairing the quality of life of users.
The role of this WG in relation to the Urban Design WG is defined as follows: SCMT WG is looking at the building and its quality both in relation to the built environment and to itself, from a holistic and an integrated perspective.

With sustainable urban management:
Part of urban management is the approval of proposals for the built environment, and as such there is an enormous potential of influencing the end result in terms of a more sustainable construction;: Many of the SCMT working group's recommendations address the urban management area, see Annex 1..

[31] This is a quote by Prof. Klas Tham, responsible for the urban master plan of the permanent exhibition area of Malmö's BO01 Exhibition;

With sustainable urban transport:

As a higher density of the built environment can favour the efficient use of all urban infrastructures as well as make people's lives easier, it is important to be aware of its strengths and weaknesses.

For density to become a positive element in people's lives, planning, management and architectural performance are even more critical than in low-density urban contexts, mainly because tolerances reduce in a higher density urban context.

Another physical common area between construction and transport are the car parking areas. As buildings can be energy producers (photovoltaics) and cars are energy users, another common ground can be found.

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