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European Experiences of Building Codes for Promoting Sustainable Housing

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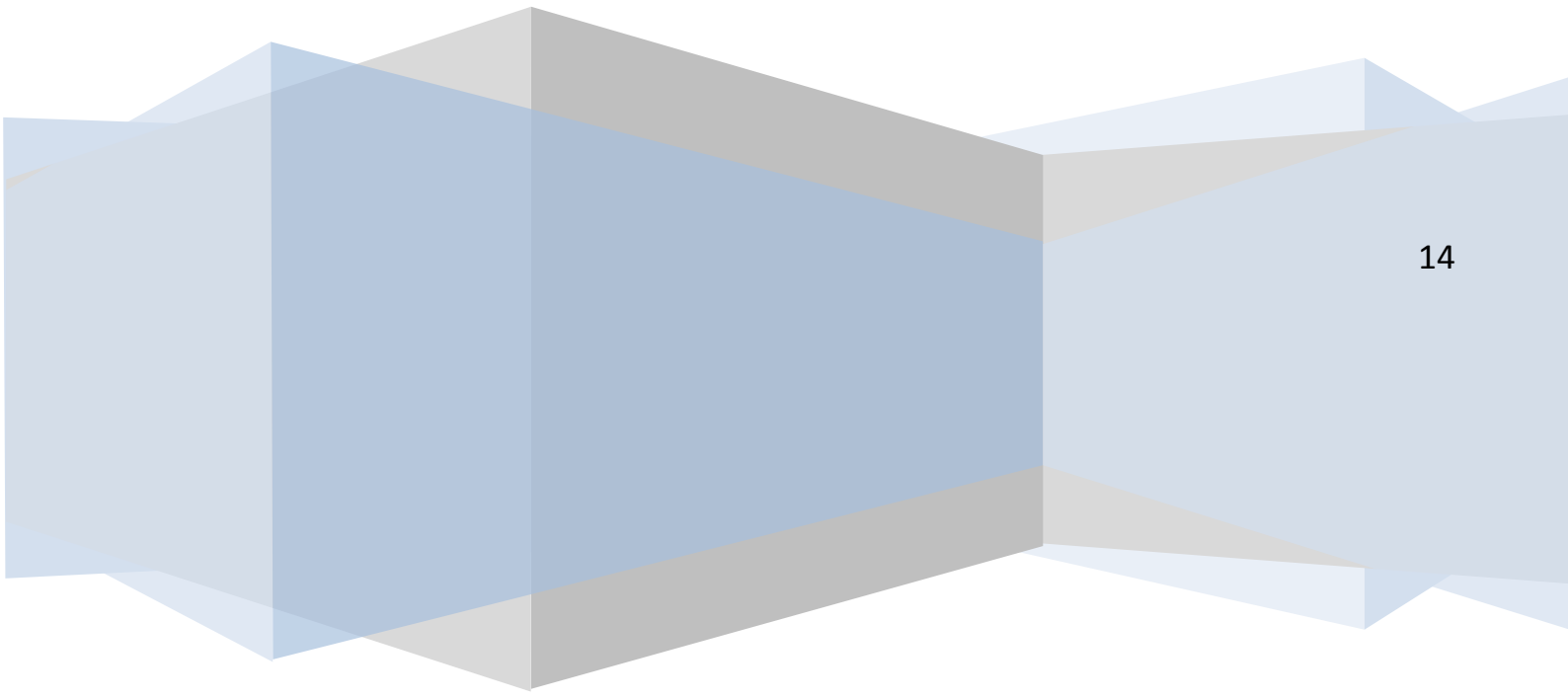

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EUROPEAN EXPERIENCES OF BUILDING CODES FOR PROMOTING SUSTAINABLE HOUSING

1. INTRODUCTION

Sustainability became a key issue in since the 1980s after the United Nations' call to make us aware and preserve the Earth's non-renewable resources. This call was followed by the world summits on environment and development held in Rio de Janeiro (The UN Conference on the Environment and Development in 1992), Kyoto Conference (Kyoto Protocol to the UN Framework Convention on Climate Change signed in 1997) and Johannesburg (World Summit on Sustainable Development in 2002).

As part of the Kyoto Protocol, many developed countries agreed to legally binding reductions in their emissions of greenhouse gases (GHG). The European Union (EU) and its 28 member states agreed to make GHG reductions of 8%. In its efforts to comply the EU has given special attention to the building sector. This is because this single sector contributes about 1/3 of global GHG emissions. Adopting simple measures such as improved insulation and efficient energy use can save costs and results in a better quality of life.

After the Kyoto conference EU member states adopted the Energy Performance of Buildings Directive - EPBD (Directive 2002/91/EC). This offered a holistic approach towards more energy efficient buildings. It impacted the housing sector of member states at national, regional and local levels and was translated into Building Codes and policies for new buildings. Building companies and associations had to provide certification of their complete building stock, revision of their Energy Performance Certification schemes, implementation of their inspection of heating systems and air-conditioning systems accompanied with quality control mechanisms, training of qualified assessors, information campaigns, incentives and subsidies to support the implementation and acceptance of these new regulations.

This report was requested by the "*Green Homes Project*" in Nepal and its purpose is to give an overview and summary of the most important legislation and policy issues which accompanied the implementation of the energy building codes in the Netherlands, the UK and Germany at national level and Malmo and Barcelona at local level. These are particularly instructive cases which the Nepalese authorities will find of great use when defining the processes and measures to be adopted for the development of their own building code.

In the following chapters we will see that efforts should not only be addressed to energy efficiency but also to the efficient use of water, waste water, waste disposal and behaviour change.

This report consists of 5 chapters. In chapter 2 we discuss how the European Commission adopted the first Energy Performance of Buildings Directive in 2002 which it revised in 2010 with more stringent targets, to reduce GHG emissions by member states indicating specific activities to be carried out to improve the energy performance of buildings.

In chapter 3 we describe the processes, legal instruments and strategies that the Netherlands, the UK and Germany followed in order to comply with the EPBD 2002 and 2010 regulations to move towards new and retrofitted nearly-zero energy buildings by 2020. We see how in each of these countries the EPBDs have shaped and been incorporated in their building codes on national and local level.

In chapter 4 we describe the way the experiences mentioned in the previous chapters can be adopted in the development of the Nepalese building code. The last chapter contains the summary of the most successful experiences from this report

Throughout the report the reader will find in **bold blue font** hyperlinks to original documents (laws, plans, etc.). By clicking on these the reader will be able to delve into any topic in as much detail as desired.

For the purpose of this report the following definition of "*Sustainable Housing*" has been used:

"A sustainable house is one that uses energy and material more effectively both in production and operation while polluting and damaging natural systems as little as possible."
(Green Building and Sustainability, John Straube, p.6)[1]

2. EU POLICIES AND REGULATIONS TO PROMOTE THE INCLUSION OF SUSTAINABLE HOUSING ISSUES IN THE NATIONAL BUILDING CODES

Under the Kyoto protocol of 1997, the country members of the European Union were required to make greenhouse gas reductions of 8%, i.e. to reduce its annual emissions by 330 million tonnes by 2012.

The original Energy Performance of Buildings Directive - EPBD (DIRECTIVE 2002/91/EC) was a core response to this target. When the Directive was adopted in December 2002 there were 160 million buildings in the EU, and it was anticipated that the Directive could deliver 45 million tonnes of carbon dioxide reduction by 2010. By 2007 the EU had committed to even more stringent targets - in particular to a reduction of 20% in the EU's total energy consumption by 2020, and a binding target for renewable energy of 20% of total supply by the same year. It was clear, therefore, that there was a need to strengthen the provisions of the Directive and a more thorough and rapid implementation. Hence the second directive, **(DIRECTIVE 2010/31/EU)** was adopted in May 2010.

This revised 2010 directive aimed to redouble the efforts to limit climate change, give the public sector a leading role in promoting energy efficiency and enhance a green economy by creating more jobs and improving energy security. The member states were obliged to carry out five specific activities for the improvement in energy performance of buildings:

a) Establish requirements for calculating an integrated energy performance of buildings;
b) Set minimum energy performance requirements for new buildings;
c) Set minimum requirements for the energy performance of existing buildings undergoing significant renovation;
d) Certify energy performance of buildings;
e) Carry out Regular inspection of boilers and air conditioning systems in buildings and an assessment of boilers older than 15 years;

Based on these energy efficiency requirements every country in Europe had to implement their energy codes for newly constructed or renovated buildings. These requirements may apply to the building envelope[2] and/or systems and can cover end uses such as heating, ventilation, air conditioning, lighting and water heating.

These Directives had a huge impact in the housing building codes of the EU country members. Some of them had to create a new building code for sustainable housing as in the case of the UK and others had to add a whole chapter to their existing building codes – as in the case of Germany and the Netherlands.

Building codes have an important impact on energy efficiency in buildings by setting minimum requirements for the energy-efficient design and construction/renovation of new and existing buildings, energy codes and policies can ensure reduced energy consumption for the life of the building (Cochrane and Dunn, 2010). Building codes which deal with energy efficiency are called Building Energy Efficiency Codes (BEEC). They consider the life cycle of a building and aim to overcome the many barriers to implementation and are key instruments for greenhouse gas (GHG) mitigation in the buildings sector. Energy efficiency requirements in building codes or energy standards for new buildings are, therefore, the single most important measures for ensuring the energy efficiency of new buildings.

Building codes alone cannot meet the requirements set up by the 2010 EPBD; they need to be supported by a package of measures which provide a holistic approach to the reduction of CO_2 emissions. In the case of the

[1] Digital version of Green Building and Sustainability can be downloaded from this link:green building and sustainability
[2] Building envelope is the enclosure of the building. The boundary separating the inside from the outside.

three countries and two cities examined in this report, some of the measures that accompanied their national building codes were:

- Implementation of new standards for determining the energy performance of new buildings
- Implementation of a new set of taxes and tax incentives to reduce energy costs
- Grants to stimulate the production of sustainable energy
- Agreements with large industries, which are large producers of CO_2, to use their energy more effectively and efficiently together with the other actors involved
- Revision of complementary building regulations
- Energy strategies
- Implementation of Municipal and climate action plans
- Construction of demonstration projects
- Awareness campaigns

In the next sections we will describe in more detail these and others measures and experiences implemented in the Netherlands, the United Kingdom, Germany, Malmö and Barcelona.

3. EXPERIENCES OF COUNTRIES AND CITIES

In this section, we will describe the process, legal instruments and strategies that the Netherlands, the UK and Germany followed in order to comply with the regulations EPBD 2002 and the revision of 2010 to move towards new and retrofitted nearly-zero energy buildings by 2020. We will see how in each of these countries the EPBDs have shaped and been incorporated in their Building Codes.

3.1 The Netherlands' Experiences

According to the EPBD enacted in 2002 and its revision in 2010 the Netherlands and all the other member states are required to implement a policy framework that will improve the energy performance of buildings in order to meet its requirements.

With this in mind, the Dutch government has expressed the intention to increase the current energy performance standard of the national building regulations for new buildings with the objective of reducing the energy consumption in the existing building stock by 50% compared to 1990 levels, and construct only energy-neutral buildings by 2020 (VROM 2007). With that goal municipalities are formulating ambitious local policies; and their current EPC[3] will have to decrease by 50% by 2015. In order to achieve this, the Dutch government added Chapter 5 to their National building code to address energy efficiency and environmental construction.

In the Netherlands the implementation of the EPBD is the overall responsibility of the Ministry of the Interior and Kingdom Relations and the **NL agency**, the Dutch energy agency is the executive body for the implementation process.

When clicking on the **links in blue and underlined** you can access the original documents and websites.

3.1.1 The Dutch Building Code

The building code in the Netherlands is called "Bouwbesluit" and the current version is the one enacted in 2012. Chapter 5 is dedicated to: Technical building regulations in terms of energy efficiency and environmental construction. To access the original document follow this link: **Building Code – "Bouwbesluit" 2012 - Chapter 5.**

The Bouwbesluit 2012 – Chapter 5, is set at National level and is a mandatory performance-based code that requires an energy frame calculation to establish the maximum allowed Energy Performance Coefficient (EPC) for residential and non-residential buildings. The code addresses most

[3] Energy Performance Coeficient. Further explained on page 5

thermal envelopee[4] requirements and energy-using systems within the EPC calculation, including HVAC[5], hot water, lighting, bioclimatic design and renewable energy.

The revised 2010 EPBD took into consideration the target set by the European Union for new buildings that after 2020 had to be energy-neutral, with an EPC value of 0, where only renewable energy sources are used. The Netherlands has ambitious goals in energy efficiency and the use of renewables for the building sector. The policy is to tighten the EPC in the Bouwbesluit to 0.4 in 2015, with the ultimate goal of 'zero energy'.

The 2012 Bouwbesluit and related national policies have been further strengthened to include, mandatory computer modelling for all new buildings, air-tightness requirements for all new dwellings, thermal bridging linear value requirements, a robust pre-occupancy commissioning and a national target to be energy-neutral by 2020.

The following are the energy uses and functions covered by the Bouwbesluit:
Heating, cooling , dehumidification, ventilation, air tightness, thermal bridging, hot water, building parts (lifts, pumps, etc), passive solar, passive cooling, natural ventilation, solar protection, day lighting requirements.

These are the different sections covered by the Code:
CHAPTER 5: Technical building regulations in terms of energy efficiency and environmental construction

SECTION 5.1: Energy efficiency
- **Article 5.1**: Control of the building
- **Article 5.2**: Energy performance coefficient
- **Article 5.3**: Thermal insulation
- **Article 5.4**: Ventilation
- **Article 5.5**: Unheated use function
- **Article 5.6**: Renewals and extensions
- **Article 5.7**: Temporary buildings

The Bouwbesluit (Code) covers residential buildings, commercial and public buildings.

Energy Performance Coefficient (EPC) Duration: 1995 – ongoing

The Energy Performance Coefficient (EPC) is part of the NL Building Code and is explained in Section 5.1, Article 5.2, and chapter 5. It focuses on the overall energy efficiency of a building. The construction industry itself provides the energy saving measures to attain the EPC.

From 1st of July 2012, the EPG[6]; which is a new standard for determining the energy performance of new buildings has been implemented. With this new standard the Netherlands meets the requirements of the revised European Energy Performance of Buildings Directive (EPBD). The aim is to tighten the requirements for energy-neutral buildings using an integration of the assessment methods for new construction, existing construction, commercial and residential buildings. The new method adapts the European standards and the latest techniques. In order to obtain a building permit, an EPC calculation is necessary.

The Netherlands has ambitious goals in energy efficiency and the use of renewables for the building sector. The policy is to tighten the energy performance coefficient (EPC) to 0.4 in 2015, with the ultimate goal of 'zero energy' house in 2020.

[4] Enclosure that holds warm or cool air inside a structure
[5] Heating, ventilation and air conditioning
[6] EPG Energy performance of buildings; is a new method to calculate the energy performance of buildings. While the EPG shows the determination method, the EPC indicates the minimum level that the building must meet. The EPC is calculated using the EPG.

ENERGY PERFORMANCE COEFFICIENT IN NL (EPC)							
Year	**1996**	**2000**	**2005**	**2010**	**2011**	**2015**	**2020**
Index	**1.4**	**1.0**	**1.0**	**0.8**	**0.6**	**0.4**	**0.0**

Source: AgentschapNL (2012)

Certifications to Support Enforcement of the Code

In order to find a common point in building standards amongst all Member States and to encourage property buyers to choose property using relatively less fossil energy, the Netherlands created a building labelling scheme along with regular inspection and assessment of heating and cooling installations. These are the most commonly used certificates:

- Energy Performance Certificates
- Positive labelling for building beyond the minimum BC level
- Inspection of boilers, done every year or two, depending on the type, size and age of the boiler
- **Inspection of HVAC** (heating, ventilation and air conditioning) systems. Introduced in the EPBD revision of 2010 in order to maintain the correct adjustment in accordance with the product specification and in that way to ensure optimal performance from an environmental, safety and energy point of view.
- Energy offsets/Green certificates

3.1.2 Regulatory instruments and supporting policies to promote green aspects in buildings

The legal instruments described in this section are all complementary to the energy code (EnEV) and have been enacted to encourage the use of energy efficient technologies of new and existing buildings and to support the reduction of CO_2 emissions to achieve greener homes.

Energy Performance Certificate Duration: 2008 – ongoing

The Energy Performance Certificate is the most visible aspect of the EPBD and all the requirements from this Directive have been incorporated in the Dutch national building code. This document assigns an energy performance rating to residential and non-residential buildings.

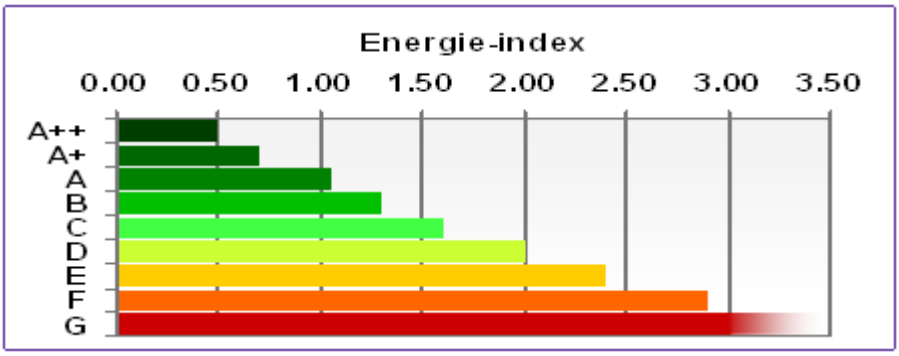
In December 2006 the "Decree on Energy Performance of Buildings" (BEG) as well as the "Regulation on Energy Performance of Buildings" (REG) were legally implemented in The Netherlands. This enabled the Netherlands to develop an Energy Performance Certificate for existing buildings that first came into force on January 1st, 2008. Since that date, the construction of houses for sale or rental requires an energy label indicating the EPC, which should be calculated as indicated in the Code.

Energy Performance Certificates must include reference values, such as current legal standards, in order to make it possible for consumers to compare and assess energy performance. They must also be accompanied by recommendations for cost-effective improvement options to raise the performance and rating of the buildings.

Issuance of Energy Performance Certificates

Certificates can only be issued by qualified assessors. This kind of certificate is needed every time a building or building unit is sold or rented out. The owner must present a valid Energy Performance Certificate at the moment of transaction. This involves a qualified assessor visiting the property and assessing the building in terms of the type and quality of constructions and installations. The assessor will then calculate the energy-Index and issue the Energy Performance Certificate. This is done by sending an automated report to the central database that is hosted by NL Agency which returns a unique number for each certificate that can then be printed.

In the Netherlands, most of the houses are C and D rated.



Dutch Energy labels and the corresponding energy index values

The Energy Index and the energy label are based on average occupancy and average outdoor climate. It reflects the thermal quality of the building. Ventilation, internal heat production, energy use for lighting and heat losses during water circulation all depend directly on useful floor area, which are defined as areas that are a part of the heated zone, including the rarely heated areas such as halls, toilets, washing rooms and storages

3.1.3 Schemes to promote green aspects in buildings

The Dutch national building code (Bouwbesluit, section 5.1. above) sets out the compulsory framework for builders to follow and to produce greener buildings. Government has also established a number of schemes which support and encourage the application of the Building Code, largely because of the high cost implications of constructing using the new guidelines. Space only allows us to consider six of them here.

Energy Investment Allowance (EIA – Energie-investeringsaftrek). Duration: 1996 – ongoing

EIA is a tax system provided by the Ministries of Finance and Economic Affairs for entrepreneurs who are investing in energy saving technologies. This kind of investment offers a double benefit: reduced energy costs and a deduction on taxable profit. These investments can cover different types of technology: insulation, ventilation, lighting, HE-boilers, solar energy, heat and cold distribution and wind energy; it also covers investments in improving energy efficiency of existing residential buildings.

Forty-one point five percent of the relevant expenditures are deductible from the taxable earnings in the year in which the equipment is purchased. The government wants the EIA to encourage Dutch companies on energy conservation and use of renewable energy. The budget for 2014 is € 111 million.

Stimulation of Sustainable Energy Production (SDE – Stimulering Duurzame Energieproductie)

This is an operating grant by which producers receive financial compensation for the renewable energy they generate. The primary target group for SDE are companies, institutions and non-profit organizations

MIA /Vamil. Duration: 1991 – ongoing

These are tax deduction schemes initiated by the Ministry of Infrastructure and Environment. The target groups for this programme are entrepreneurs who invest in environmentally friendly technologies. These could be for example, environmentally friendly lighting systems, rainwater installations, water saving toilets, or insulation systems. VAMIL provides improved liquidity for firms and interest rate advantage. This scheme also encourages innovative environmentally friendly products by facilitating their introduction to the market.

The Green Funds Scheme. Duration: 1995 – present

The Green Funds Scheme is a tax incentive scheme launched in 1995 by the Dutch government to encourage green initiatives. In a nutshell, it comprises the Green Project Scheme (which establishes the conditions governing the projects), the Green Institutions Scheme (which regulates the role played by the financial institutions) and finally the tax incentive for individual investor (which gets the flow of funds moving).

The goal of the Green Scheme is to offer new opportunities for highly energy efficient buildings. Through this scheme, projects with a so-called green certificate are eligible for funding at lower interest rates. This scheme is applicable for existing and new buildings under construction in both commercial and residential properties. To qualify for financing a green project should fall under one of the following categories related to sustainable buildings (AgentschapNL, 2012):

GREEN SCHEME		
Type of construction (project)		**Description**
A	New housing	The green certificate may vary by property from € 100,000 to € 65,000 as green funding, and it must be obtained before starting construction.
B	Conversion of office buildings to residential	The Netherlands has many empty office buildings and some of those can be converted into residential homes. The green certificate is € 1,000 per m² gross floor area as green funding with a maximum of € 100,000 per apartment.
C	Sustainable housing renovation by owners	This is to renovate homes with an energy label F, G or E and want to improve it to A or B. • From energy label E to A: € 50,000 • From energy label F to B: € 50,000 • From energy label F or G to A: € 100,000
D	Housing renovation through a company	• From energy label B, C,D to A or B = € 25,000 • From energy label E to B or C: € 25,000 • From energy label E to A: € 50,000 • From energy label F and G to C or D: € 25,000 • From energy label F or G to B: € 50,000 • From energy label F or G to A: € 100,000
E	New commercial building	Are eligible for a green certificate if they are at least 30% more efficient than conventional requirements.
F	Commercial building renovation	The energy index of the buildings that need renovation should improve by at least 0.6. The green certificate depends on the achieved reduction of the energy index per m² of gross floor area: € 300 for an improvement of the energy index of at least 0.6 € 450 for an improvement of the energy index of at least 1.2 € 600 for an improvement of the energy index of at least 1.8

Source: http://senternovem.databank.nl/

VOLUNTARY AGREEMENTS

MJA (Meerjarenafspraaken). Duration: 2005 – 2020

This is a voluntary long-term agreement between the Dutch government and large industries such as banks, universities and other big energy consumers on the effective and efficient use of energy. Under this agreement the parties commit to achieve an average Energy Efficiency Improvement for their facilities of 30% in the period of 2005 – 2020.

Agreement "More with less" for existing buildings (Meer met Minder). Duration: 2008 – ongoing

Much of the housing stock in the Netherlands is poor in energy efficiency and most of the electricity consumed by households is used for heating and domestic hot water. Many of these buildings have great potential for energy savings and reduction of GHG emissions reason why the national government introduced this agreement to stimulate energy savings in existing buildings through joint ventures with key players in the housing sector. To make this possible the website

www.meermetminder.nl was developed to give information about incentives, grants and subsidies to save energy. Adopting energy saving measures obviously costs money, but fortunately there has been many grant and funding schemes, which makes it affordable. There are national regulations, but also provinces and municipalities regularly use their own subsidies. In addition, the Ministry of Finance introduced a reduced VAT rate for home insulation to walls, roofs, and floors from 19% to 6% and the government is also providing favourable rate loans for homeowners who want to invest in energy efficiency.

This subsidy developed by NL Agency is intended for:

- Municipalities and provinces;
- Professionals in construction such as consultants, contractors, and installers;
- Housing associations;
- Private landlords and homeowners.

3.1.4 Amsterdam's Experiences

We will now look at some projects being implemented in Amsterdam to see how they are applying the regulations in the Dutch national building code regarding the development of new technology to increase energy efficiency. The Municipality believes that starting an energy saving campaign in municipal buildings is a first step towards reducing CO_2 locally.

Amsterdam's goals with respect to energy efficiency are to reduce CO_2 emissions by 40% by 2025 and to provide 30% of the city's energy with locally produced sustainable energy. Helping the city to reach these goals is a unique partnership between the private sector, authorities, research institutions and residents called **Amsterdam Smart City (ASC).** An explanatory video of this project is available in this link: "**Amsterdam Smart City – Smart Stories.**

The following are some of the projects in which the municipality is working with their partners to achieve its goals:

- **Municipal Buildings**. The municipality aspires to be an energy-neutral organization by 2015. In order to achieve this, it has started monitoring energy consumption in municipal buildings via an online portal that will enhance awareness and offer insight into and to monitor energy usages in the municipal buildings and locations. This will provide a base-line measurement for all future savings. This project is being implemented in partnership with Liander, an energy provider.

- **Climate Street**. The municipality of Amsterdam is transforming together with entrepreneurs the Utrechtsestraat into a sustainable shopping street where innovative technologies are tested.
  In the Climate Street, the municipality will determine which technologies, cooperative agreements and approaches are the most successful in making the city's (shopping) streets more sustainable on a large scale; with the aim of realizing CO_2 reductions in the street. The focus of sustainable solutions lies in three main areas: entrepreneurs, public space and logistics.

- **Nieuw-West – City-Zen.** Amsterdam is working with private partners and service providers on EUR 30 million worth of innovative projects in the district of Nieuw West. They are working together to develop innovative, sustainable solutions to energy-related issues. This project will complement planned investments by developing and implementing a range of products and services on such a scale that they can also be applied in a city as a whole. It is hoped that Amsterdam will set a leading example for other European cities.

  Residents will be the central concern during domestic renovations and the project will work closely together with them to explore how energy-saving measures can be introduced most conveniently and with minimal hassle. Over the course of this project, a total of 52,000 m² of residential buildings will be renovated.

  Some of the projects being implemented in the areas of energy saving and renewable energy are:

- Installation of solar collectors in residential buildings to supplement the heating network of West Poort Warmte with locally generated heat. These collectors will be used as well to cool 300 houses in the summer.

- Alliander, the energy provider will become a 'smart' network right up into the home. Sensors will be added to the network and all residents will gain more control over their energy usage. For example, the technology will be in place to allow a resident to sell the energy generated by their solar panels to a neighbour. Special batteries will also be installed to store energy (for example, from solar panels), enabling the resident to use it whenever they need it.

- The Waternet[7] sewerage system will make it possible to dispose of biodegradable waste using a small grinding machine. Waternet will extract this biodegradable waste during the purification process and reuse it as raw material or use it to produce biofuels. An initial trial involves 250 households.

3.1.5 Case study

Passive renovation project in De Kroeven, Roosendaal (pp. 33-40) is located in the province of Noord-Bravant, Southern Netherlands. Source: IEA ECBCS (2011)

This is considered the first "passive house"[8] renovation project in The Netherlands and was executed to promote green aspects and energy efficiency into buildings as indicated in the Dutch national building code. It consists of identical single family houses with same technical qualities owned by a housing corporation built in the 1960s. These houses have been deteriorating over recent years; they only have had regular maintenance and minor improvements, reason why the housing association decided not only to upgrade them but also to exceed the Dutch norms. This project involves 370 units of which 134 were retrofitted with the total support of the residents.

It was very important for the owner to disrupt the residents the least possible during renovation so it was decided to execute the project without moving them. The key technologies used were: prefabricated timber façades and roofs, solar thermal collectors, condensing gas boilers, heat recovery ventilation and triple glazed windows. The prefabricated elements were selected because they were cheaper, faster and less intrusive for the residents; these allowed the process to be done at a rate of one house per day.

Benefits:

The heating energy demand decreased by 80% and the hot water demand by around 55% resulting in a total 70% reduction, reducing tremendously their energy bill. Based on these calculations the residents accepted the offer from the owner to increase the rent by the same amount as the reduction in energy cost, which compensated partially the investment cost and the improvements made.

This kind of sustainable renovation increases the life expectancy of the buildings as well as the property value; because in the future the demand for houses with a very low heating cost will be higher compared to the same floor area with a high heating cost.

Conclusions:

There are not many examples that were renovated to this level of quality in the Netherlands. According to the European guideline EPBD of 2008, all buildings need to have an energy label from G rated the worst label to A++ the best. The houses in this project in Roosendaal are so much better

[7] World Waternet is a Dutch organization dedicated to improve access to clean drinking water and adequate sanitary provisions for all.

[8] Passive house is a clearly defined standard across most of Europe for buildings of a very high energy performance. For more information on Passive House requirements and standards click on this link **Passive House**

than what is currently the scope for the general policies applicable for existing buildings, so that the current energy labelling system is not able (yet) to accommodate the technical aspects of the passive house components.

Prefabrication technologies require additional planning efforts and accurate measuring of existing building structure, but the construction process has proven to be very efficient.

Economically considered, prefabrication technologies are competitive to traditional renovation measures but not necessarily cheaper. Two types of renovation have a large potential to become cheaper than traditional technologies: simple and repetitive façade and roof renewal (simple building shapes) and holistic building renewals with extensive changes (window sizes, room extensions, new roof top apartments).

The efficient construction process with prefabricated elements allows for an "inhabited construction site". However, for holistic building modernisation moving out for 3-6 months is recommended.

Project data of building before renovation		**Design data for renovated building**
Year of construction	**1965**	**Year of renovation 2011**
Number of apartments	134	134
Heated floor area	16,080 m²	16,080 m²
Total heating energy	16,500 kWh/y	4,500 kWh/y
Spec. Energy consumption	137 kWh/(m².y)	38 kWh/(m².y)
Installed heating capacity	20 kW	3.5 kW
Household electricity (without heating)	3,500 kWh/y	3,500 kWh/y
Spec. Electricity consumption	29 kWh/(m².y)	29 kWh/(m².y)
Rents (net per unit)	6,000 €/a	6,780 €/a
Heating costs	1,140 €/a	335 €/a
Rents increase per m2 (net)		-0.3%

For more information on Passive House requirements and standards click on this link **Passive House**

3.2 United Kingdom Experiences

As the UK is a member state of the European Union, its laws and regulations are required to comply with EU legislation and directives. During the 1990s many countries restructured their energy industry as a result of European pressure alongside other factors. In 2002 new directives were launched that defined an internal energy market including the building construction legislative framework with directives, principles, procedures and deadlines established in a clear, consistent and comprehensive way. The revision of the EPBD in 2010 has set even more stringent targets and for the UK that means to reduce CO_2 emissions by 80% by 2050; in order to achieve this goal the UK has taken 3 important and complementary measures:

- Enactment of the Code for sustainable Homes (CSH)
- The revision of part L of the Building Regulations (Conservation of fuel and power) and voluntary housing standards
- The launch later this year after a long consultation process of the BREEAM (The Building Research Establishment's Environment Assessment Method) 2014 revised and updated version. This is the most used building rating tool in the UK.

When clicking on the **underlined links in blue** you can access the original documents and websites.

3.2.1 The Code for Sustainable Homes

The Code for Sustainable Homes. or "The code" as it is known, is the national standard for sustainable design and construction of new homes. It aims to reduce carbon emissions and promote higher standards of sustainable design above the current minimum standards set out by the building regulations while driving continuous improvement and greater innovation in the building industry.

The code uses a rating system (from 1 to 6 stars) to indicate the overall sustainability of a home with one star representing the entry level (above the level of the Building Regulations) and six stars the highest level (reflecting exemplary sustainability standards).

It was first introduced in 2007 and it applies in England, Wales and Northern Ireland. Within England it replaces the Eco Homes, *Code for Sustainable Homes: A step-change in sustainable home building practice*[9], which was the norm previously established by the government. A number of government institutions were consulted during the process of preparing CSH including Building Research Establishment (BRE), Construction Industry Research and Information Association (CIRIA) and Senior Steering Groups consisting of Government, industry and NGO representatives.

The code became legally binding in May 2008, it is not compulsory for every new home to be built to "the Code" but each home must receive a rating.

New amendments were made to the CSH in November 2010, the Government made changes to the **Code for Sustainable Homes version 2007**, to bring it into line with new regulations such as the Part L of the Building Regulations as well as to simplify the Code.

The Code Assessments are carried out in two stages:
1- Building Design Stage
2- Post Construction Stage when evidence is shown that all the information presented in the design stage, such as the use of energy efficient products or certain building materials, have been implemented.

In the following table we can see the elements that the Code assesses and the issues identified that can impact the environment.

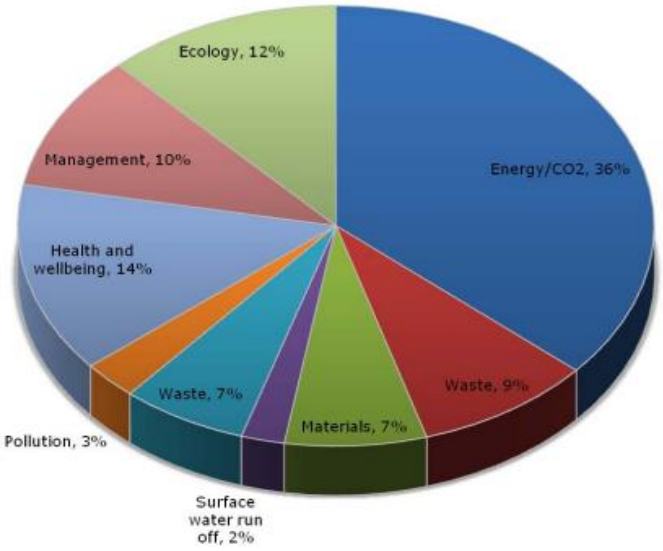
ENVIRONMENTAL IMPACT CATEGORIES AND ISSUES		
Categories		**Issues**
1	Energy and CO_2 emissions Refers to the operational energy requirements of the home under standard occupancy assumptions. The **aim** is to limit emissions of CO_2	Dwelling emission rate Building fabric Internal lighting Drying space Energy labelled white goods External lighting Low or Zero Carbon technologies Cycle storage Home office
2	Water Assessment is based on the predicted average household consumption. The **aim** it so reduce consumption of potable water.	Internal water use External water use

[9] EcoHomes launched in 2000 soon became mandatory for social housing in 2003 of which a 'Good' rating was shortly replaced in 2005 by a 'Very Good' rating. Over 200,000 homes have been certified since its launch. In April 2007 the Government's scheme, the Code for Sustainable Homes replaced EcoHomes for the assessment of 'new' housing in England, Wales and Northern Ireland. **http://www.breeam.org/page.jsp?id=21**

3	Materials Materials are assessed at the building envelope level. The **aim** is to encourage the use of materials with lower environmental impacts over their lifecycle.	Environmental impact of materials Responsible sourcing of materials – for building and finishing elements
4	Surface water run-off Refers to the peak rate of run-off into watercourses must not be greater for the developed site than it was for the pre-development site. The **aim** is to avoid, reduce and delay the discharge or rainfall to public sewers and watercourses.	Management of surface water run-off from developments Flood risk
5	Waste Assess the provision of storage space for household recyclable materials and construction related waste. The **aim** is to recognize and reward the provision of adequate indoor and outdoor storage space for non-recyclable waste and recyclable household waste	Storage of non-recyclable waste and recyclable household waste Construction waste management Composting
6	Pollution Refers to the insulating materials in the dwelling that avoids the use of substances that have a global warming potential. The **aim** is to reduce global warming from blowing agent emissions that arise from the manufacture, installation, use and disposal of foamed thermal and acoustic insulating materials	Global Warming Potential of insulants NO_2 emissions
7	Health and wellbeing Assess if the rooms in the house achieve a minimum average daylight factor. The **aim** is to improve the quality of life in homes through good day lighting and to reduce the need for energy to light the home.	Day lighting Sound insulation Private space Lifetime homes
8	Management Refers to information and commitment to comply with best site management principles. The **aim** is to encourage homeowners to operate their homes efficiently, to feel safe, and the construction sites to be managed environmentally.	Home user guide Considerate constructors scheme Construction site impacts Security
9	Ecology Assess the respect to wildlife and the use of land with limited ecological value for developments in ecological. The **aim** is to protect ecological features.	Ecological value of site Ecological enhancement Protection of ecological features Change in ecological value of site Building footprint

As can be seen from the table above, each of the nine categories is further subdivided into smaller elements and is ranked from one to six according to efficiency.

The figure below illustrates how each category carries a different weight. For example as energy and CO_2 emissions are presumed to be the most important contributors in achieving sustainability at a global scale, they are placed in Category 1 and given the maximum percentage of 36.4%. Because the UK does not actually address the surface water run-off problem, this category is allocated a minimum percentage 2.2, whilst ecology is given 12% to help conserve both the fauna and flora of the UK at a time so many living species are becoming endangered.



Percentage of overall code points available per category

The British government's ambition for the CSH is to make it the single national standard for the design and construction of sustainable homes, so that it drives improvements in home building practice in the UK.

3.2.2 Regulatory instruments and supporting policies to promote green aspects in buildings

As mentioned previously the Government, apart from introducing the CSH, has taken two other measures to encourage continuous sustainability improvement of new homes and to support emissions targets as drivers for greener homes:

1- The revision of part L of the Building Regulations or Building Code
2- The launch later this year of the BREEAM latest revised version

Revisions to Part L of Building Regulations

In the same way as the CSH, the revised Part L of the building regulations is focused on the reduction of carbon emissions although in a more limited range of design and construction activities. One important difference is that it is compulsory unlike the CSH.

Current building regulations require property developers to reduce the amount of carbon emitted from new buildings as part of the Government's wider objective of achieving zero carbon emissions from all new buildings by 2020. Those regulations are set to get tighter from April 2014, when revisions to 'Part L' of the Building Regulations are introduced.

Part L of Building Regulations concerns: conservation of fuel and power and came into effect from April 6 2014, following a consultation with industry in 2012. Amendments to the 2010 version can be

downloaded by clicking this link: **Part L 2013 changes**.

Once in place, these regulations will mean all new homes will have to be 6% more efficient than they are now and non-domestic buildings 9% more efficient than current standards. The changes will build on Building Regulations Part L revisions 2010, which require a 25% reduction in CO_2 emissions from new buildings.

Property developers are directly impacted by this policy, since the legal obligation to comply with the new regulations lies with them. The regulations increase the costs of constructing new buildings, as property developers need to invest in energy efficient building supplies in order to comply with the lower limit on carbon emissions.

BREEAM (Building Research Establishment's Environmental Assessment Method)

While the CSH refers to residential units the **BREEAM assessment process** applies to non-residential buildings. It is the most widely used building rating tool in the UK; it was created in 1990 with the first two versions covering offices and homes. Versions are updated regularly in accordance with Building Regulations.

BREEAM assess eight main areas: energy, transport, water, pollution, management, material and waste, land use and ecology, and health and well being. Credits are awarded in each of the above areas according to performance. A set of environmental weightings then enables the credits to be added together to produce a single overall score. The building is then rated on a scale of: Pass, Good, Very Good, Excellent, or Outstanding. This assessment process has two stages: design stage and post construction.

BREEAM building assessments are required by various regulatory and Government organizations. The Office of Government Commerce requires an Excellent rating for all new buildings, and the Department for Children, Schools, and Families mandates that new build and refurbishment projects achieve a Very Good rating under BREEAM Schools.

3.2.3 Schemes to promote greens aspects in buildings

These are just two of the schemes provided by the UK government to promote the construction of greener and energy efficient buildings. They apply to the CSH's categories 1, 2 and 3 (energy, water and materials)

Climate Change Levy (CCL)

The Climate Change Levy (CCL) is a tax on the taxable supply of specified energy products (taxable commodities) for use as fuels that is for lighting, heating and power, by all business consumers. CCL does not apply to taxable commodities supplied for use by domestic consumers or to charities for non-business use.

There are four groups of taxable commodities, as follows:

- Electricity
- Natural gas when supplied by a gas utility
- Liquid petroleum gas (LPG) and other gaseous hydrocarbons in a liquid state
- Coal and lignite; coke, and semi-coke of coal or lignite; and petroleum coke.

CCL is charged at a specific rate per unit of energy. There is a separate rate for each of the four categories of taxable commodity. The rates are based on the energy content of each commodity and are expressed in kilowatt-hours (kWh) for gas and electricity, and in kilograms for all other taxable commodities.
The rates are set by HM Revenue and Customs. Reduced rates are payable for participants in the Climate Change Agreement Scheme.

Renewable Heat Incentive (RHI)

In March 2011, the Government announced the details of the Renewable Heat Incentive (RHI) policy to revolutionize the way heat is generated and used. This applies to residential and non-residential sectors. Owners are financially rewarded for the installation of renewable sources of heat generation (for seven years in the case of residential buildings and up to twenty years for non-residential buildings). This is the first financial support scheme for renewable heat of its kind in the world. The aim of the scheme is to provide long-term financial support to renewable heat installations such as solar thermal technologies, biomass boilers and heat pumps, and to encourage the uptake of renewable heat. It will encourage the installation of renewable heat equipment.

The RHI tariffs are tiered and are paid based on the heat output of the renewable energy system. For non-domestic systems, heat metering is required.

3.2.4 London's Experiences

British cities are working extensively in strengthening the UK's capacity to address energy demand reduction and environmental impacts in cities, by working in the areas of building and transport technologies, district power systems, water, waste and urban planning. In the next part of this report we will try to show how London is applying the standards from the building codes to their projects and programmes.

The Mayor of London has been working very hard encouraging all Londoners to get involved and work together in making their city more sustainable. The city is focusing on protecting their resources (water, energy and waste) and using them more efficiently. It has therefore developed strategies on: Air quality, water, climate change mitigation and adaptation, energy and waste areas.

With respect to energy, the city has set out a target to reduce their CO_2 emissions by 60% by 2025 (from 1990 levels). London boroughs and social housing providers also have their own carbon reduction targets.

By clicking on this link you can access the city's website on environmental issues: **London**

The CSH categories 1, 2 and 3 (Energy and CO_2 emissions, water and materials) are addressed in London by the RE: NEW and RE: FIT programmes. Regarding the areas of waste and water included in the CSH, the city of London is also implementing several interesting projects that are mentioned in this section.

- The **RE: NEW programme** – domestic energy efficiency - has been designed to allow every home, regardless of tenure of housing type, to benefit from measures to help them reduce energy bills and stop wasting energy. A package of easy measures is installed in each household by a trained energy advisor who explains how the customer can make changes to their behaviour to stop wasting energy and water, at the end of the visit the advisor produces a personalized report for each property as an output. Part of the easy measures recommended includes: standby savers, low energy light bulbs, installation of LED luminaries, hot water tank jackets, chimney balloons, draught-proofing a home, tap aerators and shower timers.

  This programme has been implemented in partnership with London Development Agency, the Greater London Authority, London Boroughs, London Councils and the Energy Saving Trust.

  Results
  The programme has improved energy efficiency in 55,000 homes in several Boroughs, among them: Camden, Croydon, Haringey, Harrow, Havering, Kingston, Lewisham and Southwark.
  The RE: NEW, Home Energy Efficiency for tomorrow – Good Practice Manual can be downloaded from this link: **RE:NEW Manual**.

- The **RE: FIT programme** has been established by the Great London Authority and is a building retrofitting scheme to support public sector organizations to reduce their carbon footprint and

subsequent energy bills. The target is for 40% of public sector buildings to be retrofitted by 2025; if achieved, this would reduce carbon emissions of over 2.5 million tonnes per annum.

To date, the RE: FIT programme has retrofitted 257 of London's public sector buildings in 28 London Boroughs.

As an example we can mention the project in Tower Hamlets College. This comprises a portfolio of buildings ranging in age from late Victorian to modern day, and the objective is to reduce carbon generation by 20%.

The energy conversion measures planned for this college are:

- Renewal of the building management system[10],
- Renewal of the main domestic hot water boilers,
- Replacement of the heating circulation pumps with new high efficiency driven units and new atrium roof replacement. With these measures the college estimates to save 26% energy,

For more information on projects retrofitted under this programme follow this link: **RE:FIT projects**

- **WATER.** In order to comply with the CSH – category 2 which refers to reducing internal and external water use, the City's strategy is focusing on Securing London's Water Future aiming at reduce consumption and increase water efficiency by:
  - Investing in water management and sewerage system
  - Supporting and encouraging Londoners to take practical action to save water and energy in order to reduce their utility bills. With respect to water the City is planning to introduce a Universal Water Metering System. Currently Londoners pay less for their water services than many other areas in the UK because they pay a fixed charge for their water and sewerage services. Water meters will help reducing water consumption but will create water affordability problems; the Mayor will work with the water industry in order to address these problems.

- **WASTE.** Is included in category 5 of the CSH and indicates that in order to increase the sustainability of homes waste should be recycled, reused and reduced. In this respect the City is implementing several initiatives and projects such as:
  - 'Recycling Saves Money campaign' – targeted to 'non-committed recyclers'. Focusing in the fact that recycling saves money for the city. Thirty-one out of the 33 boroughs participated saving London £ 30 million last year.
  - 'Waste reduction campaign' – with the slogan 'less in your bin, more in your pocket', launched in Wandsworth. Residents were challenged to reduce the amount of rubbish they produced by one kilo per week, saving the Council £ 500,000 a year.
  - 'Community composting' – This is a waste prevention implementation plan with which the community benefits by no longer having to purchase compost. The Boroughs that participated were Hackney, Warburton, Darcy, Hoxton
  - 'Business waste recycling collection services' – This is an innovative commercial waste collection service implemented in the boroughs of Kensington and Chelsea with a strong recycling focus. The service operates seven days a week with three collections a day for recycling customers.

  For more detailed information on waste projects and the London's waste management strategies follow this link: **Municipal waste projects**

[10] BMS is a computer-based control system installed in buildings to control and monitor the building's mechanical and electrical equipment.

3.2.5 Case Study

As part of the on-going process of learning from developments being built to the Code standards and to disseminate the information about building sustainable homes, Communities and Local Government has commissioned different organizations to research and develop a four volume set of case studies on some of the developments that are being built according to "the Code" standards. These 4 volumes present 21 case studies and cover a range of social and private housing, using a variety of different systems or materials, and achieving a range of code standards.

The case studies have been selected across England and cover a range of housing types, using a variety of building systems or materials and a range of development sizes, from small to large development sites.
The four volumes can be downloaded from this link: **Code for Sustainable Homes: Case Studies**.

For the purpose of this report we have chosen the project in Graylingwell Park (described below). It provides green solutions for newly built and refurbished domestic buildings as well as for the area as a whole through commercial and community amenities including allotments for residents to grow their own food, a farm shop, and gallery and office space.
It will be one of the first developments in the UK to be net zero carbon.

Project Case Study: Graylingwell Park
Location: Chichester, UK
Type: Housing Development
Client: Housing Association
Code for Sustainable Homes level: 4 but level 6 on energy requirements

Project description
Graylingwell, an 85-acre former hospital site, is offering 750 new and converted homes along with nearly 8,000 m² of commercial and community amenities.

The goal of this project is to become one of the first developments in the UK to be net zero carbon; to achieve this, the energy strategy selected uses a combination of energy efficiency in buildings, photovoltaic panels to offset emissions from combined heat and power - plus a 40% CO_2 offset offsite.

The first phase of 110 homes is already completed as well as the energy centre next to a converted Victorian water tower which houses the Combined Heat and Power (CHP) boiler flues. Many of the new homes have photovoltaic roof panels and high levels of insulation. Heating is provided by the central heating and power plant, all appliances are energy efficient and the homes are expected to use around a third less water than usual.

Rainwater from the roof will be collected and stored in rain-water butts and will be used to supply water to irrigate the properties back gardens. More than 50% of the roof area is used for rainwater harvesting or green roofs.

The orientation and distance between buildings has been carefully calculated to maximise the benefit of solar exposure and daytime lighting for every dwelling and the solar radiation on the roof mounted Photovoltaic [PV] panels. The property embrace energy efficiency measures including super insulation and air tightness level, and passive heat recovery ventilation.

Results and Achievements
With regards to Environmental Sustainability; in Graylingwell, buildings use locally sourced material and minimise the energy use, water and waste during demolition, construction, operation and management.

Regarding Social sustainability; the engagement with the local community has been an important part of the Graylingwell design development process, to ensure local stakeholders "own" the sustainability ethos of the site.

Awards Won for the Project

- Sustainable larger social housing project of the year, at Inside Housing magazine's 2010 Sustainable Housing Awards
- Best low or zero carbon initiative, 2010 Housebuilder Awards
- Gold for „Best Sustainable Development" and Silver for „Best Brownfield Development" at What House? Awards 2011

3.3 Germany Experiences

Germany is the EU's biggest energy user, with limited internal energy supplies but a strong track record in energy saving in buildings. The use of energy is 10% higher than the UK (Europe's second highest per-capita user), partly because of the large part manufacturing plays in its economy, and partly because of its wealth. Since 1977 it has been committed to improving building energy efficiency requirements.

The first performance – based code was introduced following the implementation of the EPBD in 2002. The 2009 version of the code and supporting policies encompasses many progressive aspects including: air-tightness requirements, well established incentive schemes, frequent boiler and HVAC testing, robust EPC programmes, voluntary low energy classes and a national target for carbon free buildings by 2020.

All the original documents can be accessed by clicking on the **links underlined in blue**

3.3.1 The German Building Code

The **Energy Conservation Regulations**" EnEV is part of the German Building Code and applies to residential and non-residential buildings. The first EnEV, introduced in 2002 superseded and combined the previous Heat Protection Act (WSchV) and the Heating Systems Act (HeizAnlV).

The EnEV sets minimum energy requirements for existing, enlargement and new buildings in crediting of electricity from renewable sources, thermal insulation, cooling and ventilation systems and hot water, and it regulates the energy performance certificates.

The first major revision was in 2007 to accommodate the 2002 EPBD. The act made more significant revisions to the energy assessments of non-residential buildings, the consideration of alternative energy sources, and the inspection of ventilation systems. The act facilitated the gradual introduction of energy performance certificates becoming obligatory for existing residential buildings and the right for potential buyers and tenants to demand an energy certificate.

The last Energy Conservation Act of 2009 tightened the requirement for new and existing buildings, raising standards by 30% and heat insulation by 15% (compared to the 2002 act) and made energy performance certificates mandatory for all new buildings/units and for existing building/units when sold or rented.

Certifications to Support Enforcement of the Code:

- Positive labelling for building beyond the minimum BC level
- Inspection of boilers
- Inspection of HVAC systems
- Energy Performance Certificates

3.3.2 Regulatory instruments and supporting policies to promote green aspects in buildings

The legal instruments described in this section are all complementary to the energy code (EnEV) and have been enacted to encourage the use of energy efficient technologies of new and existing buildings and to support the reduction of $C0_2$ emissions to achieve greener homes.

Energy Performance Certificates.

The Energy Performance Certificate is the most visible aspect of the EPBD and is the most used certificate to enforce the Code. This document assigns an energy performance rating to residential buildings. DENA[11] drives the adoption of this certificate and has been gradually introduced for different types and ages of buildings since 2002. The Energy Performance Certificates documents the energy efficiency of the buildings, and a colour code displays the energy performance of the buildings, with green for good, red for poor, brown to yellow for in between. Since January 2009, whoever sells a residential building or flat, or even rents a flat to someone in Germany, is not only legally obliged to have an energy certificate but also the owner must ensure that the interested person can easily view the complete energy certificate (possibly displayed on the wall in the staircase).

In Germany there are two kinds of energy certificates:

- Verbauchsausweis, it is just based on the consumption of energy during the last three years.
- **Bedarfsausweis**, it determines the energy performance of a building based on the energy demands. Detailed information is needed for the purpose of calculating the energy demand about: the building fabric, building envelope and heating system. This is the certificate recommended by DENA

Energy Saving Act, 2009 (EnEG)

Germany's primary legal tool in reducing energy use is the Energy Conservation Act. Amended in 2009, it requires the following nationwide:
Major changes to the building envelope (e.g. roof, exterior walls, and windows) must be made 30 percent more energy efficient, and the envelope must be 15 percent better insulated;

- Heating, hot water, ventilation, shading, cooling systems must be upgraded to include energy efficient, renewable technologies (e.g., solar thermal);
- Energy sources must reduce climate change impacts and CO_2 emissions (e.g. oil, gas should be increasingly replaced by renewable energies);
- Energy Performance Certificates are mandatory and energy advisers issuing them must have accredited qualifications

Heating Costs Act, 2009 (HeizkostenV)

The Heating Costs Act (HeizkostenV), first introduced in 1981, was strengthened in 2009 to underpin the Integrated Energy and Climate Change Programme agreed by the EU in 2007. This act regulates the cost of heating and warm water in rented properties. As renters make up 60 % of German households, these changes are significant. Tenants must now pay a much higher proportion of heating charges based on consumption, creating bigger incentives for them to save energy, and for their landlords to adopt energy saving measures.

Renewable Energy and Heat Act, 2009 (EEWärmeG)

A third key legal instrument is the Renewable Energy and Heat Act of 2009 (EEWärmeG). This act increased the target for renewable sources of energy for heat to 15 percent in all newly constructed

[11] DENA is the German energy agency

buildings. For owners of existing buildings, the target is voluntary.

Renewable Energy Sources Act (EEG), 2009

This act, first introduced in 2000, sets a target for electricity from renewable sources of 30 percent by 2020. Energy providers pay renewable suppliers a fixed payment per kilowatt-hour, known as the Feed in Tariff, which is in turn passed on to end-users. The act has attracted major investment into renewable technologies and created a strong export market.

German Greenhouse Gas Emissions Trading Act (TEHG)

This act represents the enactment into national law of the EU directive on the European trading system with greenhouse gas emission rights. It forms the legal basis in Germany for trading in emissions certificates.
The German Emissions Trading Agency (DEHSt), which is located in the German Federal Environmental Office (UBA), is primarily responsible for implementing emissions trading in Germany.

German Closed Substance Cycle and Waste Management Act (KfW-/AbfG)

The central focus of the German waste management policy is on product stewardship.
In line with the law to promote waste recycling and secure the environmentally compatible disposal of waste, manufacturers and businesses have to design their products in a way that the production of waste is reduced during their manufacture and subsequent use and that an environmentally compatible re-utilisation and disposal of the residual waste material is possible.

The following are complementary regulations related to water and can be accessed following the links below:
The German Water Resources Act (WHG),
Drinking Water Regulation (TrinkwV) and
Waste Water Regulation (AbwV)

3.3.3 Schemes to promote greens aspects in buildings

The German building energy code, as well as the Dutch code, sets out the compulsory framework for builders to follow and to produce greener and energy efficient buildings. The German government also had to establish a number of schemes which support and encourage the application of the Building Code, largely because of the high cost implications of constructing using the new guidelines. The German government is working with the Kreditanstalt für Wiederaufbau (KfW)[12] to implement these schemes.

As already mentioned, the government-owned banking group KfW plays a central role concerning promotion of energy savings and CO_2 reduction in the building sector. Between 1990 and the end of 2009 subsidies for at least 3.1 million homes were implemented. In 2009, total subsidies amounted to 16.9 billion, of which 10.6 billion was for energy efficiency and 6.3 billion for renewable energies.

Government programmes to promote energy saving in housing have been in place in Germany since the 1970s. Incentive and support programs are offered through four channels:

- The Kreditanstalt für Wiederaufbau (KfW)
- The federal government
- Regional governments (Länder)
- Municipalities

KfW programmes

[12] The KfW is the public investment bank for the German government

The KfW, is the main funder of Investment in energy efficiency and renewable energy; rather than the federal government itself. It delivers specific programmes agreed between the government and the KfW. The government negotiates conditions with KfW, including access to help, the amount of loan funding available, and the level of subsidy to reduce interest rates on loans. There is no legal limit to eligibility for loans and subsidies and there is built-in flexibility to allow some subsidy programmes to apply in exceptional cases.

Beginning in 2006, federal funds of € 1 billion per year through KfW supported a strong focus on the refurbishment of existing homes and other buildings. Between 2008 and 2011, the federal budget for KfW's energy efficiency programmes grew to € 1.4 billion a year.17

Federal government programmes

The German Federal government has three special subsidy programs for existing buildings in addition to the program it channels through KfW:

- **MAP** is a subsidy programme to increase market incentives for renewable energy. This is the government's main instrument for promoting the use of renewable energy in heating with the aim of reducing dependence on fossil fuels. MAP was introduced in 1999 and has grown continually since then.

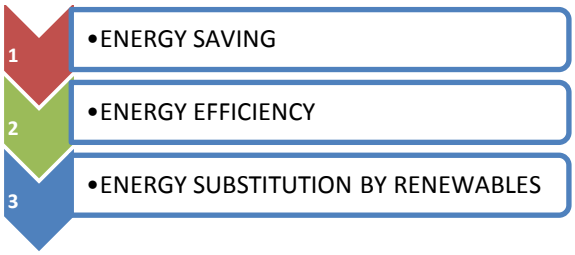
- **The energy advice for SMEs** is a programme developed by the Federal Ministry of Economics and Technology and implemented by the German Development Bank KfW. Through this programme, independent audits and consulting are offered to identify energy efficiency potential in small and medium-sized enterprises (SMEs) and increase the level of information on these potential with SMEs. The advice is largely funded by the government and further incentives are available for the implementation of identified energy efficiency measures.

- There is a smaller-scale programme for **refurbishing federal government properties**, including military buildings, which tests the use of new technologies and innovative methods for efficiency, including combined heat and power. This programme formed part of the German government's stimulus package of 2008–2011.

3.3.4 Hamburg's Experience

As a major industrial centre, Hamburg faces many environmental challenges that confront other European cities. The city has already made excellent progress in environmental protection and intends to increase these efforts. Hamburg implements all aspects of European environmental policy, enacted in the German building energy code, and aims to achieve a substantial contribution to the national goal of 40% CO_2 reduction by 2020 and 80% by 2050. So far, the CO_2 emissions per capita have been reduced by about 15% compared to 1990 with annual energy savings of about 46,000 MWh.

The city has a clear hierarchy of goals to comply with the regulations in German building energy code:



STRATEGIES TO REDUCE CO_2 EMISSIONS

In order to achieve a substantial reduction to CO_2 emissions the city's strategies are focusing on the following areas:

- Energy-Efficient Buildings and District

There are major urban redevelopment projects in Hamburg which incorporate climate change actions and focus on energy efficient buildings: these include Europe's largest waterfront redevelopment of Hafen City, and the restructuring of the older and more disadvantaged part of **Wilhelmsburg.**

The latter is the biggest urban planning project and also one of the most innovative districts in Europe. This district is located on the Elbe islands and the master plan envisages a colourful mixture of housing, offices, retail and service industries. With respect to housing, four different housing types ambitiously demonstrate the future of housing featuring everything from Hybrid Houses to Smart Materials. This district was designed with the goal to show residents how to build sustainable housing while respecting the environment.

The Water Houses, represent one of the housing types mentioned above that are located in the Wilhelmsburg district. The buildings are constructed to passive house standards; that means that they require a minimum of heating and all of their energy needs can be met using renewables. A geothermal heat pump uses the water to heat the houses, while solar thermal elements in the facades ensure the provision of a basic hot water supply. Smart building technologies control the ventilation and the energy supply, and give the residents feedback on their energy consumption.

- Renewable Energy Sources and Distributed Generation

The municipality wants to become a leading location for innovative services in the renewable energy sector. For this purpose the Renewable Energy cluster company has been set up. Since Hamburg has a large energy and district heating network, the local government has purchased a 25.1% share of the network to guarantee a strategic impact in energy decisions.

With respect to renewable energy, in 2011 the city expanded the use of roofs for solar panels as a continuation to a project which evaluated over 130,000 roofs to assess their suitability for photovoltaic or thermal solar panels.

A significant partnership programme, called "Enterprise for Resource Protection: has the objective to encourage voluntary investment in increasing energy and resource efficiency in enterprises. For each €1 invested by local government, participating companies contribute € 10. This has generated total private investment of € 146 million matched by municipal support of € 15 million. In total the enterprises currently save 134,000 tonnes of CO_2 emissions each year.

Another initiative that involves the private sector in new building technologies is the design of the Bio Intelligent Quotient (BIQ) House which is the world's first algae-powered building. A 15 unit net-zero energy apartment complex. This project features a bio-adaptive algae façade and it will serve as a testing bed for sustainable energy production in urban areas and self-sufficient living buildings. A joint team of the Austrian-based sustainable architecture firm Spitterwerks Architects, Colt International, Strategic Science Sosult and global engineering firm ARUP have developed this concept.

For more information on the BIQ House click on this link: **BIQ House**

Water

Hamburg relies on high-quality, natural, local groundwater for 100% of its supplies. This assures high quality drinking water. The city has invested in a programme of comprehensive maintenance of its infrastructure which has led to an exceptionally low leakage rate from freshwater pipes of just 4%.

Innovation also has its place, for example with pilot schemes that allow for heat from waste water to warm houses, by means of heat exchangers situated at the bottom of large sewers. The Hamburg

Water Cycle enables sewage disposal which is energy self-sustaining and neutral for the climate with nutrient reclamation. Among others, these innovations help to reduce the amount of carbon dioxide emitted and are, therefore, are an essential part of Hamburg's climate adaptation strategy.

- Waste management

Hamburg's integrated waste management system works very well, reducing landfill waste through a recycling and incineration processes. The local authorities have carried out public awareness campaigns to encourage households and businesses to sort paper, glass, plastics, metals and bio-waste. There are plans to boost recycling and energy recovery in the future.

- Economic measures

As mentioned before, the German building code sets out the compulsory framework to produce greener and more energy-efficient buildings; but since the implementation of these guidelines are very expensive the local government had to establish a number of schemes to support and encourage the application of these guidelines. Here are just some of the subsidies implemented by the municipality.

- Direct subsidies for implementing a higher standard within the social housing programme and energy renovation measures by the state-owned bank '**Hamburgische Wohnungsbaukreditanstalt**'.
- Direct subsidies for installing renewable energy systems such as solar thermal panels or biomass systems by the Hamburg Ministry of Urban Development and Environment.
- Subsidy programme for enterprises to improve energy efficiency

3.3.5 Case Study

From a report entitled "*Cutting Carbon Costs*" prepared by the organization *What Works Collaborative*; we have selected one of the thirteen case studies analyzed. That report explores how Germany has leapt ahead in developing renewable energy.

The following case study was selected because the outcome was even better than the requirements in the building code for new building standard (EnEV 2007).

Multifamily dwelling in Hanover(pp.70-81)

This refurbishment is included in the DENA[13] "Low Energy House in the Existing Stock" programme

Location: Hanover
Type: Multifamily housing
Client: Housing Cooperative WOGE Nordstadt eG, Scheiderberg
Housing units: 10
Heated occupied living area: 637 m²
Year of construction: 1895-1900
Modernization completed: 2006

Objective: to refurbish the units with solid equipment and fittings for affordable rents and modernize with passive house components.[14]

Modernization measures attracting subsidies and loans

[13] DENA is the German Energy Agency
[14] For more information on Passive House requirements and standards click on this link **Passive House**

Wood-pellet central heating boiler (25 kW) with 500-liter buffer storage and 300-liter drinking water storage; heat distribution by supply air and radiator in the bathroom; insulation of exterior wall with mineral wool (20 cm, U-value 0.16); new roof truss and insulation with cellulose fibers made from recycled paper (35-42 cm, U-value 0.11); insulation of basement ceiling (20 cm, U-value 0.17); passive house wooden windows triple glazed (U-value 0.5).

Energy demand		CO2 emissions	
Before	480 kWh (m^2/year)	Before	114 kg (m^2/year)
After	20 kWh (m^2/year)	After	5 kg (m^2/year)
Saving	**96%**	**Saving**	**96%**

3.4 Experience of other European and international cities

In the previous sections of this report we have seen the package of measures implemented on national level to support the building codes to meet the national goals in the reduction of CO_2 emissions of The Netherlands, UK and Germany. In the next section we will see how the local governments played an important role in implementing local policies and strategies in order to increase the energy efficiency of buildings and bring down GHG emissions.

3.4.1 Malmö

In 2009 Sweden set ambitious targets under the "Integrated climate and energy policy" framework regarding energy efficiency; requiring:

- to reduce energy intensity by 20% by 2020
- a share of at least 50% renewable energy in gross final consumption
- zero net greenhouse gas emissions by 2050

In order to achieve this, a new and more demanding code was produced in 2011. The **Building Energy Code** BBR Chapter 9 Energy Management states: "Buildings shall be designed in such a way that energy use is limited by low heat losses, low cooling demands, efficient use of heat and cooling and efficient use of electricity. "

Based on both documents at the national level, the municipality has prepared a plan to ensure that the city runs on renewable energy by 2030. The city is placing great emphasis on energy efficiency, reducing consumption and investing in renewable energy, to this end it has created a service department working with energy efficiency and renewable energy and a technical unit operating to optimizing buildings.

The objectives of the city of Malmö are:

- To reduce energy user per m² per year by 50% from the levels of 2001 by 2020
- The city as an organization uses 100% renewable energy by 2030.

The following are some of the strategies and projects grouped by topic, which the city is implementing to achieve their objectives.

- Renewable Energy Sources and Distributed Generation

  The municipality has developed a project named: "**100% local, renewable energy in the Western harbour of Malmö, Sweden**" which plans to house 10,000 people, offices and a University. The first stage- **the Bo01 housing estate**, was constructed and completed in 2001 and was called the "City of tomorrow". This new district is supplied with 100% locally produced renewable energy. While each technology has been tested and used before, the whole system - which combines wind power, solar photovoltaic and solar thermal, with a heat pump to supply the district with district heating and cooling – is unique. Solar energy supplies approximately 15% of the total energy needed on an annual basis. The solar collectors – totalling 2,600 m² – are located

on the roofs and façades of buildings, and are connected to the district heating system. This is a totally new solution to avoid large heat storage tanks in the buildings and instead use the district heating system as storage.

- Refurbishing of Buildings

Malmö's municipality installed Sweden's largest and most spectacular photovoltaic plant at **Sege Park** in 2007. The city is transforming a hospital area built in 1930s to a new neighbourhood. Sege Park is going to become as self-sufficient as possible using renewable energy and become an ecologically safe environment for the long term. It has a total area of 1,250 m² and a maximum effect of 166 kW. The facility produces during summer more power than is consumed in the houses
The municipality is using streets lights with solar cells also which eliminates the need to lay cables for electricity.
The roof of the central kitchen has been fitted with solar panels that produce heat, unlike solar cells that generate electricity.

Sustainable Hilda is another project taking place in the district of Rosengard; it includes an ecological total renovation of 800 flats which belongs to a housing cooperative called *HILDA* and is one of the first major renovation projects in buildings constructed in the late 1960's. This renovation process included an intensive dialogue with the residents, organizations and businesses from the area. Innovative environmental engineering is being used, in line with the city of Malmö's high demands regarding environmental sustainability and energy efficient buildings.
The renovation was made focusing on efficiency, renewable energy, water, transportation and lifestyle.
The renovation process included:
New energy-saving ventilation, renewal of all radiators, facade renovation, new internal walls, environmental investment, solar panels on the roofs.

3.4.2 Barcelona

We have been describing in this report some initiatives and strategies taken by some countries and cities to reduce their carbon emissions as required by the 2010 EPBD. Several cities have focused on renewable energies and have developed global concepts of sustainability in order to comply with their National Building Energy Codes and, Barcelona is not an exception.

To comply with the Basic Document HE from the Spanish Building Code [15] which requires:
Energy demand limitation, energy efficiency of lighting installations, solar contribution to domestic hot water and electric power; the city has focused on the use of sun as a natural source of energy because it has an average of 2,800 hours of sunshine/year.

The City intends to achieve an energy reduction potential of 58.2 GWh/year (-19.59 % of 2008 per capita energy consumption) and 14,827 t/year of GHG emissions (-23.45 % of 2008 per capita emission value). With this 23.45% GHG per capita emission reduction by 2020, Barcelona expects to accomplish the Covenant of Mayors Commitment.

The first "**Solar Ordinance**" which reinforces the Spanish Building Code in Barcelona, came into force in 2000 and was updated in 2006. It required that 60 % of the domestic hot water demand be supplied by solar thermal roof installations, in new buildings and those undergoing major refurbishment. Since then the city has developed an overall strategy for sustainable energy.

To manage this overall policy the city is working with the Barcelona Energy Agency Consortium, which includes: Barcelona City Council as the municipal manager, the Metropolitan Body for Hydraulic

[15] El Codigo Tecnico de la Edificacion (Building Energy Code) is available in this link **codigo tecnico** (only in Spanish)

Services and Waste Treatment, the Catalan Institute for Energy, the Autonomous University of Barcelona and the Catalan University Technical College (to increase knowledge and research). Its main functions consist of providing information about the Catalan energy sector, educational content, financial aid for specific technology renovations, relevant legislation and energy market statistics.

The development of renewable energy strategies is a clear priority in the City of Barcelona. These, although fully interconnected could be divided into the following groups:

- Promotion policies and Demonstration projects in municipal buildings

  These have been present in the city for several years to support the use of renewable sources, to inform and educate the people with awareness raising campaigns, and stimulate the use of these technologies amongst the private sector. Some examples are:

  - The installation of solar systems in schools, cultural centres, public libraries.
  - The solar thermal installation in the Olympics Swimming Pool andr the solar photovoltaic installation in the Town Hall building. The pergola placed on the roof of the town hall has a power of 85 kWp, its collectors take up 650 m² and it generates 93,000 kWh every year. This implies that almost 10 metric tons reduction of CO_2 emissions.
  - Urban solar PV power station "**Solar Pergola**" – Instalment of 10,700 m² of photovoltaic modules (energy obtained to serve about 1,000 homes)
  - **Ecoparc** District heating and cooling system – The incinerator plant will be transformed into an Ecoparc facility. It is based on the use of steam generated and will supply hot and cold water to the nearby neighbourhood.

- Legal instruments

  Barcelona was the first European city to have a ***Solar Thermal Ordinance***. This new policy has led the City to multiply per more than 10 the surface of solar thermal square metres (licenses requested), growing from 1,1 m²/1.000 inhabitants (in 2000) to 13 m²/1.000 inhabitants as of march 2004, the licenses requested for the installation of solar panels made up a total of: 19,543 m² of solar panels (before: 1650 m²). Nowadays more than 20 Spanish cities are now "replicating" this initiative taking Barcelona as a model.

  As part of the CEPEC project, which is a European Commission project the following actions have been carried out:
  - Development of Building Energy Codes
  - Energy Performance Contracting (EPC)

- Economic measures

  All PV installations can benefit from the Spanish feed-in-tariffs. Besides this, the Institute of Urban Landscape and Quality of Life provides subsidies of up to 25% of the installation costs for private buildings.

- Management instruments

  The following are the three major management instruments that demonstrate the commitment of the City to further promote these energy measures in a planned and structured manner. You can click on the links to access the original documents;

  – The *Catalunya Energy Plan from 2006-2015*[16]**,**
  – the *Energy climate change and air quality plan of Barcelona 2011-2020* and
  – the *Barcelona Energy Agency*

[16] Only available in Spanish and Catalan

- Integration of sustainable energy measures in urban developments

  This has been done in the New District Barcelona Forum converting an industrial and marginal area into a new central area of services and leisure, integrating the environmental infrastructures in the city. The urban solar power station is located in this area and produces energy to 1,000 homes.

1. CONCLUSIONS

As we have seen in this document countries and specially EU are setting ambitions goals and targets to reduce energy consumption and to promote the use of renewable energy in the building sector.

Several legal and voluntary instruments have been created to achieve these goals and targets. As the report shows mainstreaming energy efficiency and the use of renewable energy regulations into the building sector Code is considered by the EU as the most effective strategy to promote green home and to achieve EU targets.

The EU approach to promote green home is focused on setting energy efficiency targets and developing policies and instrument to speed up behaviour change in the building sector.

This behaviour change is being helped by the constant rise in energy costs which are driving more and more EU citizens to consider buying and/or turning their houses into more energy efficient ones. As a consequence a green building market is being rapidly developed in the EU context.

To organize and to promote this market the EU and member countries are putting in place technical standards, labels and important financial schemes to support the private construction sector in developing new green materials, technologies and recycling processes.

In the Netherlands, UK and Germany, the three main countries mentioned in this report, there are already several companies specializing in producing and promoting sustainable building products, materials, construction techniques and services.

Among the services and mechanisms being developed and marketed in EU for the building sector we could cite: rain water harvesting, grey water recycled, water treatment, taps, showers, urinals, WCs, above and below ground pipes, small turbines adapted to buildings, photovoltaic (PV) cells and modules, boilers and stoves using biomass, solar hot water, heat pump and exchangers, ventilation and others.

We hope that these particularly instructive cases and experiences presented in this report could be useful for the Nepalese authorities in defining the processes and measures to promote green homes and to develop and adopt their own building code in this area.

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