STUDY FOR THE DEVELOPMENT OF EUROPEAN ECOLABEL CRITERIA FOR BUILDINGS

Product group definition

August 2008

LIST OF CONTRIBUTORS

Supervisor: Stefania Minestrini

Project Manager: Laura Cutaia

With the contribution of:

Stefania Minestrini (§ 1, 7)

Laura Cutaia (§ 2, 3, 4, 5, 6)

Lorenzo Maiorino (§ 2)

We wish to thank the Ministry of Economical Development, the Ministry of Environment, of the Protection of the Territory and of the Sea, the Italian Ecolabel – Ecoaudit Competent Body, in particular the President of the Ecolabel section Eng. Giovanni Silvestrini.

Special thanks to all those have offered their collaboration to the realisation of this report participating to meetings and providing useful materials and data and in particular to Paolo Neri, Mauro Olivetti, Simona Fumagalli, Daniela Santonico, Eliana Cangelli, Alain Lusardi, Maria Chiara Torricelli, Antonio Basti, Giuliano Dall'O', Aldo Blandino, Maurizio Cellura, Gianfranco Rizzo.

Summary

1. Foreword

This report has been produced in order to provide further investigations finalised to a product group definition for buildings.

The report contains:

- an updating on the market analysis on the building sector;
- the consideration of existing terms and definitions provided by the CEN 350 and ISO/TC 59 and technical standards or legislation and definitions used within some existing certification schemes;
- results from LCA studies on buildings at European level;
- a first preliminary investigation on the most relevant topics insisting amongst criteria of existing ecolabels.

Concerning the last point, it will be tackled in a comprehensive way in the next background document for the first criteria proposal.

A first report finalised to a product group definition was produced and presented in the first AHWG meeting held in Rome on the 15th April 2008.

The investigations provided from this report partially confirm the proposal made in the previous report as highlighted in chapter 7.

2. The building sector in the European Countries

2.1 INTRODUCTION

In this section, we have carried out an updating of the snapshot of the buildings in EU. We have intended to refine and to deepen analysis of buildings focusing on residential sector. The residential sector is estimated accounting for the major part of the energy consumed in buildings; in developing countries the share can be over 90%. Nevertheless, the energy consumption in non-residential buildings, such as offices and public buildings and hospitals, is also significant (UNEP, 2007).

2.2 BUILDING STOCK IN EUROPE

In this section, we have focused on residential sector both because it identifies the largest building sector (it accounts for about 70% of the total building stock), and because it represents a priority instance for citizen's life especially according to paradigms of the sustainability.

From an environmental point of view, the strategic importance of residential sector it was also remarked on the World Congress Clima 2007 in Rehva (Finland). On average, buildings in Europe account for 36% of the energy use: the residential sector accounts for 27,5% and the non-residential for 8,7%. The total heating related CO_2-emissions of the EU-15 building stock are 725 Mt/a (Figure X). Buildings larger than 1000 m^2 are responsible for about 158 Mt/a (22 %). Ecofys (Petersdorff et al., 2006) has estimated that the main contributor to the total heating related CO_2 emissions of 725 Mt/a from the EU building stock in 2002 is the residential sector (77%) while the remaining 23% originates from non-residential buildings. In the residential sector, single-family houses represent the largest group responsible for 60% of the total CO_2 emissions equivalent to 435 Mt/a.

In Europe, the annual rate of increase of the total housing stock is rather low (between 0.8% and 2%). The residential building stock is not only renewing very slowly, it also consists largely of older constructions. More than 70% were built before the first energy crisis, one-third of the dwellings are more than 50 years old.

Total energy consumed in new buildings is 60 % of that used in existing buildings. The challenge is therefore in existing buildings, also because of the size of the stock and because systems change and need replacement periodically.

The new member States are burdened with the legacy of a large stock of poorly built housing and poor grid-based heat supply. They also have a high share of often sub-standard district heating, and difficulties in financing the necessary refurbishments to bring the buildings up to a relatively energy-efficient condition (REHWA, 2007).

Moreover, according to the ERABUILD report[1] (Itard et al., 2008) the owner-occupied sector accounts for 35% to 70% of the residential building stock in the countries of interest in their study (Austria, Denmark, Finland, France, Germany, the Netherlands, Sweden, United Kingdom, Switzerland and Norway). This is also a sector where the penetration of sustainable renovation is low, in spite of a lot of renovation and modernization activities are undertaken. Owner-occupation accounts for 60% to 96% of single family dwellings and 20% to 60% of multi-family dwellings. Barriers to sustainable renovations in the owner-occupied market are the low investment capacity and the lack of knowledge about technical solutions. In owner-occupied multi-family dwellings, an

[1] ERABUILD, is a strategic network for national R&D programmes from Austria, Denmark, Finland, France, Germany, the Netherlands, Sweden, United Kingdom, Switzerland and Norway, that started in 2004. The aim has been to influence the European Research Area (ERA) on sustainable development in the construction and operation of buildings by preparing frameworks for trans-national R&D cooperation and learning networks identifying best practices in programme management.]

additional barrier is the complex decision-making process related to the co-ownership of building parts.

Although this, the non-residential sector is not negligible. In all the most of Western European countries, office buildings have often already been renovated and the degree of penetration of sustainable renovation seems to be higher than in other sectors, not least because of image. The 2 OTB Research Institute for Housing, Urban and Mobility Studies shopping and leisure sector accounts for a large part of the non-residential sector, in terms of floor area and also in terms of energy use.

Additionally, educational buildings, although having a modest share of floor area and energy use in the non-residential sector could be considered as a sector of interest. Educational buildings are mostly owned by local, regional or national governments and their sustainable renovation could be seen as a standard bearer of political and social commitment. This also offers the opportunity to embed sustainability in education and to reach a large part of the population. Other good reasons to address the educational building stock are that the maintenance of schools is overdue in many countries and that many studies indicate large-scale problems with poor indoor air quality.

The following table quantifies the residential a non-residential building stock in terms of m^2 U.A. and number of units for Austria, Denmark, Finland, France, Germany, the Netherlands, Sweden, United Kingdom, Switzerland and Norway. In these eight countries studied, the total non-residential building stock is 43% of the residential building stock in terms of floor area. The percentages differ by country, being from only 4% in Switzerland to 57% in Finland and 31% at the European level (at the European level, only the cold and moderate climate zones were taken into account, and Switzerland was not accounted for in the data).

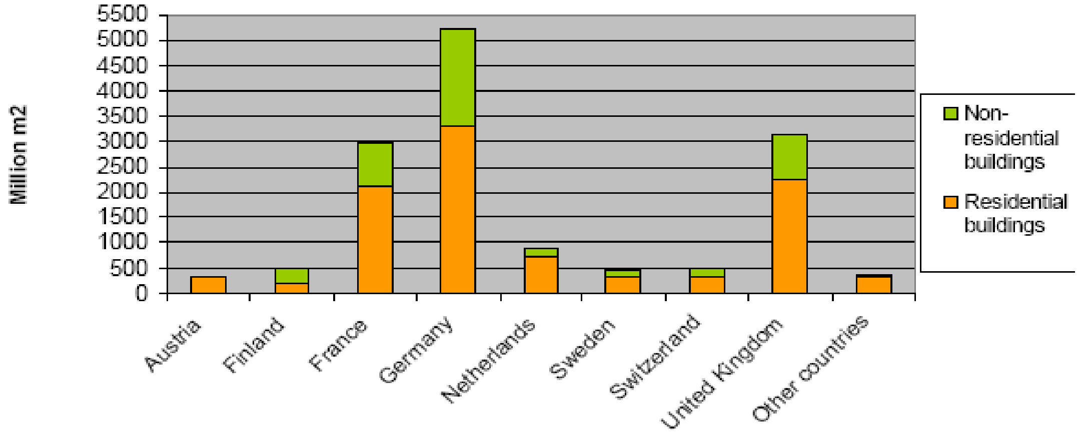
Table 2.1: Characteristics of the residential and non-residential building stock

Country	Population	Residential buildings		Non-residential buildings	
		million of m2 U.A.	number of dwellings	million of m2 U.A.	number of units
Austria	8.206.500	300	3.863.000	n.a.	116.530
Finland	5.236.600	212	2.478.000	278	198.685
France	60.561.200	2.135	25.800.000	850	n.a.
Germany	82.500.800	3.301	35.800.000	1.926	n.a.
Netherlands	16.305.500	724	6.969.931	166	224.000
Sweden	9.011.400	312	4.404.059	158	n.a.
Switzerland	7.418.400	330	3.581.000	151	84.615
United Kingdom	60.034.500	2.236	26.200.000	990	1.840.000
European stock (EU15)		**9.858**	**113.876.000**	**4354**	**n.a.**

Note: U.A.=Useful Area
Source: ERABUILD "Building Renovation and Modernisation in Europe: State of the art review" January 2008

The fig. 2.1 shows the difference between the residential and non-residential floor area per countries.

Figure 2.1: Residential and non-residential floor area per countries

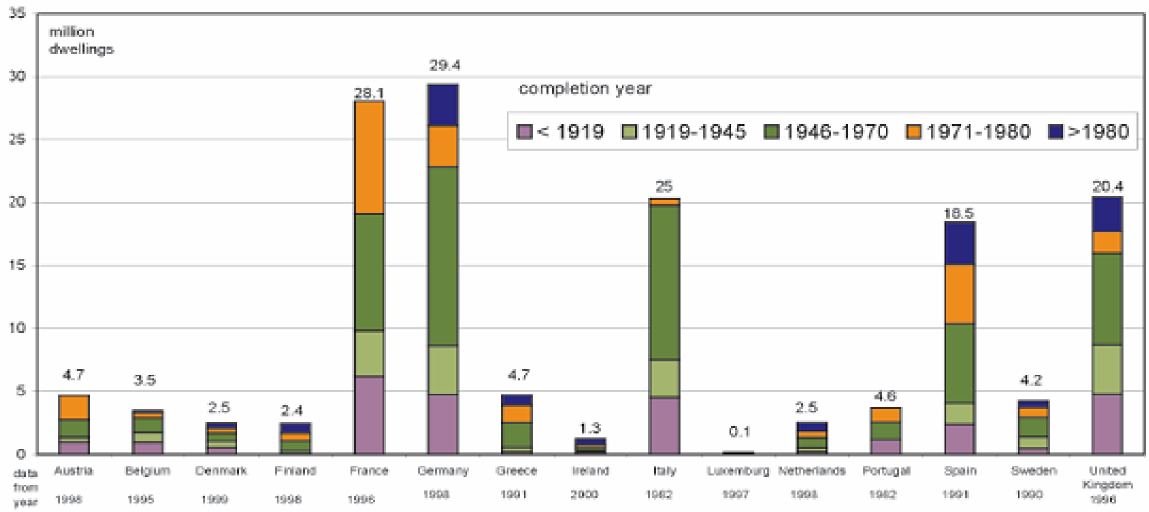


Source: ERABUILD "Building Renovation and Modernisation in Europe: State of the art review" January 2008

The quality of buildings and building activities has a great impact on both the environment and the social condition of citizens. The World Sustainable Building Conference, which was held in Oslo in September 2002, concluded that the existing building stock and rehabilitation of neighbourhoods should be the main starting point for sustainable building and housing strategies

In EU countries there exist about 150 million dwellings (fig. 2.2), which means 400 dwellings per 1000 inhabitants. Over half of the stock was built after 1946. Every third dwelling was built between 1946-1970. During that period, building methods and systems were largely aimed to quickly satisfy the huge demand and the quality of construction remained questionable.

Figure 2.2: Dwelling stock by year of completion in EU (total 150 million dwelling)



Source: Heli Koukkari and Leena Sarvaranta "Ageing challenges in the construction sector" International Journal of Strategic Property Management (2005) 9, pag. 91-97

The present buildings stocks needs refurbishment for several reasons and the proportion of refurbishment work is already about half of total input in the construction sector. The share of newer dwellings (completed after 1980) in the whole stock is less than 10%.

In table 2.2, we have reported the housing stock updated current year for each Euroconstruct countries. The table shows the available data on the European housing stock from 2004 to 2007. Moreover, in the same table, there are the forecasts for 2008 and 2009 and the outlook of 2010.

Table 2.2: Housing stock in Euroconstruct countries

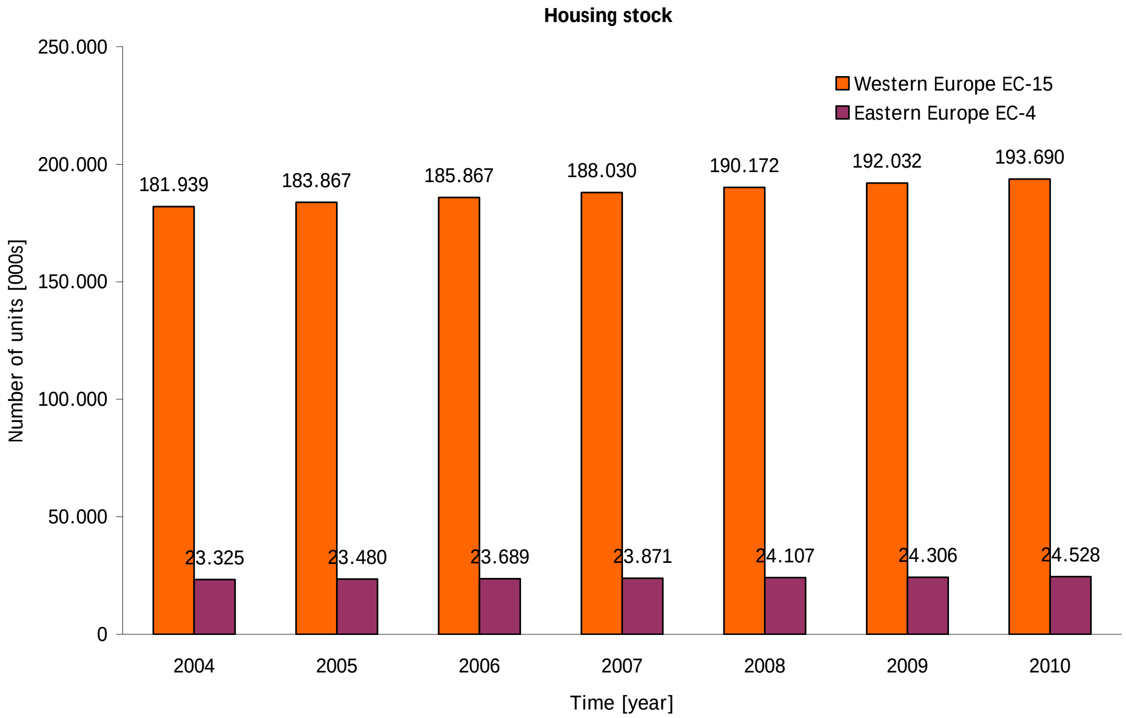
	2004	2005	2006	2007	Forecast		Outlook
					2008	2009	2010
Austria	3.849	3.879	3.910	3.941	3.963	3.986	4.005
Austria	3.849	3.879	3.910	3.941	3.963	3.986	4.005
Belgium	4.778	4.830	4.883	4.930	4.977	5.025	5.073
Denmark	2.814	2.844	2.865	2.885	2.905	2.925	2.945
Finland	2.635	2.667	2.700	2.730	2.760	2.785	2.810
France	30.264	30.610	30.952	31.283	31.604	31.920	32.231
Germany	37.380	37.500	37.600	37.700	37.800	37.900	38.000
Ireland	1.605	1.686	1.770	1.831	1.859	1.890	1.930
Italy	28.028	28.278	28.554	28.835	29.103	29.351	29.582
Norway	2.370	2.390	2.405	2.420	2.440	2.455	2.480
Portugal	5.391	5.462	5.520	5.575	5.629	5.683	5.737
Spain	22.623	23.210	23.859	24.600	25.400	25.950	26.300
Sweden	4.379	4.406	4.436	4.473	4.511	4.547	4.584
Switzerland	3.710	3.749	3.792	3.835	3.877	3.921	3.966
The Netherlands	6.810	6.859	6.912	6.970	7.027	7.083	7.136
United Kingdom	25.301	25.497	25.710	26.022	26.317	26.611	26.912
Western Europe (EC-15)	**181.939**	**183.867**	**185.867**	**188.030**	**190.172**	**192.032**	**193.690**
Czech Republic	4.430	4.462	4.514	4.545	4.580	4.610	4.640
Hungary	4.135	4.170	4.209	4.238	4.268	4.300	4.330
Poland	12.830	12.905	13.010	13.130	13.285	13.405	13.550
Slovak Republic	1.930	1.943	1.956	1.958	1.974	1.991	2.008
Eastern Europe (EC-4)	**23.325**	**23.480**	**23.689**	**23.871**	**24.107**	**24.306**	**24.528**
Euroconstruct Countries EC-19	**205.263**	**207.347**	**209.557**	**211.901**	**214.279**	**216.338**	**218.218**

Source: Data from the report "European construction market trends to 2010 Social housing and rehabilitation of suburban areas: programmes to 2015" 65th Euroconstruct Conference, Rome 12 - 13 June 2008.

In general, statistics on the supply of housing have to be treated with caution as they could provide contradictory information. From this table we obtain that the total number for housing stock is about 212 million in Euroconstruct countries, in 2007.

In order to highlight the difference between Western and Eastern European market in the following graph (fig. 2.3) we have diagrammed the housing stock trend for two European areas.

Figure 2.3: The housing stock trend for two Western (EC-15) and Eastern (EC-4) Europe

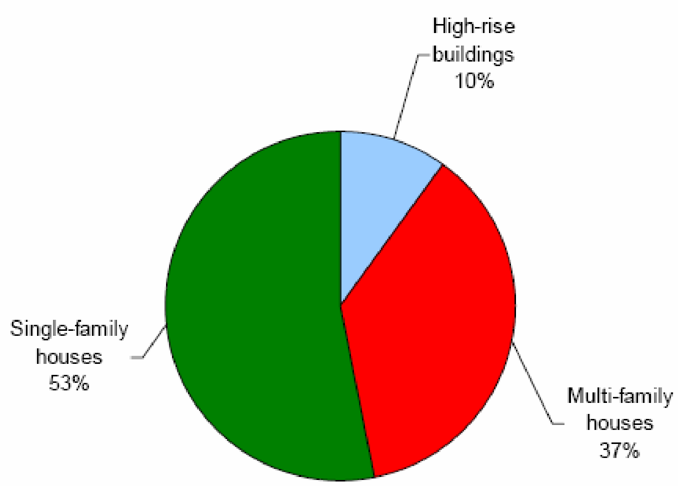


Source: Elaboration on data from the report "European construction market trends to 2010 Social housing and rehabilitation of suburban areas: programmes to 2015" 65th Euroconstruct Conference, Rome 12 - 13 June 2008.

From the figure it appears clear that the dimension of Western market is larger than Eastern.

According to Eurostat and IMPRO-Building, next figure shows the share of distribution of numbers of single-family houses, multi-family houses and high-rise buildings in EU-25 countries. As shown, **single-family and multi-family houses accounts for about the 90% of total housing stock in EU 25**.

Figure 2.4: Distribution of the housing stock in the EU-25



Source: IMPRO-Buildings

Table 2.3: Share of multi-family and high-rise dwelling in total dwelling stock (%)

Country	Multi-family dwellings	High-rise dwellings
Austria	52,1	n.a
Belgium	25,1	4,3
Cyprus	n.a.	n.a.
Czech Republic	56,5	33,8
Denmark	38,8	10,4
Estonia	68,2	n.a.
Finland	57,6	n.a.
France	43,3	15,9
Germany	53,9	6,0
Greece	40,6	n.a.
Hungary	33,6	23,2
Ireland	8,6	n.a.
Italy	74,7	22,7
Latvia	70,9	n.a.
Lithuania	61,2	n.a.
Luxembourg	29,1	16,2
Malta	n.a.	n.a.
Netherlands	31,1	6,7
Poland	63,1	38,9
Portugal	22,6	21,6
Slovak Republic	51,5	37,5
Slovenia	28,4	12,4
Spain	47,5	30,6
Sweden	51,9	n.a.
United Kingdom	18,7	2,4
EU-15	**47,0**	**14,7**
New member states	**55,8**	**34,1**

Note: High-rise dwellings are dwellings in residential buildings that contain several dwellings and have more than four storeys.

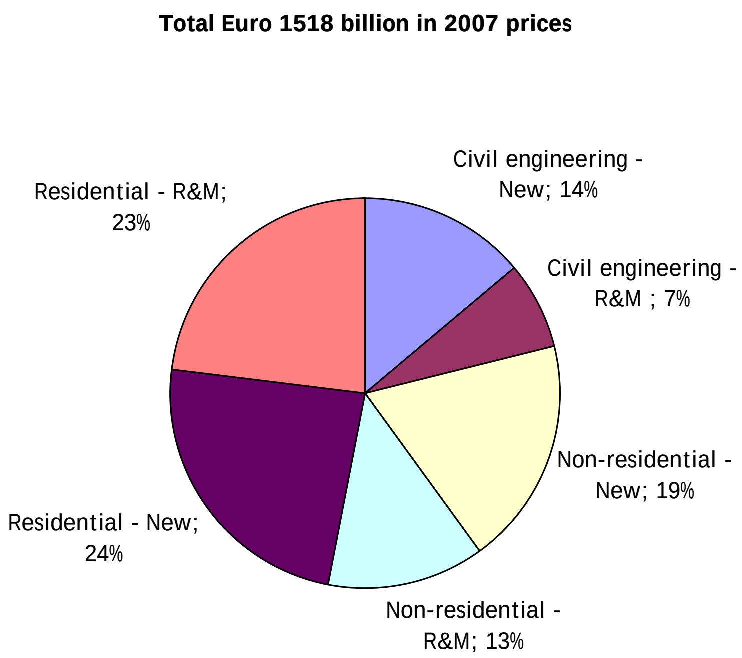
Source: National Board of Housing, Building and Planning, Sweden Ministry for Regional Development of the Czech Republic "Housing Statistics in the European Union 2004" February 2005.

2.3 THE EUROPEAN HOUSING MARKET

Most of the information used in this section comes from the report "European construction market trends to 2010 Social housing and rehabilitation of suburban areas: programmes to 2015" 65th Euroconstruct Conference, Rome 12 - 13 June 2008.

In 2007, construction sectors output was 1.518 billion Euro. Fig. 2.5 shows the share of output for new residential construction, residential renovation, civil engineering, new non-residential construction and non-residential renovation.

Figure 2.5: Share of construction sectors in 2007



Source: Euroconstruct 65th Euroconstruct Conference 2008 "European Construction market trends to 2010" – Summery Report, Rome 13 June 2008

The economic revival in Europe led to a significant increasing in construction in 2006, which slightly weakened in 2007. The 3.8 % growth in real construction output achieved by the 19 Euroconstruct countries in 2006 fell to a more modest 2% in 2007.

In the boom year of 2006, the construction sector was a significant engine in driving the overall European economy. But over the period 2007 to 2010, its dynamism is set to decline by comparison with the growth in GDP. During the forecast period (2008 to 2010), the 19 Euroconstruct countries are estimating average annual growth in GDP of 2.3%, while the construction sector of only around 1.5%. Demand for construction is falling, especially in Western Europe, whilst in Eastern European countries the sector is enjoying increasing dynamism and becoming an engine for growth for the overall economy.

The causes of the weakening economy for construction in Western Europe lie above all in the international financial crisis, the increasing strength of the Euro, higher interest rates and the bursting bubble in real estate markets (notably in Spain, Ireland and Great Britain), and the fall in overall demand in the economy.

In Central Eastern Europe, unlike Western Europe, the construction upswing is set to strengthen over the forecasting period. Following increases in real construction volume of 7.7% and 7.6% (2006 and 2007 respectively). Poland is exhibiting the greatest dynamism, with double-digit rates of growth. The construction sector in Slovakia is expected to grow more slowly, and the crisis in the Hungarian construction sector should be overcome in 2007. Growth in the Czech Republic is only likely to accelerate again to some extent towards the end of the forecast period.

Shift in trends within the construction sectors Analysis of the European construction market broken down across the individual sectors reveals an interesting shift within those segments. Whereas in 2006 housing construction still exerted key influence over growth in the overall construction sector, this segment becomes less important over the forecast period. The role as growth driver is now taken on by non-residential construction and by civil engineering. In Western Europe it is non-residential construction, which is primarily driving growth. In Eastern Europe, it is civil and - in this instance benefiting from subsidies from EU Structural Funds. The Eastern European countries are anticipating double-digit growth in 2008 - 2010. In addition, new housing construction is gaining in dynamism in Eastern Central European countries, as there is still a very significant catch-up requirement in these countries. Due to the high multiplier effects on employment and output, housing construction is playing a key role in the overall economic catching-up process in the new EU countries in particular (Euroconstruct, 2007).

According to the latest estimates (tab. 2.4), residential housing in the countries covered by Euroconstruct is forecast to generate approximately Euros 690 billion in 2008. This represents a decrease of –3.9% in real term against 2007 production (Euroconstruct, 2008).

In 2007 **new residential construction** was responsible for Euros 370.8 billion, which represents 52% of total production for the residential section.

Table 2.4: Expectations in terms of activity for new residential construction - % change of production volumes

	Forecast 2008		Forecast 2009		Outlook 2010	
	Vienna (XI'07)	Rome (VI'08)	Vienna (XI'07)	Rome (VI'08)	Vienna (XI'07)	Rome (VI'08)
Western Europe						
Total	-3,5	-8.6	-2,2	-5.1	-0,5	0.3
Total without Spain	-2,3	-6.0	-0,1	-2.4	0,1	0.8
Eastern Europe	7,0	8.8	7,4	4.9	7,0	5.7
Euroconstruct Countries	**-3,2**	**-8.0**	**-1,9**	**-4.7**	**-0,2**	**0.5**

Source: Euroconstruct, June 2008

Central and Eastern Europe maintain a positive trend in new residential construction sector in comparison with the general slowdown in the new housing in the rest of Euroconstruct zone.

2.4 HOUSING RENOVATION

Housing renovation in buildings that already been completed generated Euros 347.6 billion, 48% of total production in residential sector.

As the case in the new housing sub market, it is possible to notice a reduction from the comparison between scenario Euroconstruct hypothesized for 2008 and 2009 forecasts.

In table 2.5 it is possible to identify the two slight different hypotheses given by the experts of Euroconstruct about renovation sector. In this sector the forecast is just for stagnation in 2008 and a slow recovery of growth afterwards.

The project that involves full building renovations, developed by private initiative, are facing the same difficulties in terms of findings financing as that are being faced by new construction projects.

Renovation on the domestic scale, carried out by occupants of the house, are very frequently motivated by a change in ownership. Given that the pace of real estate transactions is slowing in a large number of countries, this is having a negative impact on renovations. The decrease in the spending power of families may also be influencing the postponement of all non-essential renovation and maintenance operations. But, on the other hand, and more in the medium term we should not rule out that the families that have decided not to buy a new home because they are shut of the market, may decide to enlarge or renovate their current homes.

Table 2.5: Expectations in terms of activity for housing renovation - % change of production volumes at constant prices

	Forecast 2008		Forecast 2009		Outlook 2010	
	Vienna (XI'07)	Rome (VI'08)	Vienna (XI'07)	Rome (VI'08)	Vienna (XI'07)	Rome (VI'08)
Western Europe	1,7	0,3	1,9	1,1	1,7	1,6
Eastern Europe	5,0	5,8	4,6	5,2	4,6	5,1
Euroconstruct Countries	**1,7**	**0,4**	**1,9**	**1,2**	**1,8**	**1,6**

Source: Euroconstruct, June 2008

2.5 NON-RESIDENTIAL MARKET

2007 marked a good year for the non-residential building sector, with output increasing by 5,2% across the Euroconstruct area in real terms, taking total output to over Euro 481 billion in 2007 prices. The new work sector did better than renovation and modernization, with increases in output of 6,8% and 2,9% respectively. However, 2007 is expected to be the peak of recent little spurt in the sector and the growth rate is predicted to moderate significantly over the period to 2010.

The most positive market in the new non-residential building sector in 2007 was the storage of miscellaneous ones, both with growth rates of close to 10%. Of the three biggest market, industrial offices and commercial, the former two of these fared best, with rises in output of over 8% during the year. Only the educational construction market was characterized by a decline in output last year, largely due to a sharp fall in UK, which accounts for nearly half of all educational construction output across the Euroconstruct area.

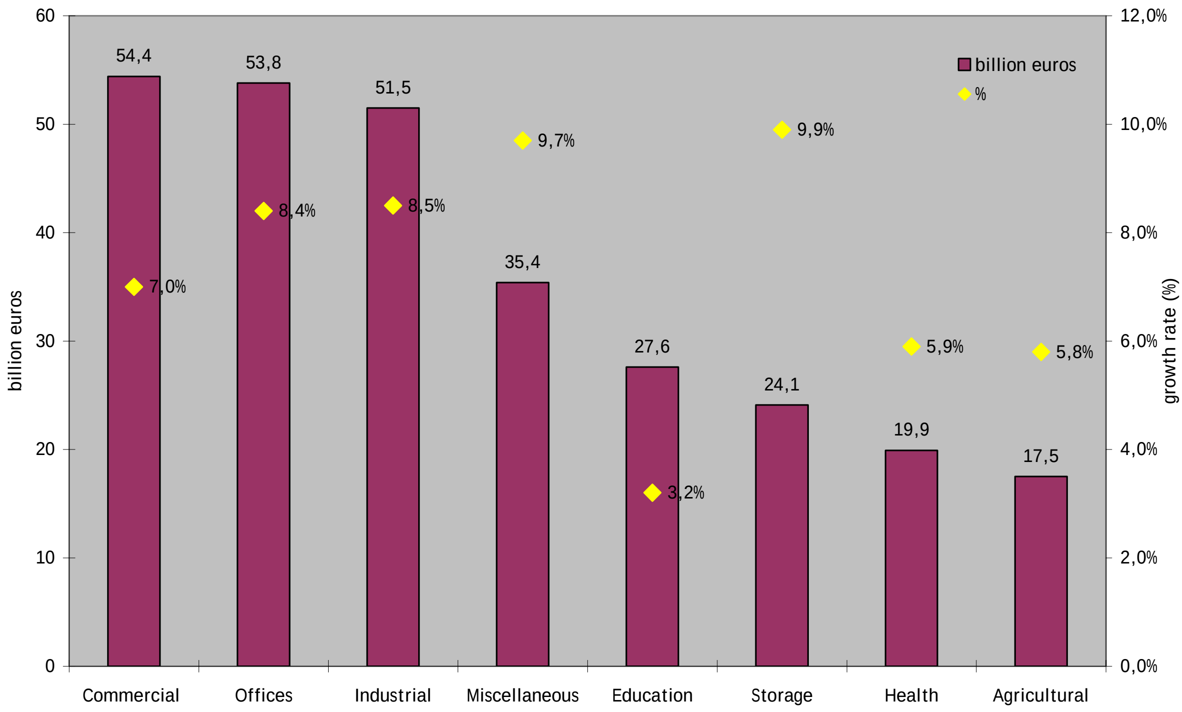
The non-residential sector marginally increased its share of total construction output in the Euroconstruct area in 2007 to 32% from 31% in the previous year. This increase in share was focused on the new non-residential sector and came at the expense of new residential building. New non-residential building increased its share of total non-residential building by 1% to 59% between 2006 and 2007, with renovation accounting for 41%.

The non-residential building sector is very heterogeneous one, comprising a variety of structure for different uses. Thus the drivers of individual market within the sector as a whole can be very different. The following list details some of main drivers for each of the market:

- Educational and health – public investment, although increasing use of private finance, demographic changes;
- Industrial – domestic demand, exports, foreign direct investment;
- Storage – transport developments, internet shopping, general economic health;
- Offices – corporate profitability and health of assets, foreign direct investment;
- Commercial – global spending, demographic changes, foreign direct investment;
- Agricultural – global food prices, Common Agricultural Policy.

In 2007, more than half (56%) of all new non-residential building (fig. 2.6), across the Euroconstruct area, was formed by three main sectors. commercial, offices and industrial markets. The following figure shows in detail the share for the new non-residential construction by market sector and growth rate, 2007

Figure 2.6: The new non-residential construction by market sector and growth rate, 2007



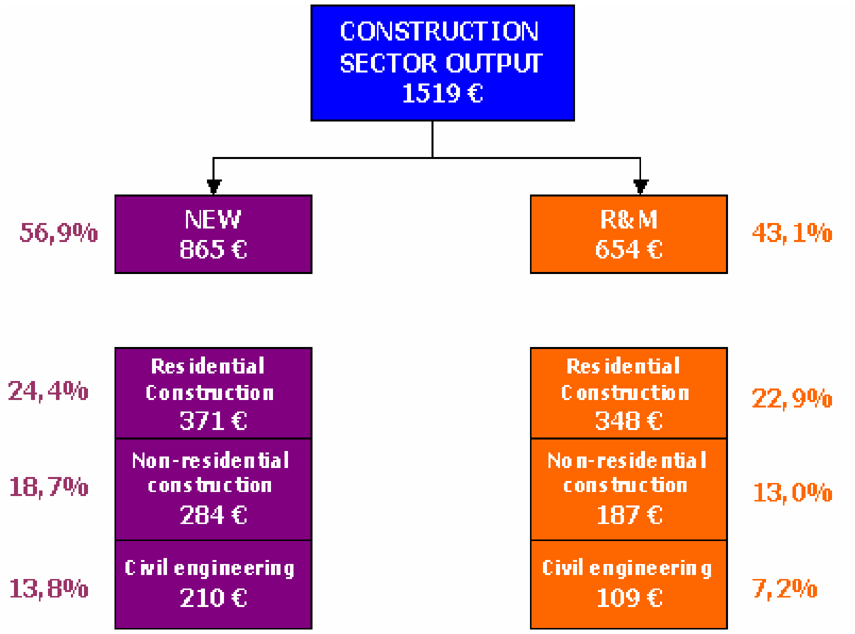
Source: Euroconstruct, June 2008

2.6 THE MARKET STRUCTURE IN 2007

In 2007 the output for the whole construction sector in the 19 countries of Euroconstruct network (fig 2.7) was quantified at more than Euro 1500 billion (at current 2007 prices) i.e. a little more than 12% of the 19 countries gross domestic product, a little less than Italy's GDP.

The residential sub-sector's role was decisive, it represented by itself almost one-half of the market, that is 718 billion euros, even if starting from 2007 it ceased to be the market's most dynamic component. For new construction and renovation non-residential more than 480 billion euros were invested, almost one-third of total investments.

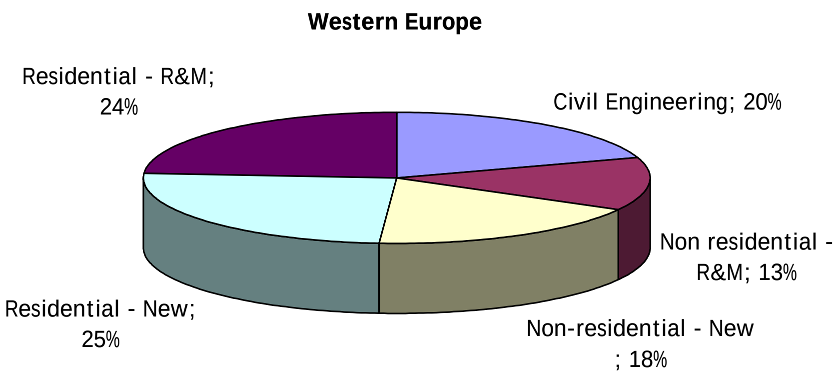
Figure 2.7: The construction market in Europe in 2007 - billions of euros,



Source: Euroconstruct, June 2008

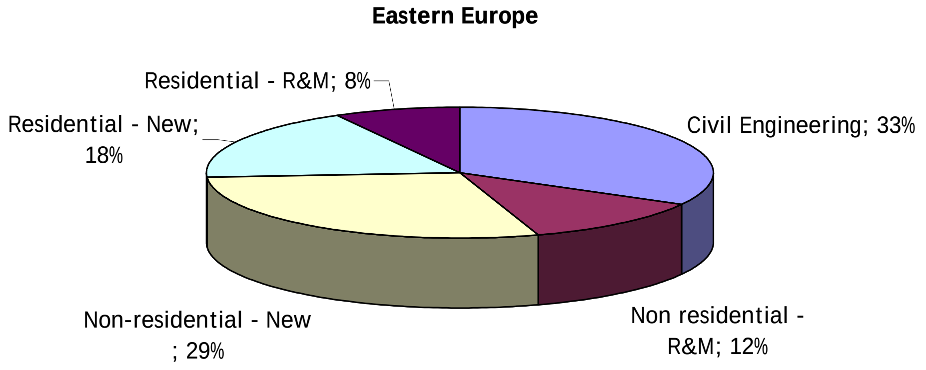
The big five countries represent together 72% of total output, of which more than 23% is due to Germany who, in the ultimate years of economic slowdown (up to 2005) still maintained her dominant position within the market. Second place goes to Spain, which gain the position in the ranking starting from 2006, surpassing the United Kingdom. The group of 4 European accounted, in 200, for less than 5% of to output produced by the entire European construction sector eastern countries

Figure 2.8: Share of construction sectors in Western Europe in 2007



Source: Euroconstruct, June 2008

Figure 2.9: Share of construction sectors in Eastern Europe in 2007



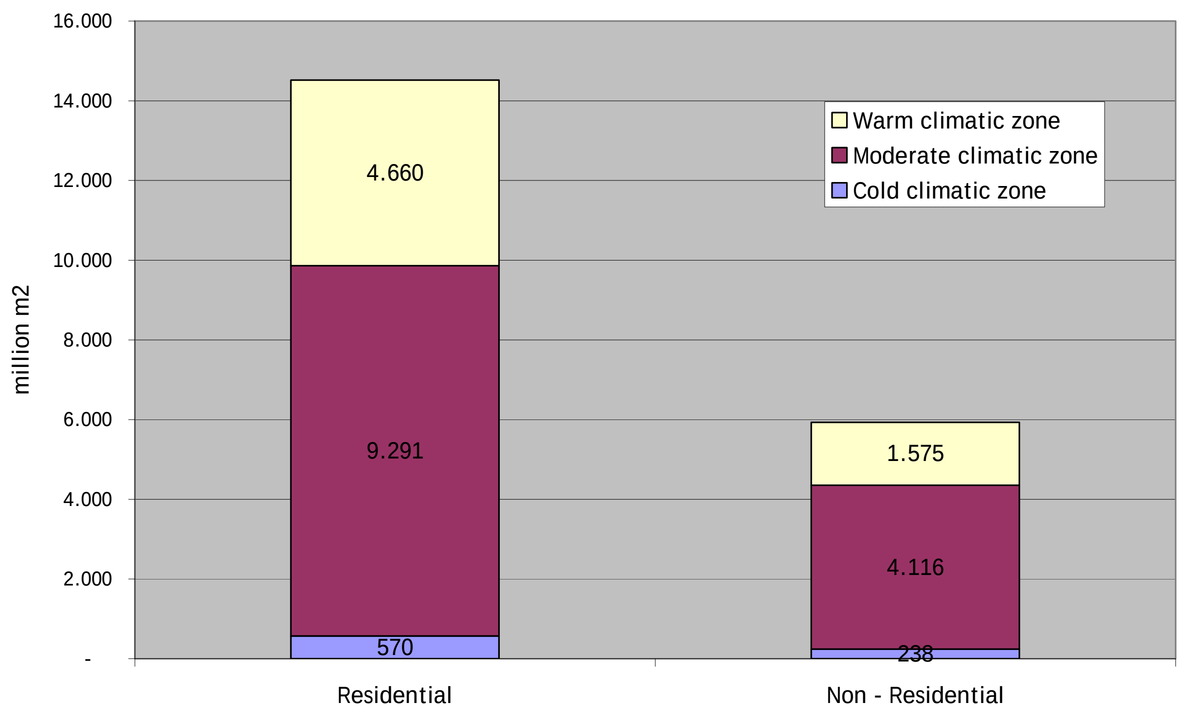
Source: Euroconstruct, June 2008

On the average for the fifteen countries of Western Europe residential production still accounts for more than 49% of total, that is more than 700 billions euros, distributed equally over new production and renovation of existing residential assets. In the East it is worth little than a half that: only 26% while the dominant slice of market is non-residential building construction.

The vitalization of the market for existing buildings (e.g., the resale market) is expected to be an effective means to promote the efficient use of building stock by reducing mismatches between demand and actual usage of buildings. Efficient markets could lengthen the real service life of buildings and provide various environmental benefits. Moreover, empirical evidence shows that development of the resale market encourages renovation work.

Figure 2.10 shows that residential building stock in Europe accounts for more than 70% in terms of m^2 most of them located in the moderate climate zone (64%).

Figure 2.10: Climatic characterisation of the European building stock



Source: Ecofys, Impact of the EPBD directive.

2.7 CONCLUSION

"…Europe is now on the way towards a substantial change in its energy supply system, reflecting a new awareness of the limited availability of fossil fuel resources and of the inescapable environmental impact of the global growth in energy demand. This new energy paradigm is composed of numerous facets. Improving the efficiency of energy consumption through the introduction of energy saving techniques both in buildings (houses, offices) and in economic activities (manufacturing, agriculture) is essential for further reducing the energy intensity of the European economy. High energy prices are also speeding up the structural transformation of the European economy towards a more technological and service-based model…" (ESPON Project, 2007).

The existing buildings stock in European countries accounts for over 40% of final energy consumption in the European Union (EU) member states, of which residential use represents 63% of total energy consumption in the buildings sector. Consequently, an increase of building energy performance can constitute an important instrument in the efforts to alleviate the EU energy import dependency and comply with the Kyoto Protocol to reduce carbon dioxide emissions.

Policy instruments for the improvement of energy efficiency in the building sector have long placed emphasis on newly built buildings. However, since the existing buildings accounts for a large proportion of the total stock upgrading the performance of existing buildings has become an urgent task.

The report focuses on residential sector because it is estimated the largest building sector (it accounts for about 70% of the total building stock).

The number of dwellings in EU-25 is about 196 million, with more than 50% of the existing residential buildings built before 1970 and about 1/3 of the dwellings built during the 1970-1990 (Norris M., Shiels P., 2004)

It is calculated that with a yearly added energy consumption reduction in dwellings of 1 %, this adds up to a 15 % in 2012 or 55 Mt on energy savings, avoiding 100 Mt CO_2 emissions a year, being 20% of the EU Kyoto commitment. Or, as another example, if we look at cost effective potential for energy efficiency measures in the building sector , it adds up to even 22 %., in heating, cooling hot water and lighting.

The total potential for dwellings, if all measures are implemented for all dwellings, reductions in CO_2 emissions could add up to 450 Mt, nearly the total Kyoto commitment only by dwellings!

The annual rate of construction of new dwellings expressed as a percentage of the size of existing stock ranging from 0.3% in Sweden to 3.5% in Ireland, with an average of 1.1%, while the estimated annual replacement rate (ratio of the annual demolition rate to the size of existing stock) for dwellings in Europe is only 0.07% (Hartless R., 2003). Furthermore, the emphasis is expected to shift towards renovation and maintenance of the existing housing stock in Western Europe, while in the developing markets of Eastern Europe is expected to accelerate sharply. About 70% of the residential buildings are over 30 years old and about 35% are more than 50 years old.

From an economic and social point of view, the problem of sustainable refurbishment and restructuring of multifamily housing stock built between the 1960s and the 1980s is a crucial issue affecting a large proportion of the population. The reasons for the poor technical condition of this part of the housing stock are: (a) low-quality construction; (b) the withdrawal of the State from maintenance and repair works as a result of mass privatization of the housing stock; and (c) a lack of institutions and homeowners' associations that could effectively take responsibility for ongoing maintenance.

Since most of these residential buildings were constructed during the same period and using similar technologies, physical stability problems are bound to arise simultaneously and on a large scale. Shortly, many of these residential buildings will become both unfit for living and dangerous. These problems pose a very significant political, economic and social challenge in the short and medium terms (United Nations – Economic and Social Council, 2008).

In conclusion, we do not have to expect much of the new constructed buildings in absolute lowering of impact, which leaves only the existing stock as a solution to lower the environmental load significantly within the next 20 or 30 years.

Policy generally followed three main approaches. First, there was a need to upgrade existing buildings to reduce energy consumption, because, for the most part, older buildings tend to be less energy-efficient than modern best practice. Second, there was a need to ensure new buildings would be built according to higher standards of thermal quality because building energy efficiency into the design and construction is cheaper than through retrofit. Third, there was a need to ensure that occupants modified their behaviour to promote the rational use of energy through being aware of how energy is used and through encouraging the elimination of wasteful practice. Total energy consumption in buildings is highly affected by occupants.

In this direction the development of methodological tools could offer (e.g. life cycle environmental impacts assessment for buildings) new opportunities for:

- ✓ Improving the design of new buildings by incorporating performances relevant to sustainable buildings, such as durability, flexibility and adaptability, in the tools assessing the environmental impact of building design;
- ✓ Promoting appropriate renovation work by applying assessment tools to the whole life cycle of buildings, including the renovation design stage;
- ✓ Assisting the decision of owners for renovation, etc., by enabling life cycle assessments;

In the OECD/IEA Workshop on Sustainable Buildings "Towards Sustainable Use of Building Stock" (15 – 16 January, 2004 Tokyo) sustainable buildings were defined as buildings having minimum adverse impacts on the built and natural environment, in terms of the buildings themselves, their immediate surroundings, and the broader regional and global setting, and in this we deem it must be the priority for the development of ecological and performance criteria of Ecolabel of buildings.

3. Terms and definitions

In this section of the report terms and definitions established from existing working groups at European and International level have been reported as well as definition used in some existing eco-labelling systems. In particular the work done so far by CEN 350 work group on Sustainability of construction works and the ISO TC59 work group on Building construction have been investigated.

Following tables show the structure and the specific topics of the CEN 350 and ISO TC59.

Table 3.1: CEN 350 - Sub-structure

SC/WG	Title
CEN/TC 350/WG 1	Environmental performance of buildings
CEN/TC 350/WG 2	Building Life Cycle Description
CEN/TC 350/WG 3	Products Level

Source: **http://www.cen.eu/**

Table 3.2: CEN/TC 350- Standards under development

Project reference	Title	Current status	DAV
prEN 15643-1	Sustainability of construction works - Integrated assessment of building performance - Part 1: General framework	Under Approval	
CEN/TC 350 /WG1 N015rev1	Sustainability of construction works - Assessment of environmental performance of buildings - Calculation methods	Under Development	2008-11
prEN 15804	Sustainability of construction works - Environmental product declarations - Product category rules	Under Approval	2010-02
	Sustainability of construction works - Environmental product declarations - Communication formats	Under Development	2010-04
	Sustainability of construction works - Environmental product declarations - Methodology and data for generic data	Under Development	2009-01
	Sustainability of construction works - Description of the building life cycle	Under Development	2009-10
prEN 15643-2	Sustainability of construction works - Integrated assessment of building performance - Part 2: Framework for the assessment of environmental performance	Under Development	2011-01

Source: **http://www.cen.eu/**

Table 3.3: ISO TC 59 - Subcommittees

Subcommittee	Subcommittee Title
TC 59/SC 2	Terminology and harmonization of languages
TC 59/SC 3	Functional/user requirements and performance in building construction
TC 59/SC 4	Dimensional tolerances and measurement
TC 59/SC 8	Jointing products
TC 59/SC 13	Organization of information about construction works
TC 59/SC 14	Design life
TC 59/SC 15	Performance criteria for single family attached and detached dwellings
TC 59/SC 16	Accessibility and usability of the built environment
TC 59/SC 17	Sustainability in building construction

Source: ***http://isotc.iso.org/***

Table 3.4: ISO TC 59/SC 17 - Subcommittees/Working Groups

Subcommittee/Working Group	Title
TC 59/SC 17/WG 1	General principles and terminology
TC 59/SC 17/WG 2	Sustainability indicators
TC 59/SC 17/WG 3	Environmental declaration of products
TC 59/SC 17/WG 4	Environmental performance of buildings
TC 59/SC 17/WG 5	Civil engineering works

Source: ***http://isotc.iso.org/***

1.1 CEN 350

In the green box below are reported terms and definitions as a result of the activities of the CEN 350 working group; the reference norm is the prEN 15643-2, Sustainability of construction works — Sustainability assessment of buildings — Part 2: Framework for the assessment of environmental performance.

Terms and definitions

For the purposes of this standard series, the following terms and definitions apply.

3.3

building

construction works (3.11) that has the provision of shelter for its occupants or contents as one of its main purposes and is usually enclosed and designed to stand permanently in one place

[ISO 6707-1:2004]

3.4
building site
specified area of land where a *building* (3.3) is located or is defined to be located and *construction work* (3.9) of the *building* and associated *external works* (3.25) are undertaken
NOTE Adapted from the definition of site in ISO 6707-1.

3.5
built environment
collection of man-made or induced physical objects located in a particular area or region.
NOTE 1 When treated as a whole, the *built environment* typically is taken to include *buildings* (3.3), *external works* (3.25) (landscaped areas), infrastructure and other *construction works* (3.10) within the area under consideration.
NOTE 2 Adapted from the definition of *environment* in ISO 6707-1.
[ISO 15392:2008]

3.7
component
construction product (3.8) manufactured as a distinct unit to serve a specific function or functions
[ISO 6707-1:2004]

3.8
construction product
item manufactured or processed for incorporation in *construction works* (3.10)
NOTE 1 *Construction products* are items supplied by a single responsible body.
NOTE 2 Adapted from the definition in ISO 6707-1 according to the recommendation of ISO/TC59/AHG Terminology.

3.9
construction work
activities of forming a *construction works* (3.10)
[ISO 6707-1:2004]

3.10
construction works
everything that is constructed or results from construction operations
NOTE 1 This covers both *building* (3.3) and civil engineering works, and both structural and non-structural elements.
NOTE 2 Adapted from the definition in ISO 6707-1.

3.13
design life
required *service life* (3.51)
NOTE Adapted from the definition in ISO 15686-1.

3.15
durability
ability to maintain *technical performance* (3.60) under the influence of the agents anticipated in service
NOTE 1 Durability can be assessed in terms of individual *construction products* (3.8), materials, and *components* (3.7) as well as whole *assembled systems (part of works)* (3.1) or *buildings* (3.3).
NOTE 2 Adapted from the definition in ISO 6707-1 according to the recommendation of ISO/TC59/AHG Terminology.

3.20
environmental aspect
Aspect of *construction works* (3.10), *part of works* (3.1), processes or services related to their *life cycle* (3.32) that can cause change to the environment
Examples: Use of energy and mass flow, production and segregation of wastes, water use, land use, emissions to air
NOTE The examples added to the definition of environmental aspect in ISO 15392.

[ISO/DIS 21931-1:2008]

3.21
environmental impact
any change to the environment, whether adverse or beneficial, wholly or partially resulting from *environmental aspects (3.20)*
NOTE Derived from the definitions of impact and environmental impact in ISO 15392.
[ISO/DIS 21931-1:2008]

3.22
environmental performance
performance (3.42) related to environmental impacts (3.21) and environmental aspects (3.20)
[ISO 15392:2008]
[ISO/DIS 21931-1:2008]

3.24
estimated service life
service life that a *building* (3.3) or an *assembled system (part of works)* (3.1) would be expected to have in a set of specific in-use conditions, determined from reference service life data after taking into account any differences from the reference in use conditions
[ISO/DIS 15686-1:2008]

3.25
external works
construction works (3.10) or landscape work on land associated with, or adjacent to, civil engineering works or a *building* (3.3)
[ISO 6707-1:2004]

3.32
life cycle
consecutive and interlinked stages of the object under consideration
NOTE 1 For consideration of *environmental impacts* (3.21) and *environmental aspects* (3.20), the *life cycle* comprises all stages from raw material acquisition or generation of natural resources up to and including final disposal.
[ISO15392:2008]

3.33
life cycle assessment
LCA
compilation and evaluation of the inputs, outputs and the potential *environmental impacts* (3.21) of a product system throughout its *life cycle* (3.32)
[EN ISO 14044:2006]
NOTE In this context a building or assembled system is considered a "product" and a part of a “product system”.

3.34
life cycle impact assessment
LCIA
phase of *life cycle assessment* (3.33) aimed at understanding and evaluating the magnitude and significance of the potential *environmental impacts* (3.21) for a product system throughout the *life cycle* (3.32) of the product
[EN ISO 14044:2006]
NOTE In this context a building or assembled system is considered a "product" and a part of a “product system”.

3.35
life cycle inventory analysis
LCI
phase of *life cycle assessment* (3.33) involving the compilation and quantification of inputs and outputs for a product throughout its *life cycle* (3.32)
[EN ISO 14044:2006]
NOTE In this context a building or assembled system is considered a "product" and a part of a “product system”.

3.36
maintainability
ability of a *component* (3.7) or an *assembled system (part of works)* (3.1) to be retained in a state in which it can perform its required functions or be restored to such a state when a fault occurs
NOTE Adapted from the definition in ISO 6707-1.

3.37
maintenance
combination of all technical and associated administrative actions during the *service life* (3.51) to retain a *building* (3.3) or an *assembled system (part of works)* (3.1) in a state in which it can perform its required functions
NOTE 1 *Maintenance* includes cleaning, servicing, repainting, repairing, replacing parts of the *construction works* (3.11) where needed, etc...(CPD Guidance Paper F).
NOTE 2 Adapted from the definition in ISO 15686-1 and ISO 6707-1 according to the CPD Guidance Paper F.

3.42
performance
expression relating the magnitude of a particular aspect of the object of consideration relative to specified requirements, objectives and/or targets
NOTE Adapted from the definition in ISO 6707-1 according to the draft recommendation of ISO/TC59/AHG Terminology.

3.44
project specification
specification of *construction works* (3.10) for a specific project that prescribes the *construction work* (3.9) and the *construction products* (3.8) to be used and how they are to be applied
[ISO 6707-2:1993]

3.45
recovery
waste (3.64) treatment operation that serves a purpose in replacing other resources or prepares *waste* for such a use
NOTE Adapted from the EC waste framework directive.

3.46
recycling
recovery (3.45) operation to reprocess materials for further use
NOTE Adapted from the EC waste framework directive.

3.47
refurbishment
modification and improvements to an existing *building* (3.3) in order to bring it up to an acceptable condition
[ISO 6707-1:2004]

3.51
service life
period of time after installation during which a *building* (3.3) or an *assembled system (part of works)* (3.1) meets or exceeds the *performance* (3.42) requirements
[ISO/DIS 15686-1:2008]

3.57
sustainability assessment of buildings
combination of the assessments of *environmental performance* (3.22), *social performance* (3.55) and *economic performance* (3.18) taking into account the *technical requirements* (3.61) and *functional requirements* (3.29) of a *building* (3.3) or an *assembled system (part of works)* (3.1), expressed at the building level

3.58
system boundary
interface in the assessment between a *building* (3.3) and the environment or other product systems
NOTE 1 *System boundary* defines what is included and what is not included in the assessment.
[ISO/DIS 21931-1:2008]

3.59
technical building system
technical equipment for heating, cooling, ventilation, domestic hot water, lighting and electricity production
NOTE 1 A *technical building system* can refer to one or to several building services (e.g. heating system, heating and domestic hot water system).
NOTE 2 A *technical building system* is composed of different subsystems.
NOTE 3 Electricity production can include cogeneration and photovoltaic systems.
[EN 15603:2008]

3.60
technical performance
performance (3.42) related to the capability of a *construction works* (3.10) or an *assembled system (part of works)* (3.1) to fulfil its required functions under the intended use conditions
NOTE Derived from the definition of "building performance" in ISO 6707-1

3.61
technical requirement
type and level of the capability of a *construction works* (3.10) or an *assembled system (part of works)* (3.1) to fulfil its required functions under the intended use conditions
NOTE Derived from the definition of "building performance" in ISO 6707-1 and from the definition of “functional requirement” in ISO/WD 15686-10

3.63
user
person or organization for which a *building* (3.3) is designed (including building owner, manager and occupants)
NOTE Adapted from the definition in ISO 6707-1.

1.2 ISO/TC 59

According to the ISO TC59 activities as described in the tables 4.3 and 4.4 and on the availability of public documents on the ISO website, is here reported a table resuming the proposed terms and definitions from the ISO TC59 - Ad Hoc Group on Terminology.

It has to be underlined that the terms and definitions set up by ISO TC 59 come from documents in progress (see Annex 1).

It has to be noting, also, the numerous connections between the ISO TC 59 definitions and the CEN 350 ones.

1.3 SOME DEFINITIONS FROM CERTIFICATION SYSTEMS

1.3.1 Nordic Swan eco-labelling

Definition from "Swan-labelling of Small houses - Version 1.5 • 15 March 2005 – 31 March 2010" states

"A Swan-labelled house is a small house produced in accordance with requirements regarding the building process, materials and energy consumption. The house has a small impact on the environment as well as a good indoor environment. Consideration is paid to all environmental aspects, from the raw materials to the end product. Requirements on the indoor environment are made by setting criteria for:

- ✓ constituent materials.
- ✓ good ventilation.
- ✓ the construction phase.
- ✓ material and quality controls to prohibit built-in damp damage.

There are also requirements regarding impact on the external environment covering:

- ✓ the prohibition of environmentally hazardous substances.
- ✓ energy efficiency in running the house.
- ✓ the environmentally suitable disposal of construction waste.
- ✓ a service and maintenance plan for the house.

<u>Small houses for residential purposes, e.g. detached, semi-detached and terraced houses can be Swan labelled.</u>

1.3.2 BREEAM rating system

In the BREEAM rating system the definition within "Ecohomes 2006 –The environmental rating for homes" is such as

Ecohomes covers all standard housing developments in England, Scotland, Wales and Northern Ireland:

- ✓ private and social housing schemes
- ✓ flats/apartments and houses
- ✓ new build and major refurbishment.

1.3.3 LEED

In “LEED for Homes Rating System – January 2008” and www.usgbc.org/leed/ is reported that

LEED for Homes is an initiative to promote the transformation of the mainstream homebuilding industry toward more sustainable practices. LEDD for Homes is targeting the top 25% of new homes with best practice environmental features.
….
LEED for Homes is a rating system that promotes the design and construction of high-performance green homes.

1.3.4 Klima:aktiv

In Technische Erläuterungen Kriterien zum klima:aktiv Haus Version 3.3.4 18. Januar 2008 is reported that criteria klima:aktiv are applicable to new residential buildings as well as existing residential buildings.

4. Main environmental impact of buildings

Main impacts produced from buildings during their life cycle have been investigated by numerous studies worldwide. These impacts are connected with the construction, use and end of life phases of buildings and can be investigated using the LCA methodology.

The LCA methodology allows evaluating impacts related with the use of energy and natural resources, with the emissions of pollutants in atmosphere, water and soil, with the consumption of the land and the production of wastes.

Nevertheless, LCA methodology can not "capture" other kind of impacts and aspects related with the connection between the building and the surrounding (in terms, e.g, of availability of public services, green areas, ecc.) and related with the connection between the building and their occupants – users (e.g. indoor quality).

For these reasons, most of environmental schemes for buildings certification (§ 6), take into account not only environmental impacts such as GWP or Resource Consumption, but also other important aspects such as Service quality and Health of users.

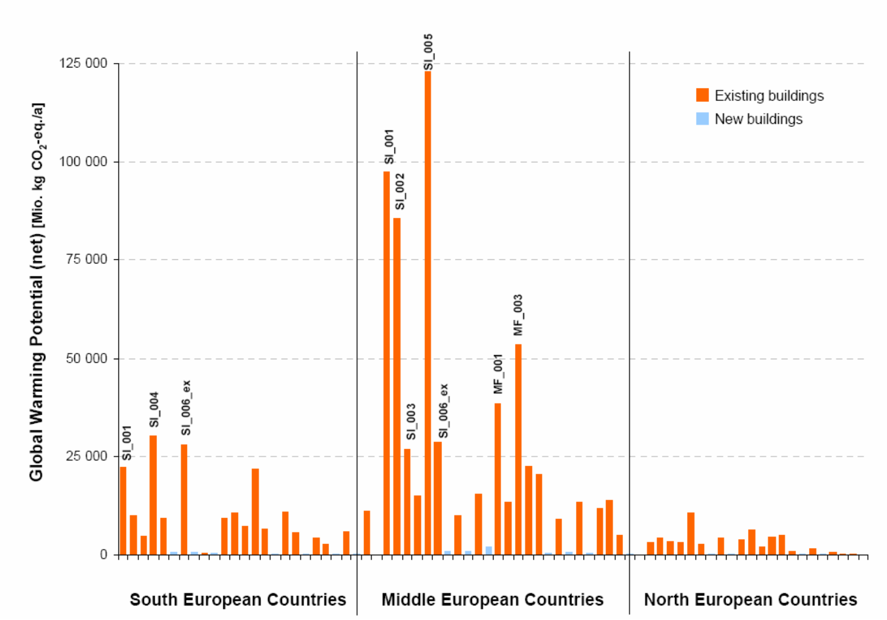
In this chapter of the report are underlined environmental impacts of buildings, focusing on those investigated with LCA methodology according also to the relevance of building sector in the CO_2 emissions.

The study "Environmental improvement potential of residential buildings" (Nemry & Uihlein, 2008), carried out for the IMPRO-Project of the European Commission, evaluates possible environmental improvements for the EU-25 residential building stock. Referring to that study for major deepening, it is interesting to point out some results of the study which examine three building types and their environmental performances, in relation with the three climatic zones of EU25 area, as follow:

Climatic zones	Single-family house	Multi-family house	High-rise building
Zone 1: South Europe			
Zone 2: Middle Europe			
Zone 3: North Europe			

Figure 4.1 shows the total environmental impact of the building stock in the EU—25 for the environmental indicator "Global Warming Potential" for existing and new buildings. It has to be noted that the contribution of new buildings on the GWP is negligible (is about 1%).

Figure 4.1: Total environmental impact of the residential building stock in the EU–25 for the environmental indicator "Global warming potential"



Source: IMPRO-Building

Following figures show very synthetically but effectively total environmental impacts of the EU-25 residential building stock, expressed for Life Cycle phase for existing (fig. 4.2) and new buildings (fig. 4.3). Impacts have been represented in two different figures for existing and new buildings because for existing ones it was not possible to evaluate impacts from construction phase.

However it is possible to compare impacts from existing and new buildings analysing, for example, the GWP for surface area and for year: figure 4.4 shows that impacts from existing buildings are, on average, always bigger than those of new buildings ones, for each building types.

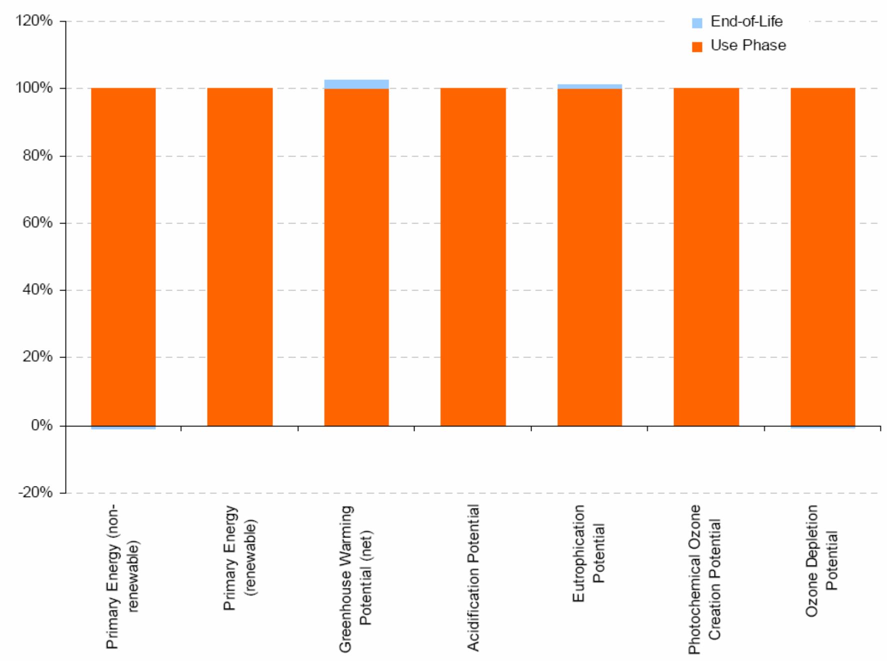
Therefore, it is interesting to observe that for new buildings, which have better environmental performances in the use phase than the existing buildings, the construction phase has an important role to reduce environmental impacts of the whole life cycle.

The figure 4.4 also shows that specific environmental performances of buildings improve in relation to an increase of dimension of buildings: is lower for single-houses, bigger for high-rise buildings. In the same figure, new buildings show better performances than existing ones.

Furthermore, due to climatic reasons, the specific environmental performances of buildings are worst for the North European Countries and better for the South European Countries.

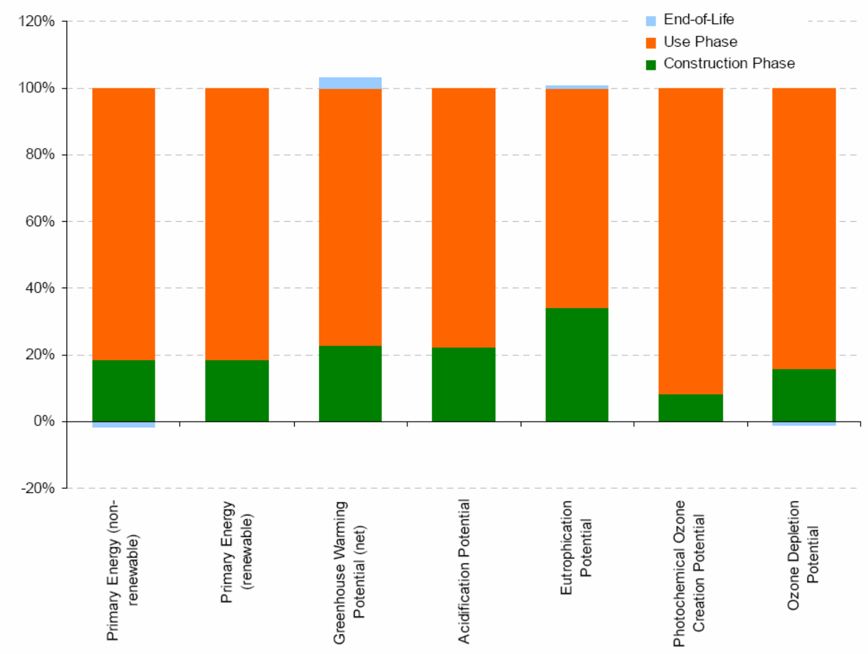
At present, due to the age of the European building stock, the use phase is the main responsible of environmental impacts of residential buildings. In the future, with renovation of old buildings and the construction of new buildings, probably the construction phase will assume more relevance in contributing to the whole impact in the life cycle.

Figure 4.2: Total environmental impact of the building stock in the EU-25 according to the life cycle phases (existing buildings)



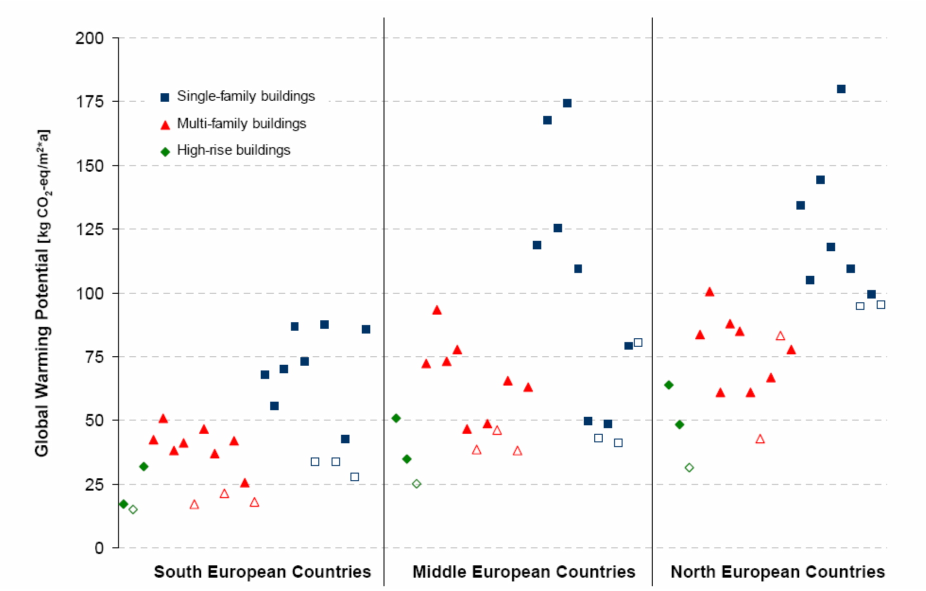
Source: IMPRO-Building

Figure 4.3: Total environmental impact of the building stock in the EU-25 according to life cycle phases (new buildings)



Source: IMPRO-Building

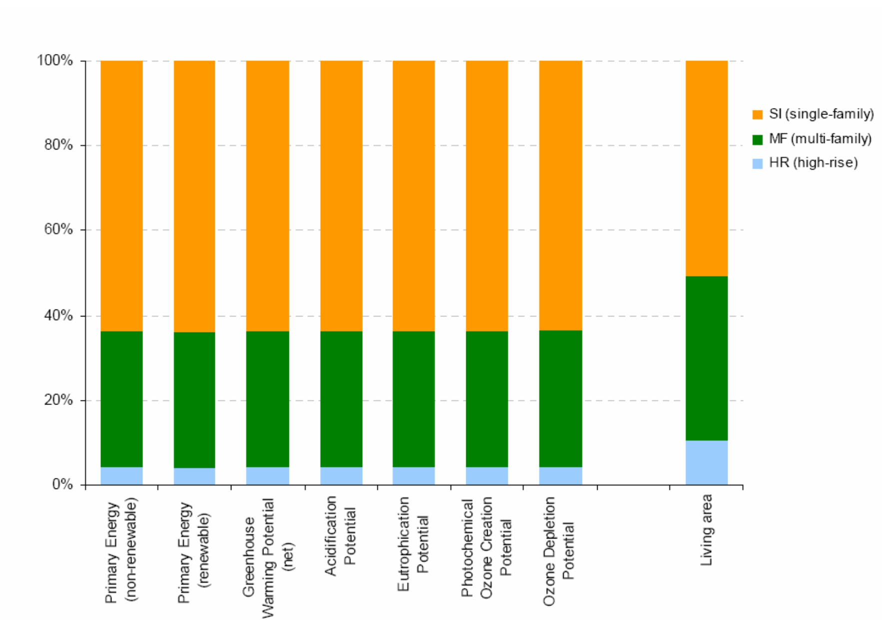
Figure 4.4: Life cycle impacts of all building types for the environmental impact category "Global Warming Potential". New buildings are indicated with blank symbols.



Source: IMPRO-Building

Total environmental impacts of EU-25 building stock are shown in the figure 4.5. It can be noted that main responsible of environmental impacts are single-family and multi-family houses for two reasons: together they account about 90% in number and have worst specific environmental performances in comparison with the high-rise buildings.

Figure 4.5: Relative contribution to the total environmental impact of the building stock in the EU-25 according to building groups



Source: IMPRO-Building

In the following part of the chapter, are reported, as an example, the main results of two LCA studies carried out on two buildings located in Italy.

The first one is an industrial building and the second one is a residential building with 8 floor and 84 flats. Results of the studies show environmental performances of those buildings.

Figures 4.7 and 4.9 show results of the two studies expressed in terms of ecopoints, according to the impact assessment method Eco-Indicator99 modified by authors.

In the first case (figure 4.7) shows that the energetic requirements in summer time is about the 54% of the overall energy consumption during the all life cycle of a building expressed in terms of ecopoints, followed by the construction phase which is about 29% and by the winter energetic requirements which is about (19%). The building is situated in a hot climate zone (Sicily) where it is necessary to largely use air conditioning system within the building.

In the second case examined (figure 4.9), the use phase is mainly accounting on the overall final impacts with about 84%. We are referring to a residential building with several floors situated in a quite cold climate zone (North of Italy).

Figure 4.6: The commercial building in Belpasso (CT), Italy

Source: Neri P. et Al., 2007

Table 4.1: LCA of a commercial building in Belpasso (CT), Italy - Main data

Case study	**Building**
Building type	Commercial
Construction material	
Title of the study	"Analisi del ciclo di vita di un capannone industriale prefabbricato in cemento armato precompresso prodotto dalla Sicep S.p.A. di Belpasso (Catania)"
Site	Belpasso (CT) - IT
Year	2006
Land occupation	62,41m2*55 year
Functional unit	The complete building (377m3)

System boundary	From the extraction of raw materials to the end of life of the building
Further details	
Life cycle (year)	55 anni
Authors	Carlo Ingrao-Paolo Neri
Reference	doc ENEA - ACS – P135 – 024 e 'Verso la certificazione degli edifici'- Alinea Editrice
Certification body	
Data from	SICEP Belpasso (CT) - IT
primary	
secondary	
Assessment method	Eco-indicator 99 modified
Indicator	Eco-point
Software	SimaPro7

Source: Neri P. et Al., 2007

Table 4.2: LCA of a commercial building in Belpasso (CT), Italy - Characterisation table according to Eco-indicator95 method

Impact factor	u.m. eq.	Construction phase	Winter energy consumption	Summer energy consumption	End of life	Total
greenhouse	kg CO2	2,849E+05	1,015E+06	2,738E+06	-7,804E+04	3,960E+06
ozone layer	kg CFC11	5,312E-02	3,303E+00	7,313E+00	-4,801E-03	1,066E+01
acidification	kg SO2	1,403E+03	3,608E+03	1,060E+04	-1,739E+02	1,544E+04
eutrophication	kg PO4	1,511E+02	2,073E+02	6,091E+02	-1,244E+01	9,550E+02
heavy metals	kg Pb	4,793E+00	4,142E+00	1,133E+01	-8,274E-01	1,944E+01
carcinogens	kg B(a)P	4,157E-02	2,455E-02	7,010E-02	-1,151E-03	1,351E-01
winter smog	kg SPM	5,829E+03	2,628E+03	7,713E+03	-1,352E+02	1,603E+04
summer smog	kg C2H4	1,212E+02	2,094E+02	6,122E+02	-7,928E+00	9,388E+02
energy resources	MJ LHV	3,395E+06	8,024E+06	2,360E+07	-7,298E+05	3,429E+07
solid waste	kg	-2,861E+02	0,000E+00	0,000E+00	-8,437E+04	-8,437E+04

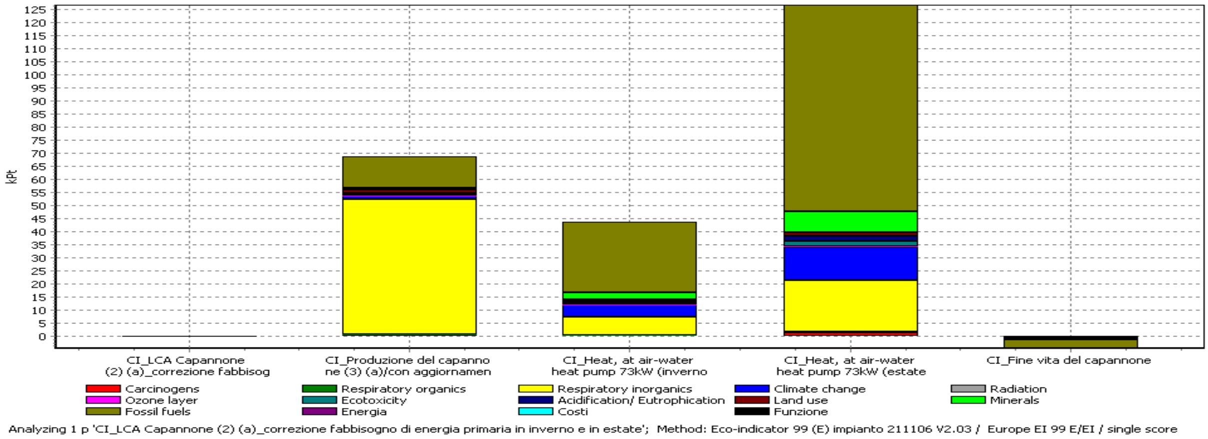
Source: Neri P. et Al., 2007

Table 4.3: LCA of a commercial building in Belpasso (CT), Italy - Characterisation table according to Eco-indicator99 method (modified)

Impact factor	u.m. damage assessment	Construction phase	Land use	Winter energy consumption	Summer energy consumption	End of life	Total
Human Health	DALY	2,492E+00	0,000E+00	5,650E-01	1,597E+00	-4,284E-02	4,611E+00
Ecosystem Quality	PDF*m2yr	3,660E+04	2,883E+03	2,777E+04	8,029E+04	6,469E+02	1,482E+05
Resources	MJ Surplus	2,263E+05	0,000E+00	5,292E+05	1,551E+06	-6,302E+04	2,244E+06
Non renewable energy	MJ	3,395E+06	0,000E+00	8,024E+06	2,360E+07	-7,298E+05	3,429E+07
Internal costs	€	1,061E+05	0,000E+00	1,125E+05	3,361E+05	1,350E+03	5,561E+05

Source: Neri P. et Al., 2007

Figure 4.7: LCA of a commercial building in Belpasso (CT), Italy - Ecopoints results according to Eco-indicator99 method (modified)



Source: Neri P. et Al., 2007

Figure 4.8: The residential building in Domodossola, Italy

Source: Neri P. et Al., 2007

Table 4.4: LCA of a residential building in Domodossola, Italy - Main data

Case study	Building
Building type	Residential – Multi-family house
Construction material	
Title of the study	Lo sviluppo sostenibile dell'Ucraina
Site	Domodossola - IT
Year	2008
Land occupation	1053.49m2*100 years

Functional unit	The complete building (84 modules)
System boundary	From the extraction of raw materials to the end of life of the building
Further details	8 floor building - 84 flats (modules)
LC (year)	100 years
Authors	Valentina Toscano-Paolo Neri
Reference	ENEA - ACS - P795 - 010
Certification body	
Data from	DOMUSFUTURA - IT
primary	
secondary	
Assessment method	Eco-indicator 99 modified
Indicator	Eco-points
Software	SimaPro7

Source: Neri P. et Al., 2007

Table 4.5: LCA of a residential building in Domodossola, Italy - Characterisation table according to Eco-indicator95 method

Impact factor	u.m. eq.	Construction	Use	Total
greenhouse	kg CO2	2,222E+06	1,968E+07	2,191E+07
ozone layer	kg CFC11	2,165E-01	1,013E+01	1,035E+01
acidification	kg SO2	9,200E+03	1,190E+05	1,282E+05
eutrophication	kg PO4	1,017E+03	4,417E+03	5,435E+03
heavy metals	kg Pb	2,724E+01	1,385E+02	1,657E+02
carcinogens	kg B(a)P	2,873E-01	7,118E-01	9,990E-01
winter smog	kg SPM	6,102E+04	9,862E+04	1,596E+05
summer smog	kg C2H4	9,094E+02	4,036E+03	4,946E+03
energy resources	MJ LHV	2,858E+07	4,463E+08	4,749E+08
solid waste	kg	2,867E+04	0,000E+00	2,867E+04

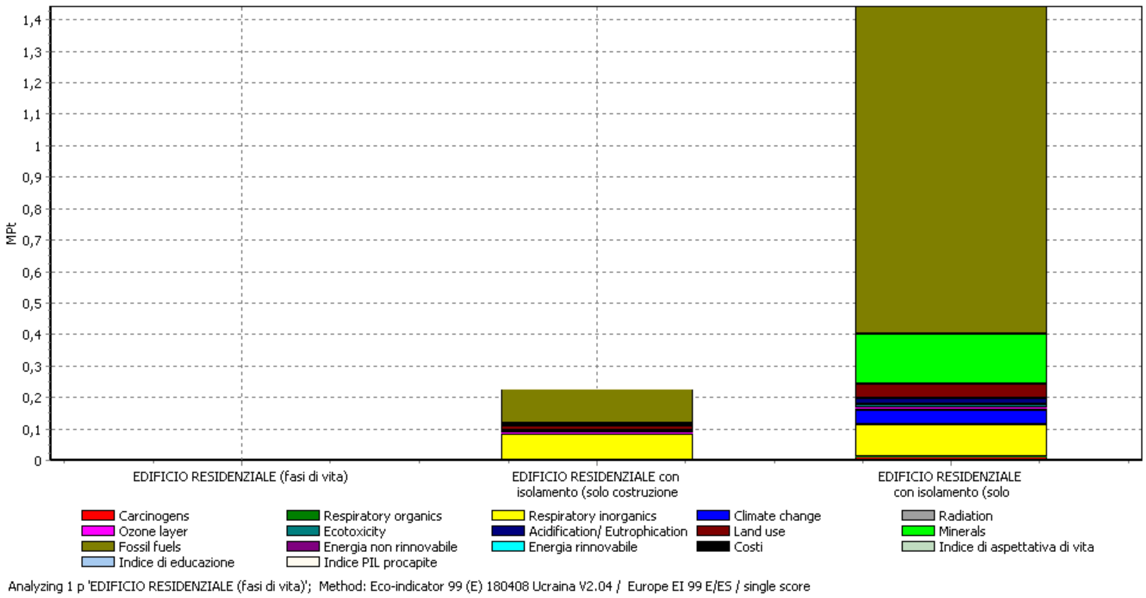
Source: Neri P. et Al., 2007

Table 4.6: LCA of a residential building in Domodossola, Italy - Characterisation table according to Eco-indicator99 method (modified)

Impact factor	u.m. damage assessment	Construction	Use	Total
Human Health	DALY	8,239E+00	1,537E+01	2,361E+01
Ecosystem Quality	PDF*m2yr	3,633E+05	1,150E+06	1,486E+06
Resources	MJ Surplus	2,098E+06	2,146E+07	2,356E+07
Non renewable energy	MJ	2,726E+07	4,243E+08	4,516E+08
Renewable energy	MJ	1,323E+06	2,197E+07	2,329E+07

Source: Neri P. et Al., 2007

Figure 4.9: LCA of a residential building in Domodossola, Italy - Ecopoints results according to Eco-indicator99 method (modified)



Source: Neri P. et Al., 2007

5. Rating systems statistics

In order to have an overview on the application of various building certification systems worldwide, available statistics data from two well spread certification systems have been investigated: the Breeam and the Leed rating systems. Both these rating systems can be applied at various kinds of buildings and at various life cycle phases.

From the statistic of Breeam system it emerges that Eco-homes rating system represents for the Breeam, developed and adopted in the UK, the most important building certification systems with the 75% of the total certificated buildings in the UK. BREEAM Ecohomes can assess new homes, apartments/flats, and houses, apartments and flats undergoing major refurbishment at the design stage and post construction. With about the 15% of the certified buildings, the Breeam Office represents the second application in the UK.

Therefore it results that Breeam system, which is applicable to the European building context, is mainly applied within the residential market, both for new and renovated buildings.

Table 5.1 and the following text explain data and the fields of application of the Breeam rating systems.

Concerning the LEED system, born and developed in USA but also spread in many other countries, the main application field is the LEED New Construction with about 47% of certified buildings in USA.

In other terms the major interest for the market is coming from the new construction market as well as from renovation on public and commercial buildings. Nevertheless the LEED Homes system applicable to residential buildings, receives a similar interest from the market comparable with the previous sector: about 36% of certified buildings by LEED are residential buildings.

It is important to underline the difference between the USA's building stock compared to the UK building stock and to the European ones, in particular with respect to the type of residential buildings.

In table 5.2 are reported data of certified buildings in USA within the LEED system. The following explanation points out the different fields of application as defined by the LEED system.

Table 5.1: Breeam certified buildings.

	n.	%
Aspire Defence Capital Works	63	0,92%
Bespoke	203	2,97%
Bespoke EcoHomes	25	0,37%
Code for Sustainable Homes	8	0,12%
Ecohomes	5.124	75,02%
Industrial/Warehousing	356	5,21%
International Bespoke	1	0,01%
Office	996	14,58%
Retail	17	0,25%
Schools	34	0,50%
Secure Prison Accommodation	3	0,04%
Total	**6.830**	**100,00%**

Source: our elaboration on Bre data

BREEAM Buildings can be used to assess the environmental performance of any type of building (new and existing). Standard versions exist for common building types and less common building types can be assessed against tailored criteria under the Bespoke BREEAM version. Buildings outside the UK can also be assessed using BREEAM International that can be used to assess a single development or BRE can also assist in creating a BREEAM version for a country or region.

BREEAM Buildings:

- BREEAM Bespoke can assess buildings that fall outside the standard BREEAM categories, including leisure complexes, laboratories, higher & further education buildings and hotels at the design stage and post construction.
- BREEAM Courts can assess both new build and the major refurbishment of court buildings. BREEAM Courts assessments are certified through the Bespoke BREEAM.
- The code for sustainable homes. In April 2007 the Code for Sustainable Homes replaced Ecohomes for the assessment of new housing in England. The Code is an environmental assessment method for new homes based upon BRE's Ecohomes and contains mandatory performance levels in 6 key areas.
- BREEAM Ecohomes can assess new homes, apartments/flats, and houses, apartments and flats undergoing major refurbishment at the design stage and post construction.
  Ecohomes Assessments can be carried out at both the design stage or post construction for New build and major refurbishment projects;
- BREEAM ECOHOMES XB. A tool for housing associations and housing stock managers as a stock management aid for existing buildings.
- BREEAM Industrial can assess storage and distribution, light industrial units, factories and workshops at the design stage and post construction. BREEAM Industrial can be used to assess the environmental impact of storage and distribution, light industrial units, factories and workshops. BREEAM Industrial assessments can be carried out for new buildings, design stage and post construction stages, buildings undergoing major refurbishment;
- BREEAM International can assess a single development or BRE can also assist in creating a BREEAM version for a country or region outside of the UK.
- BREEAM Multi-Residential can assess student halls of residence, sheltered housing for the elderly, supported housing and hostel type accommodation at the design stage and post construction.
- BREEAM Prisons can assess high and standard security prisons, young offenders institutions, local prisons and women's prisons at the design stage and post construction.
- BREEAM Offices can assess new build or major refurbishment and existing offices, at the design stage, post construction and in use. BREEAM Offices assessments can be carried out on both new and existing office buildings - not occupied or occupied, as follows: New build or refurbishment: design and procurement; Existing office (occupied): management and operation.
- BREEAM Retail can assess new build or major refurbishment, post construction, tenant fit-out, existing (occupied), management and operation.
- BREEAM Schools can assess new schools, major refurbishment projects and extensions at the design stage and post construction. Assessments can be carried out at the design stage and verified post construction for primary and secondary schools including the following: New Schools; Major refurbishment projects; Extensions.

Table 5.2: LEED rating systems - buildings registered/certified

	Registered	Certified	Registered	Certified
Commercial interiors	1.001	216	9,7%	10,4%
Core & Shell	1.341	59	13,0%	2,9%
Existing buildings	979	70	9,5%	3,4%
Homes	n.a	743	n.a	35,9%
Neighbourhood Development	234	-	2,3%	0,0%
New Construction	6.442	980	62,5%	47,3%
Retail	86	2	0,8%	0,1%
School	227	-	2,2%	0,0%
Total	**10.310**	**2.070**	**100,0%**	**100,0%**

Source: our elaboration on GBC data

- New Construction. LEED for New Construction and Major Renovations is designed to guide and distinguish high-performance commercial and institutional projects.
  The LEED for New Construction Rating System is designed to guide and distinguish high-performance commercial and institutional projects, including office buildings, high-rise residential buildings, government buildings, recreational facilities, manufacturing plants and laboratories.
- Existing Buildings. LEED for Existing Buildings: Operations & Maintenance provides a benchmark for building owners and operators to measure operations, improvements and maintenance. LEED for Existing Buildings can be used to certify the following types of buildings:
  - LEED-NC certified buildings seeking ongoing re-certification
  - LEED for Existing Buildings certified buildings seeking ongoing re-certification LEED for Existing Buildings
  - Non-LEED buildings seeking initial certification and ongoing re-certification
- Commercial Interiors. LEED for Commercial Interiors is a benchmark for the tenant improvement market that gives the power to make sustainable choices to tenants and designers.
  The LEED-CI Rating System is applicable to tenant improvements of new or existing office space.
- Core & Shell. LEED for Core & Shell aids designers, builders, developers and new building owners in implementing sustainable design for new core and shell construction.
- Schools. LEED for Schools is the recognized third-party standard for high performance schools that are healthy for students, comfortable for teachers, and cost-effective. The LEED for Schools Rating System is most applicable to new construction and major renovation projects in K-12 educational spaces. Other projects, such as university educational buildings, K-12 athletic facilities, or interpretive centres, may choose to use LEED for Schools if they wish.
- Retail. LEED for Retail recognizes the unique nature of retail design and construction projects and addresses the specific needs of retail spaces. IN PILOT
- Healthcare. LEED for Healthcare promotes sustainable planning, design and construction for high-performance healthcare facilities. – DRAFT
- Homes. LEED for Homes promotes the design and construction of high-performance green homes.
- Neighbourhood Development. LEED for Neighbourhood Development integrates the principles of smart growth, urbanism and green building into the first national standard for neighbourhood design.

6. Overview of criteria adopted by existing building certification schemes

In order to present a preliminary overview of the most relevant criteria used in existing eco-labels, certification schemes or guidelines, the existing initiatives listed below have been analysed. In this chapter have been reported the principal application field of criteria examined, while the detailed analysis, qualitative and quantitative, for each criterion will be elaborated in the next report.

The building certification systems which have been examined are:

- ✓ Breeam Eco-Homes;
- ✓ CasaClima-KlimaHaus;
- ✓ Guidelines for sustainable building;
- ✓ Haute Qualité Environnementale (HQE);
- ✓ iiSBE;
- ✓ ITACA;
- ✓ Klima:aktiv;
- ✓ LEED;
- ✓ LEnSE;
- ✓ SB100
- ✓ Nordic Swan eco-labelling.

The main topics tackled by the listed different schemes are reported in table 6.1.

The table shows that the majority of criteria focus on specific aspects which characterise the performance not only environmental, of buildings such as:

- ✓ Energy aspects;
- ✓ Material characteristics and resource management;
- ✓ Indoor wellness.

Most criteria are also addressed to characteristics of the building related to the territory in terms of site choice, inclusion of the building in the social-cultural context, availability and quality service presence (in particular concerning service transport and waste management).

It is interesting to point out that some criteria are also related to the quality of the service offered by the building such as correct maintenance plans and management of the building itself.

Some ecolabels are also addressing criteria to the project phase, construction and management phase.

It is important to notice that the ecolabels examined present different methodological approaches, such as qualitative or quantitative. Some of them are working on the base of a point system (i.e. Breeam or LEED), others are based on levels to be achieved (i.e. swan-ecolabelling).

Table 6.1: Main topics of criteria for many environmental certification schemes of buildings

Main topics	Breeam eco-homes	CasaClima - KlimaHaus	Guidelines for sustainable building	Haute Qualité Environnementale	iiSBE	ITACA	klima:aktiv	LEED Homes	LEnSE	SB100	Swan ecolabelling
Pre-assessment scenario			x		x			x	x		
Design				x	x		x	x	x		
Construction phase				x	x		x	x			
Energy	x	x	x	x	x	x	x	x	x	x	x
Transport	x		x			x			x		
Pollution & Waste	x		x	x	x	x		x	x	x	x
Materials & Resource use	x	x	x	x	x	x	x	x	x	x	x
Water	x		x	x	x	x	x	x	x	x	
Land use and ecology	x		x	x	x	x		x	x	x	
Health and well being	x		x	x	x	x	x	x	x	x	
Management	x		x		x	x		x	x	x	x
Service quality					x	x					x
Economic aspects			x		x				x	x	
End of life			x							x	
Socio-cultural aspects			x		x	x			x		

7. Product group definition

From the analyses carried out and briefly reported in this document it emerges the prevalence in terms of market data, existing certified buildings, existing certification schemes in place, of residential building sector.

Considering that new construction buildings are the most relevant target for environmental improvements in terms of applicability for new available techniques and materials, starting from the design phase throughout the all life cycle;

considering that existing residential buildings are accounting for the 70% of the total stock buildings and that can have a high margin for environmental improvements during use phase by means for instance technological improvements;

according to the discussion emerged during the AHWG meeting about the consideration of residential buildings and buildings for use of offices;

considering the synergies already in place within the European environmental policies and the potential synergies amongst Ecolabel criteria and Green Public Procurement;

considering the potential interest of Public Administration in using European Ecolabel criteria;

according to the existing definition of some national Ecolabels already developed and spread in some European Member States;

product group definition for “buildings” shall comprise: “buildings considered in their entirety, as well as small houses, new or existing, public or private, used for residential purpose and for use as offices”.

From the definition part of the building such as dwellings are excluded.

New buildings include also major refurbishments.

Existing buildings include also renovations.

Residential purpose is meant as for dwelling purpose.

Use as offices is meant to be the use of the building for administrative, bureaucratic and educational activities of a public or private nature.

Criteria structure:

according to the product group definition proposed and according to the different level of potential environmental improvement that occurs in new buildings compared to existing ones, the criteria could be divided in two main sections:

- criteria for existing buildings
- criteria for new buildings

8. References

CEN, CEN350 - prEN 15643-2 - Sustainability of construction works — Sustainability assessment of buildings — Part 2: Framework for the assessment of environmental performance

ESPON project, "Scenarios on the territorial future of Europe", may 2007

EUROCONSTRUCT, "European construction market trends to 2010 Social housing and rehabilitation of suburban areas: programmes to 2015" 65th Euroconstruct Conference, Rome 12 - 13 June 2008.

EUROCONSTRUCT, The 64th EUROCONSTRUCT conference organized by WIFO - the Austrian Institute of Economic Research is held on 23rd November 2007 in Vienna

Hartless R., Application of energy performance regulations to existing buildings. Final report of the Task B4, ENPER TEBUC Project, SAVE 4.1031/C/00-018, Building Research Establishment, Watford UK; 2003

ISO, ISO/TC 59 - BUILDING CONSTRUCTION - Ad Hoc Group on Terminology

Itard Laure, Meijer Frits, Vrins Evert & Hoiting Harry, "Building Renovation and Modernisation in Europe: State of the art review"; on behalf of ERABUILD; Delft, 31 January 2008.

Nemry F., Uihlein A., "Environmental improvement potentials of residential buildings (IMPRO – Building), IMPRO Project, EC, 2008.

Neri P. et Al., Casi studio LCA della rete di ricerca - "Verso la valutazione ambientale degli edifici", Firenze, 2007.

Norris M, Shiels P., "Regular National Report on Housing Developments in European Countries", Synthesis Report. - The Housing Unit, Dublin, Ireland; 2004.

Petersdorff Carsten, Boermans Thomas and Harnisch Jochen, "Mitigation of CO_2 Emissions from the EU-15 Building Stock. Beyond the EU Directive on the Energy Performance of Buildings", Environmental Science and Pollution Research, Springer Berlin / Heidelberg, Volume 13, Number 5 / September, 2006

REHWA, Summary of Workshop in REHVA World Congress Clima 2007 - WellBeing Indoors - WS 15 – Economics of Indoor Climate, 12 June 2007

UNEP, Building and Climate Change, Unep 2007

United Nations – Economic and Social Council (Economic Commission for Europe), "PROGRAMME OF WORK FOR 2008–2009 HOUSING MODERNIZATION AND MANAGEMENT "Multifamily housing management: analysis of the replies to the questionnaire" July 2008.

www.breeam.org

www.usgbc.org/leed/

Appendix 1 - Terms and definitions from ISO TC 59

WG 1 General Principles **(WG1 N039rev Beijing edit)** **ISO 15392** **Terminology: ISO 21932**	**WG 2 Indicators** **(SC17 "N469" ballot version)** **ISO 21929**	**WG 3 Declaration** **(N468 draft 13rev Beijing edit)** **ISO 21930**	**WG 4 Assessment** **(N140 DTS)** **ISO 21931**
For the purposes of this standard, the following definitions and the definitions contained within ISO 6707-1, ISO TR 21932 and ISO 14050 apply. Where conflicts exist, the terms and definitions contained within this standard govern. Note Terms are not defined where they retain their normal dictionary definition	For the purposes of this Technical Specification, the terms and definitions given in ISO 6707-1, ISO 14041, ISO 14050, and ISO/CD 21932 apply, together with the following definitions.	For the purposes of this standard the terms and definitions given in ISO 6707-1, ISO 14001, ISO 14025, ISO 14050, ISO/DTS 21932, and the following definitions apply.	For the purposes of this Technical Specification, the terms and conditions given in ISO 14050, together with the following definitions, apply.
Cross references to be inserted bold (3.2) throughout all documents			
aspect: particular element or particular quality of the whole. 3.1.1 economic aspect: aspect (3.1) of construction works (3.5), parts of works, processes or services related to their lifecycle (3.11), that can interact with economic conditions. 3.1.2 environmental aspect: aspect (3.1) of construction works (3.5), parts of works, processes or services related to their lifecycle (3.11), that can interact with the environment. NOTE: Adapted from ISO 14001 3.1.3 social aspect: aspect (3.1) of			3.5 environmental aspect of a building characteristics of a building, its operation or its services that can interact with the environment **proposed change:** **aspect** (x.x) of **construction works** (x.x), parts of works, processes or services related to their **lifecycle** (x.x), that can interact with the environment. NOTE: Adapted from ISO 14001

construction works (3.5), parts of works, processes or services related to their lifecycle (3.11), that can interact with society or quality of life.			
3.2 building: construction works (3.5) that has the provision of shelter for its occupants or contents as one of its main purposes; usually partially or totally enclosed and designed to stand permanently in one place. (ISO 6707-1)			
building environment: surroundings in which a building (3.2) is located, including air, water, land, resources, flora, fauna, human beings and their interrelation. NOTE 1 Surroundings in this context includes the environment within a building as well as outside. NOTE 2 Derived from the definition of *environment* in ISO 14001		3.3 building environment interior and exterior of buildings , including air, water, land/soil, resources, flora, fauna, human beings and their inter-relations **proposed change:** surroundings in which a **building** (x.x) is located, including air, water, land, resources, flora, fauna, human beings and their interrelation. NOTE 1 Surroundings in this context includes the environment within a building as well as outside. NOTE 2 Derived from the definition of *environment* in ISO 14001	3.1 building environment surroundings in which a building operates, including air, water, land, natural resources, flora, fauna, human beings and their inter-relations NOTE Surroundings in this context extend from within a building to the boundaries of the building site **proposed change:** surroundings in which a **building** (x.x) is located, including air, water, land, resources, flora, fauna, human beings and their interrelation. NOTE 1 Surroundings in this context includes the environment within a building as well as outside. NOTE 2 Derived from the definition of

			environment in ISO 14001
building performance ability of a **building (3.2**) to fulfil its required functions under the intended use conditions or behaviour when in use NOTE: Derived from ISO 6707-1 **proposed change:** NOTE: Derived from the definition of *performance* in ISO 6707-1	3.2 building performance ability of a **building (x.x)** to fulfil required functions under intended use conditions or behaviour when in use NOTE Adapted from the definition of *performance* in ISO 6707-1 **proposed change:** NOTE: Derived from the definition of *performance* in ISO 6707-1		
		3.2 building product item manufactured or processed for incorporation in a building or other construction works. NOTE 1 The manufacturing or processing of the building product may take place at the factory or on the construction site. NOTE 2 Adapted from ISO 6707-1	
			3.3 environmental benefits from buildings any beneficial factors and advantages from buildings brought to the environment NOTE: An example of environmental benefits from buildings would be rehabilitation of the exterior physical environment, such as building on a brown field site.

			3.2 environmental impacts of buildings any change to the environment, whether adverse or beneficial, wholly or partially, resulting from environmental aspects of building. Note Construction products in this context include production of building components and onsite construction, operation of the building, refurbishment and deconstruction of buildings
3.5 construction works: everything that is constructed or results from construction operations. (ISO 6707-1)			
3.6 construction work: activities of forming a construction works (3.5). (ISO 6707-1)			
3.7 environmental performance: performance of a building (3.4) related to its environmental impacts and aspects (3.1.2) NOTE 1 The environmental performance is influenced by all processes related to the life cycle of the building. NOTE 2 It can be expressed either quantitatively or qualitatively, usually relative to a scale of values			3.4 environmental performance of a building measurable (quantitative or qualitative) effect of a building on the environment relative to a scale of values or a benchmark NOTE 1 A positive effect of a building on the environment can be measured by the degree of the reduction of environmental impacts and by the improvement in the f quality of life given to people who utilize buildings

or a benchmark → use same as WG4 "environmental performance of buildings"			during the building lifecycle. NOTE 2 In ISO 14031:1999 and ISO 14050:2002, environmental performance is defined as results of an organization's management of its environmental aspects. Environmental performance of buildings is the result of processes of management of environmental aspects of buildings including design, construction, operation, refurbishment and deconstruction stages NOTE 3 The environmental performance of a building allows comparison between the interested parties' specific requirements and the building's environmental related characteristics and attributes. **Remark**: Definition problematic, because the definition relates performance relative to assessment results, rather than assessment results relative to performance. **You can keep the above definition when referring to that this is an application of note 2 from WG1: apply the definition and expand on note 2**
		3.7 functional unit quantified performance of a building product (3.2) for use as reference unit in an environmental declaration for the life cycle of the product	

		NOTE Adapted from ISO 14040	
			3.8 Interested party person or group having an interest in the performance or outcome of a building NOTE 1 "Outcome" includes agreements and utilization of products NOTE 2 This generic definition is not taken directly from any other document. The concept is defined specifically from the point of view of environmental performance in ISO 14001 (with identical definition in ISO 14004 and ISO 14031), of type I environmental labeling in ISO 14024, of type III environmental declaration in ISO/TR 14025 and of life cycle assessment in ISO 14040.
3.11 life cycle: consecutive and interlinked stages of a product system, from raw material acquisition or generation of natural resources to final disposal [ISO 14040] Note: A Life cycle can be described from more than one perspective, e.g. a physical and a project perspective. For the physical product perspective, the ISO 14040 definition applies. For			

the project perspective, the life cycle encompasses processes related to the physical product, e.g. planning, design and management.			
	3.8 life cycle costs total cost of a building or its parts throughout its life, including the costs of planning, design, acquisition, operations, maintenance and disposal, less any residual value [ISO 15686-1]		
		3.11 material Substance or preparation that can be used to form products for construction works Example: Cement, metal, plastic, sand and wood. NOTE Adapted from ISO 6707-1	
Performance [6707-1] ability of a product to fulfil required functions under intended use conditions or behaviour when in use.			
3.12a product: any goods or services construction product: item manufactured or processed for incorporation in construction works building product: item manufactured or processed for incorporation in a building			

		3.14 product category group of building products (3.2) that can fulfill equivalent functions	
		3.15 PCR review process whereby a third party (3.19) panel verifies the product category rules (3.16) [ISO/FDIS 14025]	
		3.16 product category rules set of specific rules, requirements and guidelines for developing Type III environmental declarations (3.20) for one or more product categories (3.14).	
			3.9 quantitative representation representation of an assessment result by quantitative means
		3.17 reference service life (1) service life that a building product would expect to have in a certain set of in-use conditions. (2) service life that a building product is predicted to have in a reference set of in-use conditions. NOTE 1 The reference service life is applied in the functional unit/declared unit NOTE 2 Adapted from ISO 15686-1	

3.13 service life: period of time after installation during which a building (3.2) or its parts meet or exceed the performance requirements. [ISO 6707-1]			
			3.6 system boundary interface between a building and the environment or other product systems Note; boundary defines what is included and what is not included.