JRC Scientific and Technical Reports

Towards additional policies to improve the environmental performance of buildings

Andreas Uihlein and Peter Eder

EUR 23775 EN - 2009

JRC EUROPEAN COMMISSION

Institute for Prospective Technological Studies

The mission of the IPTS is to provide customer-driven support to the EU policy-making process by researching science-based responses to policy challenges that have both a socio-economic and a scientific or technological dimension.

European Commission
Joint Research Centre
Institute for Prospective Technological Studies

Contact information
Address: Edificio Expo, c/ Inca Garcilaso 3, 41092 Seville, SPAIN
E-mail: jrc-ipts-secretariat@ec.europa.eu
Tel. +34 954488318
Fax +34 954488300

http://ipts.jrc.ec.europa.eu
http://www.jrc.ec.europa.eu

JRC 50149
EUR 23775 EN
ISBN 978-92-79-11633-9
ISSN 1018-5593
DOI 10.2791/86422

Luxembourg: Office for Official Publications of the European Communities

Printed in Spain

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

GLOSSARY

AC	air conditioning
ANAH	Agence Nationale de l'Habitat
BCA	building code of Australia
CEN	European Committee for Standardization (Comité Européen de Normalisation)
COP	corporate operational plan
DHW	domestic hot water
EACI	Executive Agency for Competitiveness and Innovation
EE	energy efficiency
EEA	European Economic Area
EIB	European Investment Bank
EMAS	eco-management and audit scheme
EnEV	Energieeinsparverordnung (Energy Saving Ordinance)
EPA	Environmental Protection Agency
EPBD	energy performance of buildings directive
ERDF	European Regional Development Fund
ES	energy services
ESCO	energy service company
ESF	European Social Fund
ETV	environmental technology verification
EUEB	European Union Eco-label Board
EuP	energy-using product
GBP	Great Britain Pound
HVAC	heating, ventilating and air conditioning
ICC	International Code Council
IEA	International Energy Agency
IECC	international energy conservation code
IEE	intelligent energy Europe
IEEA	Intelligent Energy Executive Agency
IPMVP	international performance measurement and verification protocol
KfW	Kreditanstalt für Wiederaufbau
LESA	landlord's energy saving allowance

M & V	measurement and verification
MEC	model energy code
MEPR	minimum energy performance requirements
MPR	minimum performance requirements
MS	Member State
OECD	Organisation for Economic Co-operation and Development
R & D	research and development
RDI	research, development and innovation
SCF	Structural and Cohesion Funds
SCP	sustainable consumption and production
SEH	survey of English housing
VAT	value added tax
WBCSD	World Business Council for Sustainable Development
WEEE	waste electrical and electronic equipment

EXECUTIVE SUMMARY

Introduction

The objective of this report is to take stock of existing measures and policies to improve the environmental performance of residential buildings in the EU, and to assess if there are additional policies to the existing ones that could lead to further improvements.

One important ingredient of the report is a review of existing research on the environmental performance of buildings, on the barriers to energy efficiency and the measures to overcome them. The other main element is an inventory of existing and planned EU policy instruments dealing with the environmental and energy performance of buildings, building elements and equipment. Finally, barriers, available measures and policy instruments are assessed against each other to find out what more could be done.

The purpose of the assessment is to support EU policymaking on sustainable consumption and production (SCP) in the area of buildings, which were indentified as being particularly relevant for environmental improvements (EIPRO study by the JRC-IPTS).

While the objective of SCP policies is to address all the different types of environmental impacts in a balanced way, previous research by the JRC-IPTS (IMPRO-buildings study) has shown that the energy consumption during the use phase of the buildings is by far the most important factor to take into account for the life cycle environmental impacts of buildings. Moreover, residential buildings are responsible for 27 % of final energy demand in the EU. That is the reason why this report gives special attention to energy efficiency and how it can be improved.

Barriers towards energy efficiency

In principle, there are many options to reduce energy use and environmental impacts of buildings, without compromising, or even allowing improving, their residential quality. Even though most of these options are also cost effective, a great share of the improvement potential still remains untapped. This phenomenon is often called the energy efficiency gap. The existence of the energy efficiency gap can be explained by barriers that prevent investments into energy efficiency even if in theory such investments are economical. The following types of barriers have been identified as most relevant.

Problems of financing

Usually energy efficiency investments in existing buildings are made when refurbishment works are carried out for other reasons. For example, insulation material is added on the external wall of a building when new painting or other wall conservation work is needed. The energy efficiency measures then add an important additional cost. Financing for this is often hard to get and the initial costs of energy-efficient measures may become an insurmountable barrier, even if the measures make sense from a full life-cycle cost standpoint.

Unclear performance of energy efficiency technologies

Energy efficiency measures are often affected by uncertainties concerning the measurement and verification of the energy-saving, resulting from a lack of standardised measurement and verification protocols. Consumers and investors sometimes mistrust information on energy-efficient technologies because they were previously mislead by faulty technologies or they obtain conflicting information from different sources. Often there is also an operational risk that energy-savings may degrade over time, especially if the equipment is poorly maintained.

Lack of knowledge and know-how

The lack of knowledge and know-how about energy efficiency measures affects professionals in the buildings sector as well as the consumer side (private households and house owners) and financiers. A lack of technical skill may lead to choosing conventional, less energy-efficient options, as well as poor installation and maintenance of energy efficiency technologies. On the side of households there is often a lack of time or abilities to evaluate energy efficiency options thoroughly.

Split incentives

Split incentives, also known as principal-agent problems, can be observed when two parties involved in an economic relationship pursue different goals. If the tenant is responsible for the energy utility bills and the landlord is responsible for decisions affecting energy efficiency, then it is in the landlord’s interest to provide least-first-cost equipment rather than consider the equipment’s energy efficiency while the tenant aims at high energy-efficiency in order to reduce his energy costs. A similar problem occurs when the payback period of the investment exceeds the expected duration of the inhabitation of a building by a homeowner. A tenant will also be reluctant to invest in energy-efficient appliances when he is not allowed to take the equipment with him when he moves out of a dwelling. Split incentives also exist when the constructors of a building (e.g. architects, engineers) choose the energy-relevant features of a building. In general, they aim at reducing the initial costs which means that they opt for low energy-efficient equipment while the occupants of the building would prefer energy-efficient appliances which, in general, exhibit lower total costs.

Measures and policy instruments in the EU

Literature suggests a broad set of measures that can help to stimulate energy-saving measures in buildings and to overcome the energy efficiency gap. Generally, it is thought that a well-balanced set of measures will be much more effective than isolated measures and that the composition of the measure mix needs to be adapted to the specific circumstances of a country or region.

Financial support

A number of different measures are used to address the problem of financing energy efficiency investments. They comprise grants and subsidies, tax allowances and exemptions, as well as preferential loans.

Financial measures are often put into place at the national level. Grants and subsidies supporting energy efficiency measures in buildings can be found in many EU Member States. They seem to be the most commonly used type of financial measures. Tax allowances and exemptions supporting energy efficiency measures in buildings are not very common in the EU. An exception is France and, to some extent, the UK, where reduced taxes and tax deductions for energy efficiency measures play an important role. Preferential loans are a widely used measure to support energy efficiency in buildings in Germany. The instrument is also used for this purpose in some smaller EU Member States.

There is also some limited financial support provided by the EU cohesion policy, which identified the support to energy efficiency as an important objective. However, in the financing period 2007–13 refurbishments of the housing stock — and related energy efficiency measures — can be financed from the European Funds only in those Member States that acceded to the EU on or after 1 May 2004. Furthermore, expenditure is limited to multifamily and social housing.

Regulatory framework and standardisation

Increasingly, building codes and standards are used to define minimum performance requirements concerning environmental issues, especially the energy use and the energy efficiency of buildings. The minimum performance requirements can include reference to the building as a whole and to the different elements and energy systems of a building like the building envelope itself, space heating or cooling systems, electricity and/or lighting. In general, it is expected that the inclusion of minimum energy performance requirements into building codes and standards will lead to substantial energy-savings. Nevertheless, the introduction of minimum performance requirements tends to only eliminate worst practice rather than to 'drive best practice'. Additional measures that provide incentives or information towards best practice are needed in order to not only meet the minimum requirements but envisaging further improvement.

Energy certificates of buildings document and display the energy demand or energy performance of a building. According to the results of the calculation or measurement of the energy performance the building is assigned to efficiency classes e.g. from A (most efficient) to G (least efficient). Producing energy performance certificates normally includes energy audits by independent entities. Energy certificates show several advantages: landlords can refer to accomplished and planned modernisation measures and can use the energy certificate as a proof for future energy-savings. Tenants can estimate the expected energy costs by using the certificate. Energy performance data can be used in rental negotiations.

Furthermore, there is the possibility of environmental and energy performance requirements and benchmarks at the level of building components (e.g. boilers, heaters, windows). Eco-labels may be used to distinguish the best performing building elements.

The 'energy performance of buildings directive' (EPBD) includes obligations regarding minimum performance requirements and energy certificates. More specifically, the EPBD requires establishing a methodology for calculating the energy performance of a building, minimum standards for energy quality of buildings to be determined by Member States, certification for buildings to make energy consumption levels visible, and inspection of boilers and air-conditioning systems. An OECD/IEA report says that thus far the EPBD is the instrument with most potential impact on energy efficiency in existing residential buildings in the short and medium terms. A number of countries have transposed the directive, but a large number are still lagging behind. As of April 2008, the Commission has initiated 17 infringement cases against Member States. Meanwhile, the Commission has already made a proposal for recasting the EPBD in order to improve the present wording and to strengthen the level of ambition of the directive, e.g. by demanding minimum energy performance requirements also for major renovations of small buildings (currently excluded).

The directive on the eco-design of energy-using products (also called eco-design directive or EuP Directive) is the most relevant existing EU policy instrument allowing for regulation regarding the energy performance of individual building elements. Implementing measures, which may include energy performance requirements, are envisaged inter alia on building energy systems (e.g. boilers, heaters, water heaters, residential room conditioning appliances, lighting). Building elements like windows, floors, walls, or roofs are not concerned by the current version of the eco-design directive. A recast of the eco-design directive is, however, being prepared, and the European Commission has proposed to broaden the scope of the directive by including also energy-related products.

First proposals suggest covering e.g. water-using devices, building insulation materials, and windows. There is the intention to complement the revised eco-design directive by labelling schemes (e.g. through a revised EU eco-label regulation), green public procurement and taxation incentives. Especially relevant in this respect is the energy labelling directive. This directive aims to harmonise the labelling and product information schemes of a number of household appliances. The Commission has proposed to expand the scope to household appliances that are not yet included (e.g. boilers, water heaters) and to products that do not use energy themselves during the use phase but are energy-related such as, for example, building elements.

Information, capacity building and market transformation

Information measures are important because a lack of suitable information is widely recognised as a main barrier to energy efficiency measures. Digestible and trustworthy information is needed for all the different players: house owners, the construction industry and service providers, financiers and regulatory authorities. A wide range of contents need to be exchanged, including on e.g. technological options, saving potentials, support schemes, regulations.

Many efforts have already been made in Member States and at EU level to improve the information flow and it is not possible here to give the full picture. A particular measure is supporting the establishment of energy service companies (ESCOs). ESCOs are regarded especially useful for helping overcome the bounded rationality and lack of information barriers. Energy services provided to final energy users may include also the supply and installation of energy-efficient equipment, the supply of energy, as well as building refurbishment, maintenance and operation. Furthermore, ESCOs in a strict sense also offer financing and guaranteed energy-savings with savings-tied remuneration.

The EU directive on energy end-use efficiency and energy services has a comprehensive scope and tackles many barriers to achieve an overall energy-saving target of 9 % by 2016. For example, the Member States have to ensure that there are sufficient incentives for ESCOs, energy consultants or energy advisors to offer and implement energy services, energy audits and energy-efficient improvement measures. The directive also asks for the dissemination of information on energy efficiency mechanisms and financing options. The Member States shall as well ensure that qualification, accreditation and certification schemes are available for providers of energy services, or energy audits. The impact of the directive will greatly depend on the specific implementation and the ambition of single Member States.

Technology verification

The aim of environmental technology verification (ETV) programmes is to increase the acceptance of new technologies, such as energy efficiency technologies, by providing the costumer with credible and understandable performance information. ETV programmes would allow tackling market barriers related to uncertainty regarding the performance of energy efficiency technologies, bounded rationality and inadequate information. ETV programmes were developed in the mid-1990s in North America. The Commission planned to adopt a legislative proposal to establish a European ETV system in principle before the end of 2008.

Potential of additional policies

The assessment shows that the different barriers and the possible measures to overcome them are already addressed to a large extent by existing EU policy instruments. Some of the existing instruments are currently being overhauled in order to reinforce their effectiveness, to strengthen certain provisions of the instruments or to widen their scopes. The recast of the EPBD is of particular interest. For instance, the Commission has proposed to reduce or completely remove the limit above which existing buildings undergoing major renovations must comply with minimum energy performance requirements. This and other changes to the directive would allow increasing its impact on energy efficiency substantially.

There are, however, still some gaps in the otherwise already quiet tight EU policy framework. The main gap identified in this assessment is that EU instruments do not yet aim at the retrofitting of individual elements of the building envelope that show low thermal performance compared with the best available (or even average new) technologies on the market. In fact, it is economically reasonable to aim first at energy efficiency improvements on the occasions of ‘scheduled’ major renovations of whole buildings. To some extent, however, there is additional potential for cost-effective energy efficiency measures even outside the major renovation cycles. These measures would mainly consist in an accelerated retrofitting of single building components, such as roofs or windows. Also, the provision of minimum performance requirements for single building elements could be an option, which would then apply when building elements are replaced and the average performance of the respective elements on the market would be enhanced compared with the base case without minimum performance requirements.

In the case of windows, for example, an acceleration of the replacement rate of windows in the existing building stock with highly energy-efficient windows may offer a substantial environmental improvement potential. Besides windows, also the additional insulation of roofs may be a cost-effective measure even outside the normal renovation cycles (especially in southern and central Europe). The addition of insulation material (or the improvement of thermal performance of the roof insulation) needs relatively low investment compared with additional façade or floor insulation and could lead to considerable energy-savings. The heat losses due to roofs can reach up to 30 % of the environmental impacts of the total building stock for some regions and building types in the European Union.

The Commission has already proposed to broaden the scope of the eco-design directive from energy using to energy-related products. This would be an opportunity for defining minimum performance requirements for building envelope elements like windows or insulation materials. There are also plans to align the eco-design directive with other instruments, including energy labelling and the EU eco-label. These instruments could be used to label windows and other building elements that are especially energy-efficient and environmentally friendly.

However, the overall size of the additional energy-savings potential, the associated environmental gains, as well as the economic costs and benefits are not known yet. There are also important technical variables of retrofitting that would have to be assessed, such as the optimal thermal insulation levels of the building elements to be attained (which will certainly depend on the climatic conditions) and the pace of retrofitting. These are all important questions that need to be addressed before concrete proposals for additional policies can be made.

1 INTRODUCTION

1.1 Objectives

The purpose of this report is to support EU policymaking on sustainable consumption and production (SCP) in the area of buildings. The EU SCP policies aim at improving the overall environmental performance of products throughout their life-cycle, promoting and stimulating the demand of better products and production technologies, and enabling consumers to make better choices. A broad range of environmental challenges will be tackled through this policy, with priority being given to the reduction of greenhouse gas emissions, to the improvements in the efficiency of the use of natural resources and energy, and to the phasing out of the use of hazardous materials.

The report takes a sectoral approach and looks into how SCP policies could serve to further improve the environmental performance of buildings and what the impacts would be. More specifically, this report aims at:

- identifying the most promising policy options for going beyond existing EU policies in order to improve the energy efficiency of residential buildings;
- preparing for building scenarios regarding the concrete terms of how the policies could be put into place and for assessing *ex ante* the possible environmental and socio-economic impacts of the proposed scenarios.

The report draws from previous research on the environmental performance and energy efficiency of buildings by the JRC-IPTS and others, consolidates it in a comprehensive review and develops new insights by quantitative modelling of measures and impacts. Special attention is given to the policy measures considered in the recent Commission proposals on SCP policies ([1]). Proposed SCP policy measures include for example establishing minimum energy and environmental requirements for products, developing a product labelling system, and promoting energy-efficient and environmentally performing products through fiscal incentives and public procurement based on the benchmarks.

1.2 Background

The so-called EIPRO study by the JRC-IPTS on the environmental impacts of products had found that cars, food and buildings were the products with the greatest environmental impacts (JRC-IPTS, 2006). The subsequent JRC-IPTS study on environmental improvement potentials of buildings (IMPRO-Building) showed that energy consumption during the use phase of buildings (for heating and cooling) was by far the most important factor for the environmental impact of buildings. The biggest related improvement potentials were

([1]) See press release from 16/07/2008: 'Action plan for sustainable consumption, production and industry', available on the Internet (http://europa.eu/rapid/pressReleasesAction.do?reference=MEMO/08/507).

identified for retrofitting single-, two-family and terrace houses with better wall and roof insulation (Nemry and Uihlein, 2008).

Similarly, the OECD/IEA (2008a) stresses that the existing building stock causes over 40 % of the primary energy consumption and about 25 % of the CO_2 emissions worldwide. In the EU, residential buildings are responsible for 27 % of final energy demand (including space heating, water heating, cooking, electrical appliances, and lighting). The total building sector (residential and commercial buildings) accounts for about 40 % of the energy demand of the European Union (OECD/IEA, 2008a).

Numerous measures and options to reduce both energy use and environmental impacts from buildings have been identified. Even though most of these options are cost effective, a great share of the improvement potential remains untapped so far (Nemry et al., 2008). The unused potential for energy efficiency improvements is usually referred to as the energy efficiency gap (OECD/IEA, 2008a; The Allen Consulting Group, 2004). How to bridge the energy efficiency gap is the central question underlying this study.

1.3 Approach

This report identifies and analyses qualitatively the most promising policy options for going beyond existing EU policies in order to close the energy efficiency gap in residential buildings. Such analysis looks at the barriers that impede achieving higher energy efficiency in buildings (Chapter 2), the policy measures that have been identified as suitable for addressing the barriers (Chapter 3), and the different EU policy instruments that have already implemented such measures or could serve to implement the additional measures (Chapter 4). Finally, conclusions are drawn regarding additional policies that would help to improve energy efficiency even further than existing policies and suggestions are made for an analysis of the additional policies (Chapter 5).

This information is needed for the subsequent (not covered by this report) scenario analysis that will assess *ex ante* the environmental and socio-economic impacts of at least some of the policy options/scenarios identified, with a resolution for EU sub-regions or Member States. Use of available quantitative models is planned, in particular environmentally extended input-output models, to estimate the impacts of policies (including indirect effects) on parameters such as the environment, employment, or sector output.

2 BARRIERS TOWARDS ENERGY EFFICIENCY

2.1 Introduction

The energy efficiency gap can be explained by the existence of various barriers (Weber, 1997). These barriers towards more energy-efficient buildings have been analysed thoroughly in a number of studies and they are quite well understood (Brown, 2001; DeCanio, 1993; EuroACE, 2004; OECD/IEA, 2008a; Sorrell et al., 2004; WBCSD, 2007).

For this chapter, the barriers which are the most relevant in the building sector have been identified through a thorough literature review. General market barriers such as, for example, price distortion, unpriced costs, or unpriced goods are not included in this analysis ([2]). Instead, the focus is on barriers that are specific for the building sector. Based on the review, the barriers which are relevant concerning the energy efficiency gap in the building sector have been grouped into the following categories:

- problems of financing;
- unclear performance of energy-fficiency technologies;
- bounded rationality and inadequate information;
- split incentives;
- other barriers (including lack of technical skills).

Apart from these barriers to the implementation of cost-effective energy efficiency measures, the reason for not implementing measures may also be that the cost-effectiveness as such is only apparent and does not materialise in practice. The analysis of the different types of barriers is therefore preceded by a discussion of the uncertainties regarding the cost-effectiveness.

2.2 Uncertainties regarding cost-effectiveness

The term energy efficiency gap highlights that there is an untapped potential to improve energy efficiency through investments that are cost-effective. It is generally assumed that there are various barriers that prevent the cost-effective energy efficiency potential from being exploited. In addition, there are uncertainties about what cost-effectiveness means in reality. The uncertainties are related to factors such as:

- the results of the analysis depend on the assumptions made on interest rate, the lifetime of the energy efficiency equipment, and future energy prices;

([2]) These barriers are already addressed in other discussions concerning, for example, climate change or energy cost issues.

- there are often hidden transaction costs that are not typically considered in general studies;
- the outcome of energy efficiency measures may be rather heterogeneous so that cost-effectiveness on average means little in the specific case;
- many potential investors will not even take the step to making a rational assessment of cost-effectiveness.

2.2.1 Differences in assumptions

There are different ways to assess cost-effectiveness. One approach is to calculate the total equivalent annual costs of an energy efficiency measure. The total equivalent annual costs are calculated as the sum of annual operational and maintenance costs, plus annualised capital costs. To convert the investments into constant annual capital costs, the investment costs are multiplied by the equivalent annual cost factor or annuity factor, which is based on the lifetime of the measure and an interest rate. The results of the assessment depend on the values assigned to these parameters. Societal interest rates can differ significantly from those relevant to the capital costs or expected returns on investment for companies or individuals, i.e. the cost optimum for society is often different from an investor's optimum (Ecofys, 2005). An important specific uncertainty relates to future energy prices and hence the potential cost savings from an investment in energy efficiency. To be on the safe side, individuals may apply higher discount rates than otherwise appropriate. In terms of amortisation, energy efficiency projects, even if cost efficient, tend to have a longer payback period than more classical investments (OECD/IEA, 2008a). As a result of different assumptions, there will be cases were a measure is not attractive for the individual investor even if it is cost-effective for the society.

Jakob (2007), for example, argues that energy efficiency renovations are often economically viable if long-term average real interest rates (3 % to 3.5 %) and lifetime parameters in the order of the technical lifetime of the renovations are assumed. If building owners assume nominal instead of real interest rates and if their energy price assumption is guided by the past rather than by potential future developments, the outcome of cost–benefit estimations is altered significantly.

2.2.2 Hidden costs

There are hidden costs of energy efficiency investments that are usually ignored in studies that show the existence of an energy efficiency gap, such as costs of adoption and transaction costs. Examples are the costs of gathering information and perceived inconvenience of installing new equipment.

Transaction costs may weigh heavily on private house owners, which usually are not frequently confronted with renovation decisions. Per renovation, they face then unacceptable information search costs. The fact that the suppliers in the renovation market, who serve as first contact point, are often small firms with limited offers regarding energy-efficiency measures and related consulting contributes to such problems (Jakob, 2007).

2.2.3 Heterogeneous outcomes

It can also be expected that there are heterogeneous outcomes of a measure for different consumers, in that while the process may be shown to be cost-effective on average, there will be populations for which the adoption is not cost-effective, for example due to different behaviour or usage patterns (The Allen Consulting Group, 2004).

2.2.4 Lack/inability of rational assessment

Many potential investors in energy efficiency measures will not even take the step to carry out a detailed assessment of the cost effectiveness but be deterred right away by an 'irrational focus on upfront costs'. This can be seen as a consequence of 'bounded rationality', or inability to process information, and adds to existing inertia to change, preventing uptake (see also Section 2.5.2). 'This behaviour is likely to be a major component in the potential gap that may exist for the residential sector, where private agents have relatively limited resources to examine potentials for increasing their financial returns for all investments' (The Allen Consulting Group, 2004).

2.3 Problems of financing

The additional upfront financial needs for energy efficiency improvements are often considerable. Usually energy efficiency investments in existing buildings are made when refurbishment works are carried out for other reasons. For example, insulation material is added on the outside wall of a building when new painting or other wall conservation work is needed. The energy efficiency measures then adds an important additional investment cost that requires financing. As an example, the additional costs of energy efficiency improvement when renovating the building envelope of a single-family house were estimated at 7 % to 10 % of typical purchase prices of existing single-family houses in Switzerland (Jakob, 2007).

The OECD/IEA (2008a) points out that the higher initial cost of energy-efficient measures often represents an insurmountable barrier for customers, even if the measures make sense from a life-cycle cost standpoint. Often consumers prefer the least efficient solution because of the low initial cost. Even if in theory the market should provide capital for all investment needs at a risk-adjusted price, private households, especially low-income borrowers, and small business owners may have extreme difficulties in accessing capital. Generally, energy efficiency projects do often not rank high on financiers' agendas because projects tend to have a longer payback period than more classical investments.

However, it appears that the importance of financing problems as a barrier was recognised quite early and measures that were taken as a consequence have already improved the situation. According to a study for EuroACE (The European Alliance of Companies for Energy Efficiency in Buildings), availability of capital was a major constraint one or two decades ago but was less so in 2004, except in the new Member States from Central and Eastern Europe (EuroACE, 2004). The reasons given are that financial institutions have gained more experience with energy efficiency equipment and are more willing to provide financing. Innovative ways of financing were introduced, such as third-party financing and through energy service companies.

Some problems with financing remain, however, especially when energy efficiency investments are relatively small and financial institutions are reluctant to provide funding, due to high transaction costs relative to the total cost of the investments (EuroACE, 2004). Also the (OECD/IEA, 2008a) stresses the problem of small size and transaction costs. The high uncertainty typical for energy-saving measures, the high risk associated with the projects, the difficult replicability and their small size are all seen as contributing to higher transaction costs for energy efficiency projects. Investors then tend to prefer other projects which are more easily replicable. Furthermore, energy efficiency investments are often perceived as too uncertain or risky by commercial bankers.

From the perspective of the potential customer, there still appears to be a frequent lack of information on the financial options to investment. The option of improving energy efficiency may then erroneously be perceived as impossible and be discarded early in the decision making process. This again can be seen as one of the aspects of the bounded rationality and inadequate information problems discussed in Section 2.5.

2.4 Unclear performance of energy efficiency technologies

2.4.1 Uncertainty concerning measurement and verification of energy-savings

Energy efficiency measures are often affected by uncertainties concerning the measurement and verification of the energy-saving of an investment. Investors have to spend more time to assess the energy efficiency projects compared with other investment options. Despite these efforts, the energy-savings of a project may still remain uncertain which might prevent investors from financing energy efficiency measures (WBCSD, 2007). The transaction costs increase due to uncertainty concerning the measurement and verification of energy-savings. The uncertainty concerning the measurement and verification of energy-savings itself is caused by the lack of standardised measurement and verification protocols (WBCSD, 2007).

The barrier due to uncertainty concerning the measurement and verification mainly affects third party financing projects and ESCOs ([3]) (see Section 3.3.2 and Section 3.4.2) and seems to be of minor relevance for e.g. owners of single-family houses.

The lack of standardisation of measurement and verification (M & V) has been analysed for third-party financing projects in Germany. The study concluded that '[...] a standardised framework for M & V was seen to make presumably a useful contribution but it appears not to hit the crucial problems' (Ramesohl and Dudda, 2001). Many projects face more severe barriers before the measurement and verification step, e.g. when the project as such is developed and the technological concept has to be decided on (Ramesohl and Dudda, 2001).

Policies that are known to help overcoming this barrier include the introduction of standards for M & V like the US-DOE initiative International Performance Measurement and Verification Protocol (IPMVP) (Ramesohl and Dudda, 2001; IPMVP, 2002).

Currently, energy audits are required by the EPBD to compile the energy performance certificates (see Sections 3.3.3 and 4.2.1). They can also be seen as a 'possible method to provide data for measuring and calculating energy-savings' (OECD/IEA, 2008a; OJL 114,

([3]) ESCO: energy service company. A company that, in general, but not always, provides heating, cooling, and/or lighting services instead of energy supply (e.g. natural gas, electricity). These companies may also assure the supply, installation, operation and maintenance of related (energy-efficient) equipment as well as retrofitting or refurbishing measures.

2006). The EPBD also established the general framework for a methodology to calculate the energy performance of buildings (see Section 4.2.1). With a mandate from the European Commission, the CEN develops standards for the calculation procedures according to the EPBD (see Section 4.2.2).

2.4.2 Mistrust of information on technologies

One barrier towards more environmental friendly and energy-efficient buildings is the mistrust of information on energy-efficient or clean technologies. Consumers and investors sometimes mistrust information 'because they were previously misled by faulty technologies' (Golove and Eto, 1996; OECD/IEA, 2008a). Consumers can be confused by conflicting information (EuroACE, 2004).

According to Hall et al. (2005), apart from the lack of information, mistrust of information is a common barrier. Apparently, information has to be approved by several trustworthy sources before an investment decision is taken. Inconsistent information from different (trusted) sources will retard a decision (Hall et al. 2005). (EuroACE, 2004) points out that 'the credibility and reliability of information is essential, but difficult to guarantee'.

Mistrust of information on technologies poses a barrier both for private households as well as for companies and thus affects the residential and the commercial building sector. In general, the lack of information or other information-related barriers are perceived to be quite important (Caird et al., 2008). The size of the specific barrier due to mistrust of information is difficult to assess (see also Section 2.4.1 and Section 2.5.3).

The 'environmental technology verification' could be an interesting approach to tackle the mistrust of information, at least for the commercial and industrial sector (see Section 4.2.7). Concerning household appliances, labelling programmes (see Section 4.2.6) are seen to overcome mistrust of information (EuroACE, 2004).

2.4.3 Operational risks

Operational risks include all risks a business or a company is exposed to due to business processes and which can lead to business damages. Operational risks are risks that result from inadequacy or failure of procedures, humans and systems (e.g. fraud risk, legal risk, machinery breakdown) or due to external incidents (e.g. environmental risks).

The main operational risks for energy efficiency projects in the building sector include the degradation of energy-savings due to poor maintenance of the equipment (Mills et al., 2006). Another operational risk could be the occupant take-back: occupants of more energy-efficient buildings opt for a higher level of comfort (increased demand for energy), which reduces energy-savings (Haas et al., 1998; Stein, 1997; Caird et al., 2008) ([4]).

([4]) Stein (1997) gives an example for the takeback effect: '[...] occupants of energy-efficient houses choose a higher level of energy service than occupants of inefficient houses, thereby 'taking back' some of the expected savings. For example, if a house is inefficient and is very expensive to heat, the occupants might settle for a lower temperature in the winter in order to save money. In contrast, occupants of a more efficient house might opt for warmer temperatures in the winter. In other words, the savings have been achieved but they do not show up on utility bills because they have been consumed in the form of greater service'.

In general, the operational risk is regarded to be of minor importance compared with other risks (e.g. economic risks such as energy price developments, changes in capital and labour costs, exchange rate issues). Operational risks can be controlled by risk management procedures. Degradation of energy-savings can be detected by monitoring and diagnostics as well as by end-user training and information (Mills et al., 2006).

2.5 Bounded rationality and inadequate information

2.5.1 General lack of information and knowledge concerning energy efficiency measures

There is a widespread perception that the actors in the building sector (e.g. construction industry, suppliers, manufacturers, financiers, house owners) exhibit a general lack of information and knowledge concerning energy efficiency measures (OECD/IEA 2008a).

Hall et al. (2005) state that ‘there is a lack of people or resources in the market that customers can go to for help or information. This typically is seen as a lack of readily available experts or people with the knowledge and skills [...]’. Apparently, it is quite difficult for costumers to find adequate help from financiers once they decided to invest in energy efficiency measures and financial institutions seem to be unaware concerning specific tools (and aids) for energy efficiency measures (OECD/IEA, 2008a). But also on the custumer side (private households and house owners) a lack of information and knowledge impedes the implementation of energy efficiency measures (Caird et al., 2008).

Information and capacity building measures (e.g. demonstration programmes, education) might be a cost-efficient option to loosen up this barrier (see Section 3.4.1). According to EuroACE (2004), countries try to ‘improve the quality of information and the information flow’ but ‘there is still a great need for more information on cost-effective opportunities’.

“Many countries have improved their training schemes and introduced energy management into higher education. However, there are not many examples where EU-wide funds for training are being used to improve the quality of the energy service sector’ (EuroACE, 2004).

2.5.2 Bounded rationality constraints

Private households and companies can suffer from bounded rationality which means that energy efficiency measures cannot be evaluated thoroughly due to a lack of time, abilities, or other reasons (Wilson and Dowlatabadi, 2007; Sanstad and Howarth, 1994). Concerning companies, bounded rational constraints are widespread and can result from e.g. organisational failures (DeCanio, 1993, OECD/IEA, 2007). Bounded rationality constraints are seen to be one of the primary barriers towards energy efficiency (The Allen Consulting, Group, 2004).

The bounded rationality constraint for energy consumption in private households often is reinforced by minor attention paid to possible investments in energy efficiency due to the small share of the households’ expenditure for energy compared with total expenditures and the focus on initial costs instead of life cycle costs (The Allen Consulting Group, 2004). Private households often ‘have relatively limited resources to examine potentials for increasing their financial returns for all investments’ (The Allen Consulting Group, 2004).

The bounded rationality constraints are closely related to the broader issue of transaction costs which also add to the barriers towards energy efficiency by increasing the costs of the implementation of energy efficiency measures.

Bounded rationality constraints and high transaction costs can be tackled by all policy measures that aim at providing additional information on energy efficiency to companies and private households (see Section 3.4.1). These measures offer high potential at low cost and can be implemented for the residential as well as the commercial building sector (The Allen Consulting Group, 2004).

The establishment of an energy service sector could lead to a reduction in transaction costs and help to relax the bounded rationality constraint (Schleich and Gruber, 2008). Compared to information and capacity building options, the development of an energy service sector shows higher costs (The Allen Consulting Group, 2004).

2.5.3 Insufficient and incorrect information on energy features

Insufficient and incorrect information on energy features can lead to suboptimal investment or even non-investment in energy efficiency measures (Brown, 2001). When the energy features of a product or a system are not known, consumers will, in general, not make an investment (Office of Technology Assessment, 1993; Levine et al., 1995). Lack of information is closely related to high transaction costs and bounded rationality constraints because these include the cost and the time of collecting information (see also Section 2.3 and Section 2.5). (Brown, 2001) gives a nice example of insufficient information on energy features concerning electric household appliances: '[...] residential consumers get a monthly electricity bill that provides no breakdown of individual end-uses. This is analogous to shopping in a supermarket that has no product prices; if you get only a total bill at the checkout counter, you have no idea what individual items cost'.

It is quite difficult to assess the importance of this barrier. In general, the lack of information is mentioned as one of the most dominant barriers towards more environmental friendly buildings. Insufficient and incorrect information on energy features might be more relevant concerning household appliances but it also plays a role for insulation measures or energy systems (e.g. boilers, space heating and cooling). The barrier resulting from insufficient and/or incorrect information on energy features occurs both in the residential as well as the commercial building sector.

Of course, information measures and capacity building programmes can help in overcoming the barrier of insufficient and incorrect information (see Section 3.4.1). At the European level, there are already some information initiatives existing funded by the 'intelligent energy Europe' (IEE) programme (see Section 4.2.10). Other European policies include the energy labelling directive (see Section 4.2.6), the eco-label regulation (see Section 4.2.5), and the eco-design directive EuP (see Section 4.2.4). These regulatory measures aim primarily at improving the environmental performance of household appliances (including energy systems in buildings) but do not cover building insulation or refurbishment measures.

2.6 Split incentives

Split incentives, also known as principal-agent problems, can be observed when two parties involved in an economic relationship pursue different goals (OECD/IEA, 2007). In the building sector, the landlord–tenant relationship is an often cited problem with the tenant being responsible for the energy utility bills, and the landlord being responsible for providing household appliances. Thus, it is in the landlord's interest to provide least-first-cost equipment rather than consider the equipment's energy efficiency while the tenant aims at high energy-efficient appliances in order to reduce his energy costs (Jolley, 2006).

A similar problem occurs when the payback period of the investment exceeds the expected duration of the inhabitation of a building by a homeowner or a company (OECD/IEA, 2007). A tenant will also be reluctant to invest in energy-efficient appliances when he is not allowed to take the equipment with him when he moves out of an apartment or a building (OECD/IEA, 2008a).

Split incentives also exist when the constructors of a building (e.g. architects, engineers) choose the energy appliances of a building. In general, they aim at reducing the initial costs which means that they opt for low energy-efficient appliances while the occupants of the building would prefer energy-efficient appliances which — in general — exhibit lower total costs (Brown, 2001).

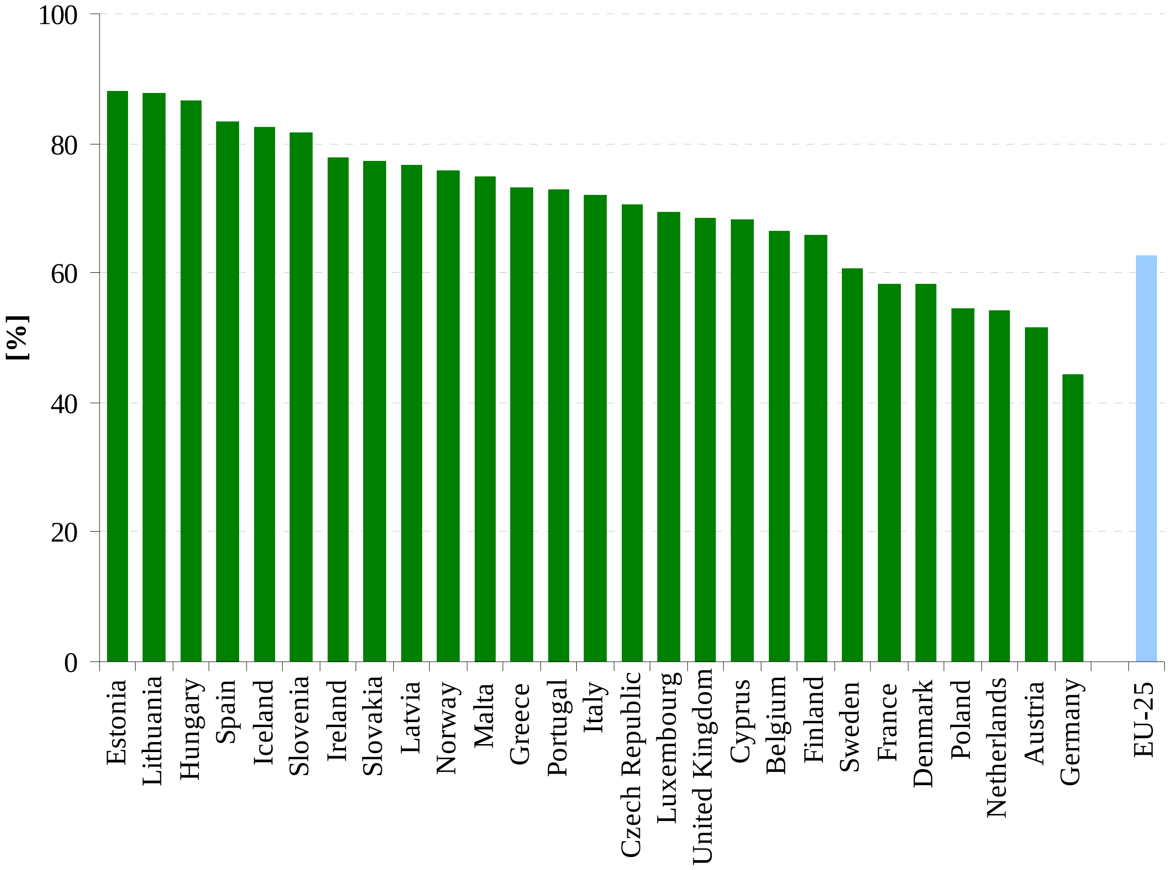
According to (Brown, 2001), the misplaced incentives problem is particularly important for multifamily buildings because in general, the majority of the inhabitants are renters. Split incentives seem to be less important concerning single-family houses which are often owned by the occupants (often the owner is also involved in the selection of energy appliances of the building). In the EU-15, about 70 % of houses are owned by their inhabitants (Table 1) while only about 25 % of all flats (in multi-family houses and high-rise buildings) are owned by their occupants (Eurostat, 2008a). In the EU-25, about 63 % of the population own their dwelling) while 37 % of the population are tenants (Figure 1).

Table 1: Housing type by tenure status and socio-economic status in the EU-15 from 1994 to 2001

Tenure status	Housing type	1994	1995	1996	1997	1998	1999	2000	2001
Owner	House	66.4	67.1	67.2	67.9	68.3	69.0	69.5	69.6
	Flat	25.4	25.3	25.5	25.0	24.9	24.7	24.4	24.4
	Other	8.1	7.7	7.4	7.1	6.9	6.3	6.1	6.1
Renter	House	27.3	27.4	28.3	27.7	28.3	28.4	28.4	29.8
	Flat	63.5	64.5	64.4	65.9	65.7	66.0	66.7	65.9
	Other	9.0	8.1	7.4	6.5	6.0	5.6	4.9	4.3
Total population	House	50.0	50.9	51.6	52.2	53.2	54.0	54.6	55.4
	Flat	41.3	41.3	41.0	41.0	40.3	40.0	39.6	39.1
	Other	8.6	7.8	7.4	6.8	6.5	6.0	5.8	5.5

Source: (Eurostat 2008a)

Figure 1: Tenure status of households in the EU-25 in 2005. Share of households that own their homes



Source: (Eurostat, 2008b)

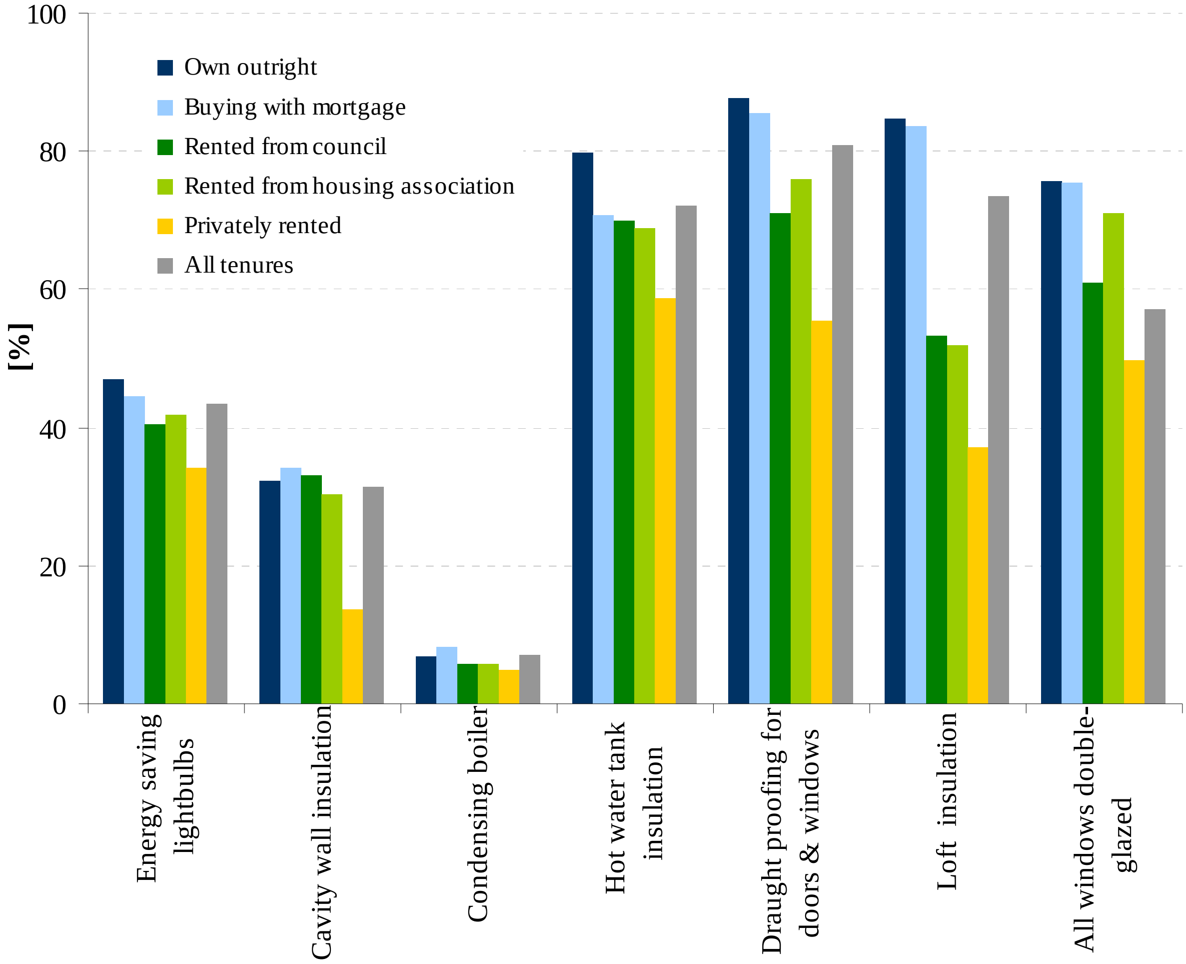
Concerning the correlation between the level of energy efficiency equipment in household and the ownership status, little information is available. The survey of English housing (SEH) contains some data on the endowment of households with energy efficiency equipment and on the insulation level of windows according to tenure status (SEH, 2008). Figure 2 depicts that, in general, households owning their dwelling show a higher level of energy efficiency equipment and insulation level compared with renters. The differences are quite substantial when comparing owned dwellings and privately rented dwellings. Interestingly, even for energy-saving light bulbs for which not only the landlord but also tenants are responsible, ownership status makes a difference: owned dwellings show higher levels of equipment with energy-saving light bulbs than households renting their dwellings.

Concerning the commercial sector, there is a case study available for The Netherlands which assumes that 40 % of the energy use in commercial offices is affected by split incentive problems (OECD/IEA, 2007).

Summing up, the split incentive presents an important barrier towards energy efficiency affecting both the commercial and residential building stock. In the residential sector, the split incentives seem to be more relevant concerning multi-family and high-rise buildings compared with single-family houses.

Several policies or measures exist to tackle the split incentives barrier in the building sector. The landlord–tenant problem concerning residential or commercial buildings could be resolved by contracting. In these cases, the tenant contracts the landlord to improve the energy efficiency of the building (e.g. by adding additional insulation) and accepts to pay a higher rent which is offset by reduced energy bills. An obstacle for this solution is the uncertainty arising from the occupation period of the tenant: the landlord does not know if the willingness-to-pay of another tenant will be the same, thus it is uncertain whether their investment will be paid off (The Allen Consulting Group, 2004).

Figure 2: Endowments of households with energy efficiency equipment according to tenure status in England in 2004/05 (double glazing) and 2000/01 (all other equipment)



Source: (SHE, 2008)

In general, the possibilities of a landlord to pass the investment cost of energy efficiency measures through to the tenant are limited. Jakob (2007) proposes contracting or a splitting of energy costs as possible solutions to overcome the split incentive barrier in Switzerland. The limits for the passing-through of costs to the tenants should be raised.

In the public sector, the split incentive problem was mainly tackled by governments by the allowance for third-party financing of energy efficiency projects (EuroACE, 2004). Directive

93/76/EEC asked the Member States to prepare and implement third-party financing programmes for investments in energy efficiency in the public sector (OJL 237, 1993). Directive 2006/32/EC (repealing Directive 93/76/EEC) broadened the scope and aims at developing a market for energy services and energy efficiency services both in the energy end-use sectors (OJL 114, 2006).

An interesting measure to avoid principal-agent problems in the public sector could be contracting by energy service companies (ESCO). These develop, finance and manage energy efficiency projects and provide energy at the contracted cost to the owner (WBCSD, 2007; Bertoldi and Rezessy, 2005). The profit of the ESCO is directly dependent on the energy-savings achieved through an investment (see Section 3.4.2).

The OECD/IEA (2007) concludes that a mix of policies rather than a single measure would be suited best to overcome the principal-agent barrier (OECD/IEA, 2007).

According to Jolley (2006), awareness-rising amongst tenants on energy cost issues by information programmes would help to make tenants take into account energy consumption 'when making decisions about which buildings to choose for tenancy. If tenants are fully informed, they should be more willing to pay higher rentals for energy-efficient buildings, thereby encouraging owners to take energy considerations into account in building design and fit-out'.

2.7 Other barriers

2.7.1 Lack of technical skills

The lack of technical skills mainly poses a barrier at the level of manufacturers and the construction industry. WBCSD (2007) states that 'there is a widespread lack of personal and corporate know-how in the market [...]'. The great variety of buildings, energy systems and appliances in the residential building sector adds to the difficulties (EuroACE, 2004).

The lack of technical skill mainly concerns the inadequate planning, the poor or improper installation and maintenance of energy efficiency technologies. Some specific energy-efficient technologies can require technical skills quite different from conventional technologies. 'Structural insulated panels, for example, provide framing, insulation and exterior insulation in one component. While requiring less skill than conventional framing, assembly of the panels into the exterior envelope of a house is substantively different' (Penney, 2007).

In general, according to Penney (2007), the 'lack of skills and/or training is not (at this time) a major barrier to the adoption of energy-efficient buildings/systems'. If there is an additional need to improve technical skills, training could be provided by a number of bodies including e.g. colleges, in-house training by developers, industry association, or non-profit associations. The main driver for enhanced training will be a higher demand for energy efficiency technologies and the implementation of regulations and standards for energy-efficient buildings (Penney, 2007).

2.7.2 Barriers to technology development

The development of environmental friendly technologies in the building sector (e.g. insulation materials, energy-efficient energy systems) is impeded by various barriers including e.g. low energy prices, the lack of incentives and governmental policies.

An important barrier towards technology development is the fact that the knowledge and the financial benefits obtained from R & D do not remain exclusively with the developer (e.g. due to imitators) ([5]). Investment in research and development is thus lower than what would be expected by the returns (Ford et al., 2007). Due to the high fragmentation of the building sector, single companies are often too small to invest significantly in R & D (EuroACE, 2004). The European Union tries to tackle this barrier by promoting and funding R & D on energy efficiency, particularly in the building sector in the FP7 (OECD/IEA, 2008a).

Barriers at the demand side for energy-efficient and environmental friendly technologies also play a role (see also Section 2.3 and Section 2.6). If the demand for and the implementation of such technologies is hampered, then the investment in R & D has to take this into account which might lead to lower levels of investment because the incentive for innovation is too low (EuroACE, 2004; Ford et al., 2007). Governments play a major role in overcoming barriers towards technology development. Possible policy options include funding for research and development, private-public partnership in research, education and information programmes (Ford et al., 2007). International collaboration should be intensified. Governments could grant property rights to allow the developers of environmental friendly and/or energy-efficient technologies to increase their returns on their R & D spending (The Allen Consulting Group, 2004).

Market based instruments can give incentives on the demand side for environmental friendly and/or energy-efficient technologies in the building sector. For example, (Jolley, 2006) mentions the carbon tax as an appropriate policy option in the building sector. Also standards could impact (Ford et al., 2007). According to Jolley (2006), demand side subsidies could also stimulate R & D, 'facilitating the take-up of desirable technologies so that market conditions reach a minimum critical mass for scale economies to be obtained.'

([5]) According to The Allen Consulting Group (2004), 'The process of technological development and innovation is a well known pathway for those seeking competitive advantage, and can occur across the full range of economic activities including energy use. An innovator will often have an incentive to try to keep secret their technological successes and failures — at a potential cost not only to their direct rivals but also to other organisations that might benefit from their experiences. On the other hand, innovators must often accept that, as soon as their product is put on sale, competitors will purchase and analyse its features, then incorporate them into their products, usually with sufficient differences to avoid patent claims. Thus, innovators can find it difficult to capture the full advantage of their work'.

3 MEASURES

3.1 Introduction

Literature suggests a broad set of measures that can help to stimulate energy-saving measures in buildings and to overcome the energy efficiency gap. Usually it is considered that a well-balanced set of measures is much more effective than isolated measures and that the composition of the measure mix needs to be adapted to the specific circumstances of a country or region.

For the sake of presentation, this chapter serves to introduce the measures one by one, discussing the barriers they address, for which types of buildings they are suitable, lessons that have been learnt where they have already been implemented, etc. The measures fall into different categories, including financial measures, regulation, standardisation, performance certification, labelling, provision of information, capacity building and market transformation.

3.2 Financial measures

3.2.1 Providing financing for cost-effective measures

One type of financial measure is the provision of financing through preferential loans. The OECD/IEA (2008a) concludes that preferential loans are an important measure to support energy efficiency in buildings in Germany. EuroACE (2004) shows that loan support can also be found in Austria, Finland, Lithuania, the Netherlands and the Slovak Republic. The instrument seems less relevant in the other big EU Member States.

Preferential loans are zero or low interest rate loans provided for specific purposes, such as energy efficiency investments. These loans are often offered by way of public–private partnerships, although they may also be provided directly by public bodies.

In Germany, the government’s funding programmes are managed by the Kreditanstalt für Wiederaufbau (KfW), a non-profit public banking group. The KfW raises funds from the financial market and transfers this capital, via commercial banks, to programme applicants in the form of lower interest loans. Financing for projects is channelled exclusively through regular banks; private households cannot apply directly to the KfW. The bank faces low interest rates in the financial markets because KfW is AAA-rated due to the guarantees accorded to it by its public status. In addition, federal funding is also used to further decrease interest rates. Loan repayments are used to pay back the bank’s liability on the financial market.

KfW programmes include long-term low-interest financing of energy efficiency improvements and CO_2 emission reduction measures (see Section 4.3.1). Apart from a low interest rate, applicants may be exempted from credit repayment during the first years. Up to 100 % of the investment costs are financed. The maturity period of the long-term loans is up to 35 years. Fixed interest rate periods of up to 15 years are also offered.

On average, the OECD/IEA (2008a) estimates that the reduced interest rates results in savings equivalent to about 7 % to 12 % of the loan amount. According to this same source, the preferential loan programmes offered by the KfW proved flexible and were restructured a number of times until it became successful in effectively transforming housing loan provision and the real estate market so as to include energy efficiency and make energy efficiency measures financially viable for housing owners, buyers and renters.

From 1996 to 2005 the cumulative housing space in existing buildings where energy efficiency improvements were promoted by KfW amounts to 73 million m^2. This is equivalent to about 2.2 % of the total building stock. The OECD/IEA (2008a) estimates that the energy demand of the existing building stock in Germany would be about 10 % to 20 % higher if the different policy measures in Germany had not been implemented.

Simple application procedures, avoiding confusing mixes of diverse programmes and targeted information campaigns (provided through information and advice centres) were identified as key success factors.

3.2.2 Grants and subsidies

Grants and subsidies supporting energy efficiency measures in buildings can be found in many EU Member States (EuroACE, 2004). They seem to be the most commonly used type of financial measures.

In the UK for example, grants play an important role in providing financing for energy efficiency improvements in private homes. Grants for energy efficiency measures are provided within programmes that aim at combating ‘fuel poverty’. Fuel poverty exists when there is a combination of purely insulated, energy inefficient housing and low incomes. The OECD/IEA (2008a) reports that the warm front scheme for example was launched to tackle fuel poverty in the private sector in England in 2000, and is the UK’s largest fuel poverty reduction programme. Since the scheme’s introduction in June 2000, over 1.46 million households have received assistance. It has been estimated that the potential energy-savings amount to almost 10 GJ per household every year for the next 20 years. Similar programmes exist in the other devolved administrations (see Section 4.3.1).

Since 2007, also the KfW in Germany offers direct grants for the modernisation and renovation of residential buildings if certain requirements to reduce energy consumption are met. The grant cannot be combined with a KfW loan programme (see Section 4.3.1).

The overall assessment of the OECD/IEA (2008a) regarding grants and subsidies stresses that they offer the advantage of filling an immediate financial gap. Although they were not always targeted at energy efficiency directly, they contributed to reduce the energy consumption of low-income houses, and to spread information on energy efficiency.

3.2.3 Fiscal measures

Tax allowances and exemptions supporting energy efficiency measures in buildings do not seem very common in the EU. The OECD/IEA (2008a) shows that fiscal measures in the form of reduced taxes and tax deductions for energy efficiency measures play an important role in France and, to some extent also in the UK.

In France both income tax reductions and a reduced VAT scheme exist ([6]). There are also special incentives for investments in the rental sector. This is regarded as particularly beneficial since this sector is affected by principal-agent problems.

However it seems that the effect of these fiscal measures on energy efficiency is limited. One reason given is that the technical requirements to obtain tax credits are relatively modest compared with what can be achieved with available state-of-the-art technology. There are also fixed upper limits capping fiscal incentives related to income tax. This may discourage building owners from undertaking large retrofit projects and making more energy-efficient choices when renovating. This drawback has been partly offset with the reduced VAT scheme, which reduces tax for building works from about 20 % to 5.5 %. However, the scheme only applies to energy efficiency materials or systems, but not to installation or labour costs (this cost could typically represent up to 50 % or more of the total costs, in particular in the case of insulation work).

In the UK, the 'landlord's energy saving allowance' (LESA) provides tax deductions to landlords who make investments in certain energy-saving measures (a deduction against profits of up to GBP 1500 per property for energy efficiency installations). The government is awaiting state aids clearance to extend LESA to corporate landlords, making the allowance available to an additional 25 % of properties within the sector.

A reduced VAT rate of 5 % (down from 17.5 %) is applied in the UK for the grant-funded installation of certain energy-saving materials in the homes of the elderly, less well off and vulnerable households.

In Germany, fiscal measures are not favoured as a means of financing energy efficiency improvements because they are regarded as inflexible and lacking clarity. Preferential loan programmes are the preferred option.

In general, the OECD/IEA (2008a) concludes that fiscal measures did not appear to have had particularly large impacts in the cases where they were studied. They are relevant in targeting a financial liquidity barrier, because they can reduce the cost of energy efficiency improvement measures, for example through reductions in VAT rates for energy-efficient installations. However, fiscal measures often lack clarity and are not well known by or explained to the public. Being tied to large administrative bodies for changes, they also tend to be inflexible.

Often it seems also unclear if the tax reasons are really a relevant motivation for the implementation of energy-related measures. There may be a considerable proportion of free-riders. The effectiveness of the tax incentives in stimulating energy efficiency investments depends on the details of their design.

([6]) Member States are allowed to apply a reduced VAT rate to a specific list of labour-intensive services, including renovation of private dwellings (this expires on 31.12.2010, but an extension is under consideration).

3.3 Regulatory framework and standardisation

3.3.1 Minimum performance requirements for renovated and new buildings — building codes and standards

Building codes and standards are rules to ensure public health, safety, and welfare by establishing minimum safety specifications for buildings. Building codes and standards can include diverse issues like statics (e.g. stability, protection against earthquakes), regulations concerning emergency exits and escape routes, exposure to light and air, protection against noise, humidity, and corrosion as well as fire protection regulations.

Increasingly, building codes and standards are used to define minimum performance requirements (MPR) concerning environmental issues, especially the energy use and the energy efficiency of buildings (OECD/IEA, 2008b; RICS, 2008). The geographical coverage of building codes can vary from country to country. Some countries have a national code that is adopted throughout the country while others only provide a model code which can then be adopted by states or regions.

Minimum performance requirements for energy efficiency in buildings can comprehend qualitative or quantitative statements (e.g. energy use per m^2 of living area). The minimum performance requirements can include different elements and energy systems of a building like the building envelope itself, space heating or cooling systems, electricity and/or lighting (RICS, 2008).

In general, minimum performance standards apply only for new buildings and for existing buildings (sometimes only large buildings) that undergo major refurbishment or renovation actions (see for example OJL 001 2003). Often, the minimum performance requirements in building codes are split for 'houses' and 'other buildings' or for 'residential buildings' and 'other buildings'. For houses or residential buildings the issues covered in general are the R-value ([7]) and the seal of the envelope, the window-to-wall ratio of the envelope, and insulation of piping. For larger buildings the requirements can be complex and consist of very detailed approaches 'taking into account thermal resistance of walls, floors, roof and windows as well as radiant gains through windows and skylights' (Office of the Australian Buildings Codes Board, 2000).

In general, it is expected that the inclusion of minimum energy performance requirements (MEPR) into building codes and standards will lead to substantial greenhouse gas emission reductions (OECD/IEA, 2008b). Nevertheless, the introduction of minimum performance requirements tends to only eliminate worst practice rather than to 'drive best practice' (Australian Greenhouse Office, 1999). Additional measures have to provide incentives or information towards best practice and support building designers and architects in order to not only meet the minimum requirements but also to envisage further improvement.

Minimum energy performance requirements are supposed to lead to a higher demand for energy efficiency services and environmental friendly and efficient energy systems. Due to

([7]) The R-value (Km^2/W) measures the thermal resistance of a building element. The bigger the R-value, the better the insulation level of the element. The U-value (W/m^2K), a measure for the rate of heat transfer through an element over is the reciprocal of the R-value.

this demand side incentive there might be several barriers relaxed at the same time. First of all, minimum performance requirements will help to overcome the split incentive problem (landlords have to comply with the standards for energy efficiency). A higher demand for energy efficiency services will lead to more experience with energy-efficient equipment or systems thus leading also to an increase of technical skills. The introduction of minimum energy standards will raise awareness of energy efficiency issues and contribute to information and capacity building.

3.3.2 Standardised methodologies for calculation, measurement and verification of the energy performance of buildings

Standardised methodologies for the calculation, the measurement and the verification of the energy performance of buildings now exist in almost all countries. In general, these methodologies are included in the building codes and standards defining minimum energy performance requirements for buildings (see Section 3.3.1).

In the European Union, the EPBD obliges every Member State to define a means of calculating energy performance in its buildings within a common EU framework. The EPBD also asks for the development of standard methodologies to calculate the energy efficiency of lighting and air-conditioning (AC) systems (see Section 4.2.1).

Concurrently, a large number of EN and ISO standards exist to calculate the energy performance of buildings (Levin and Bro, 2003). The European Commission mandated the CEN to produce a variety of standards to support the national implementation of the EPBD by the Member States (see Section 4.2.2). The standards now cover almost all aspects of the calculation of the energy performance of building envelopes (thermal losses), of heating and domestic hot water (DHW) systems including the calculation of cooling load and cooling energy use, and of internal gains (Hogeling and van Dijk, 2008). What is still missing are standards for the use of renewable energies. Also methods concerning the verification of energy performance calculations still do not exist (Levin and Bro, 2003).

According to (Hogeling and van Dijk, 2008), the knowledge concerning the integration of calculation methodologies into national building codes and standards is still rather limited. (Hogeling and van Dijk, 2008) also point out that the CEN standards are not mandatory for the Member States, i.e. Member States can use the standards for national legislation but most of them do not require the direct application of the CEN standards but instead use them as a basis for national regulation.

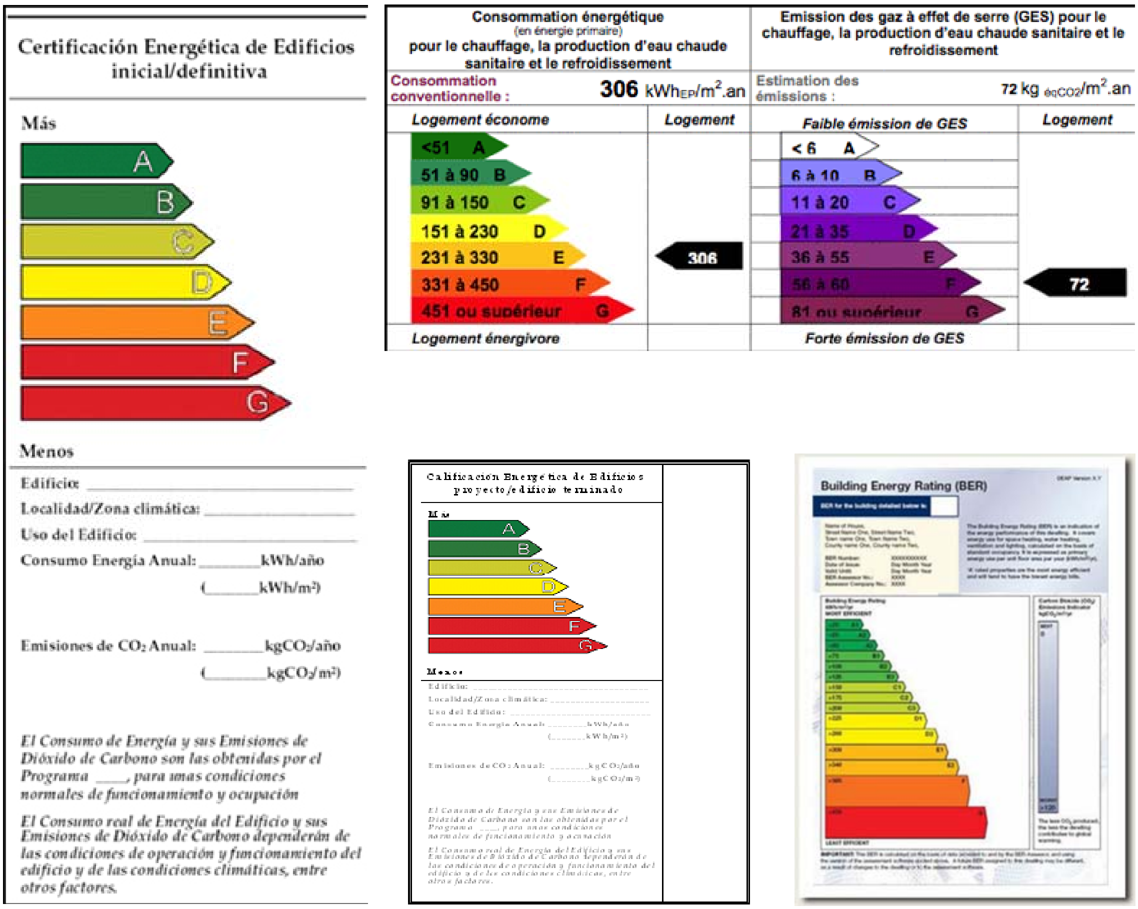
Improvements concerning the standardisation of the methodologies to calculate and verify the energy performance of a building will help to overcome the problem of uncertainty concerning the measurement and the verification of energy-savings of energy efficiency measures (see Section 2.4.1) and will help to remove the mistrust of information of energy-efficient technologies (see Section 2.4.2).

A related measure is the development of simple tools that can be easily used, including by non-professionals, in existing residential buildings and even in individual households to evaluate the energy-saving potential, taking into account the different building categories and climate zones.

3.3.3 Energy certification of buildings, including the obligation to display the certification

Energy certificates of buildings document the energy demand or energy performance of a building. Energy certificates always refer to a whole building by not only including heating or DHW systems but also taking into account insulation levels or glazing. Energy certificates usually display the energy demand and CO_2 emissions (per year or per m^2) of the building. According to the results of the calculation or measurement of the energy performance the building is assigned to efficiency classes e.g. from A (most efficient) to G (least efficient) (see Figure 3). Producing energy performance certificates normally includes energy audits by independent entities.

Figure 3: Examples for different energy certificates in EU Member States



Energy certificates show several advantages: landlords can refer to accomplished and planned modernisation measures and can use the energy certificate as a proof for future energy-savings. Tenants can estimate the expected energy costs by using the certificate. Energy performance data can be used in rental negotiations (e.g. discount on the rent to compensate for high energy costs until energy efficiency is improved). Of course, owners of energy-efficient buildings will have some benefits in future due to the rising value of their property compared with less energy-efficient buildings. Last, but not least, the issuers of the energy certificates will profit from increased demand for certification ([8]). Energy certificates for buildings will lead to a general increase of the awareness of energy consumption of buildings which might lead to higher investments in energy efficiency measures.

The disadvantages of energy certificates are twofold: first, some (or most) landlords might perceive energy certificates just as an additional paper they have to obtain without implementing energy efficiency measures. Second, the calculation of the energy consumption of the building (as displayed in the energy certificate) could differ from real energy use. This might also lead to wrong conclusions concerning the proposal of improvement measures (e.g. untenable promises on energy-savings, wrong profitability calculations).

3.3.4 Eco-design requirements for building components

Eco-design or ecological design is geared to the principles of sustainability. The design process pays special attention to reduce the environmental impacts of a product during the whole life cycle. According to the European Commission, it is ‘estimated that over 80 % of all product-related environmental impacts are determined during the design phase of a product’ ([9]). Eco-design makes it possible to reduce environmental life-cycle impacts of products already at an early stage of product development.

In the European Union, Directive 2005/32/EC on the eco-design of Energy-using Products (EuP) was adopted in 2005 (OJL 191, 2005). The directive establishes a framework for eco-design requirements for EuPs including all sectors of the economy (see Section 4.2.4). The directive itself does not include binding requirements for specific products but defines the criteria for the setting of these requirements. The directive will be followed by implementing measures for single products ([10]). Currently there are preparatory studies ongoing for 15 single products which mainly include household appliances (e.g. refrigerators, freezers, dishwashers, washing machines, vacuum cleaners) and consumer electronics (e.g. television, computers, monitors, copiers, faxes, printers). Concerning building elements, there are studies ongoing mainly on building energy systems (e.g. boilers, heater, water heaters, residential room conditioning appliances, lighting). Building elements like windows, floors, walls, or roofs are not concerned by eco-design requirements under Directive 2005/32/EC.

There is a variety of eco-design manuals or guidelines such as UNEP's ‘Promise eco-design manua’ (UNEP plans to issue the new global guide ‘Design for sustainability’ in late 2008), the ‘Life-cycle design manual of the US EPA’ (Keoleian and Menery, 1993), or the ISO technical report 14062 (Dewulf and Duflou, 2004). The ISO technical report 14062:2002, ‘Integrating environmental aspects into product design and development’ presents methodologies, procedures and current practice on how to integrate environmental aspects into the design and development process (ISO/TR 14062:2002).

([8]) In Germany, the cost of the energy certificate was below EUR 300 for a majority of buildings [EA.NRW 2008).

([9]) See http://ec.europa.eu/energy/demand/legislation/eco_design_en.htm

([10]) See also http://ec.europa.eu/energy/demand/legislation/eco_design_en.htm for more information

The benefits from considering eco-design principles into the product-design phase may include: lower costs, innovation and better product quality ([11]). Dewulf and Duflou (2004) state that despite '[...] of legislative actions and intensive research programmes, the wider industrial community has still not adopted eco-design as an evident part of business practice'.

3.4 Information, capacity building and market transformation

3.4.1 Information programmes

Information programmes have a role to play because a lack of suitable information is widely recognised as a main barrier to energy efficiency measures. Digestible and trustworthy information is needed for all the different players: house owners, construction industry and service providers, financiers and regulatory authorities. A wide range of contents need to be exchanged, including on technological options, saving potentials, support schemes, regulations, etc. Many efforts have already been made in Member States and at EU level to improve the information flow and it is not possible here to give the full picture. Only some of the initiatives at EU level are therefore mentioned.

ManagEnergy is an initiative of the European Commission Directorate-General for Energy and Transport, which aims to support the work of actors working on energy efficiency and renewable energies at the local and regional levels. The main tools are sectoral advice, training, workshops and online events. Additionally information is provided on case studies, good practice, European legislation and programmes. The website ([12]) includes a partner search system with some 3 500 organisations, including 380 energy agencies, which can provide expertise and partnerships on energy activities at local and regional levels. Furthermore there are a monthly newsletter and a 'KidsCorner' section, which provides educational resources for children, young adults and their teachers in 23 languages.

The 'sustainable energy Europe 2005–08' campaign is an initiative of the European Commission, Directorate-General for Energy and Transport, in the framework of the 'intelligent energy Europe' (2003–06) programme, which aims to raise public awareness and promote sustainable energy production and use among individuals and organisations, private companies and public authorities, professional and energy agencies, industry associations and NGOs across Europe.

The Intelligent Energy Executive Agency (IEEA) — now the 'Executive Agency for Competitiveness and Innovation' (EACI) was established to implement the 'intelligent energy Europe' programme ([13]). The EACI manages the different projects and events funded under the IEE programme, and disseminates the know-how and best practices which result.

([11]) See also http://www.iso.org/iso/pressrelease.htm?refid=Ref840

([12]) See http://www.managenergy.net

([13]) Since July 2007, the IEEA also manages the Community actions concerning entrepreneurship, eco-innovation, and sustainable freight transport (Enterprise Europe Network, eco-innovation, and Marco Polo programme). These additional tasks are also reflected by the new name.

3.4.2 Support to energy service companies (ESCOs)

Energy service companies (ESCOs) are regarded as useful to help overcome the bounded rationality and lack of information barriers. They can also help to deal with investment risks and to provide financing for energy efficiency investments.

Energy services provided to final energy users may include the supply and installation of energy-efficient equipment, the supply of energy, as well as building refurbishment, maintenance and operation. Furthermore, energy service companies (ESCOs) in a strict sense also offer financing and guaranteed energy-savings with savings-tied remuneration. Usually ESCOs then retain an ongoing operational control in measuring and verifying the savings over the financing term. Alternatively, financing may also come from a third party (third party financing) (Bertoldi and Rezessy, 2005).

Despite the benefits they promise, ESCO’s activities were concentrated in only a few EU Member States (such as Germany, UK and Austria) a few years ago. Recognising their potentially important role in facilitating energy efficiency improvements, the EU and national governments have then taken steps to promote ESCOs. In particular, the EU energy service directive was put into place to reinforce the role of ESCOs throughout the EU (see Section 4.2.3). The directive includes, amongst other measures, a supply-side obligation for energy distributers and retailers to offer efficiency improvement measures to their customers, and a requirement for Member States to remove barriers to ESCOs and third party financing.

Recent research has shown that the residential sector is becoming attractive for ESCOs in some countries, although originally this sector was believed to be a difficult market for ESCOs because of its complexity in decision making, small project sizes and large transaction costs. Linking ESCO services to national or other support programmes for domestic buildings often appears to be the key success factor (Bertoldi et al., 2007).

4 POLICIES

4.1 Introduction

In Chapter 2 we presented the market barriers towards energy efficiency in the building sector. We assume that these market barriers could be tackled by governments through policy measures and that policy intervention to support energy efficiency is justified (Golove and Eto, 1996). In this chapter, we will present the EU legislation currently in place (Section 4.2) and examples for some policy measures at Member State level (Section 4.3).

Finally, we will contrast the barriers towards energy efficiency with the existing EU policy in order to see which of the barriers is effectively addressed or which barrier is not or partly addressed only. The policy instruments in place will be analysed according to the level they reached their respective potential. We will then be able to identify the gaps of current EU legislation and to propose additional policy measures (Section 4.4).

4.2 Policies at EU level

4.2.1 'energy performance of buildings' directive (EPBD)

The EU directive on the energy performance of buildings aims at ensuring that building standards across Europe place a high emphasis on minimising energy consumption. This is expected to reduce the use of energy in buildings across Europe. The EPBD requires:

- the establishment of a methodology for calculating the energy performance of a building, taking account of local climatic conditions, inter alia;
- minimum standards for energy quality to be determined by Member States and applied to all new buildings and to major renovation ([14]) of existing large buildings (above 1 000 m^2);
- development of certification for buildings to make energy consumption levels visible to owners, tenants and users;
- inspection of boilers and air-conditioning systems.

The deadline for the implementation of the first two provisions was in January 2006 and for the last two — due to the challenges facing Member States as regards training and accreditation of experts to carry out the certifications and inspections — a further grace period of up to three years (i.e. until January 2009) was allowed.

([14]) Major renovations are cases such as those where the total cost of the renovation related to the building shell and/or energy installations is higher than 25 % of the value of the building, excluding the value of the land, or those where more than 25 % of the building shell undergoes renovation.

A number of countries have transposed the directive, but a large number are still lagging behind. As at April 2008, the Commission has initiated 17 infringement cases against Member States that have failed completely or partially to notify national implementing measures or properly to implement the EPBD.

Meanwhile, the Commission is planning to make a proposal for recasting the EPBD by the end of 2008 in order to improve the present wording and to strengthen the level of ambition of the directive. A background paper by the Commission ([15]) suggests to:

- reduce the limit above which existing buildings undergoing major renovations must comply with minimum energy performance requirements set by the Members States (the current threshold is 1000 m^2);
- clarify the requirements for energy performance certificates because currently some certificates issued in Member States are not of satisfactory quality and it is not assured that they are systematically made available during property transactions when they could help to overcome the split incentives problems;
- include in the directive clearer specifications, requirements and objectives for the inspections of boilers and air-conditioning systems;
- introduce a benchmarking system for comparing minimum energy performance requirements across Member States.

Regarding the possible impacts, the background paper also stresses that reaping the energy-saving potential in the building sector will contribute to EU economic growth and job creation by providing additional employment and business opportunities and cost-effectively supporting local development.

The OECD/IEA (2008a) report says that ‘thus far the EPBD remains the instrument with most potential impact on energy efficiency in existing residential buildings in the short term (a five to ten year period) or even in the medium term up to 2020’.

4.2.2 EPBD-related CEN mandate to develop a set of standards (Mandate 343)

The European Commission detected the need to support the EPBD with European standards. Within CEN mandate 343, a set of consistent standards should be developed. First, Member States with limited experience in the area of the EPBD should benefit from the standards and second, future harmonisation could lead to benefits for all Member States. An important issue of CEN standards is that they allow for flexibility regarding different climatic conditions, user behaviour, and building types throughout Europe (Hogeling, 2006).

In total, the set of CEN-EPBD standards contains 44 single standards or titles which can be grouped as follows (Hogeling, 2006):

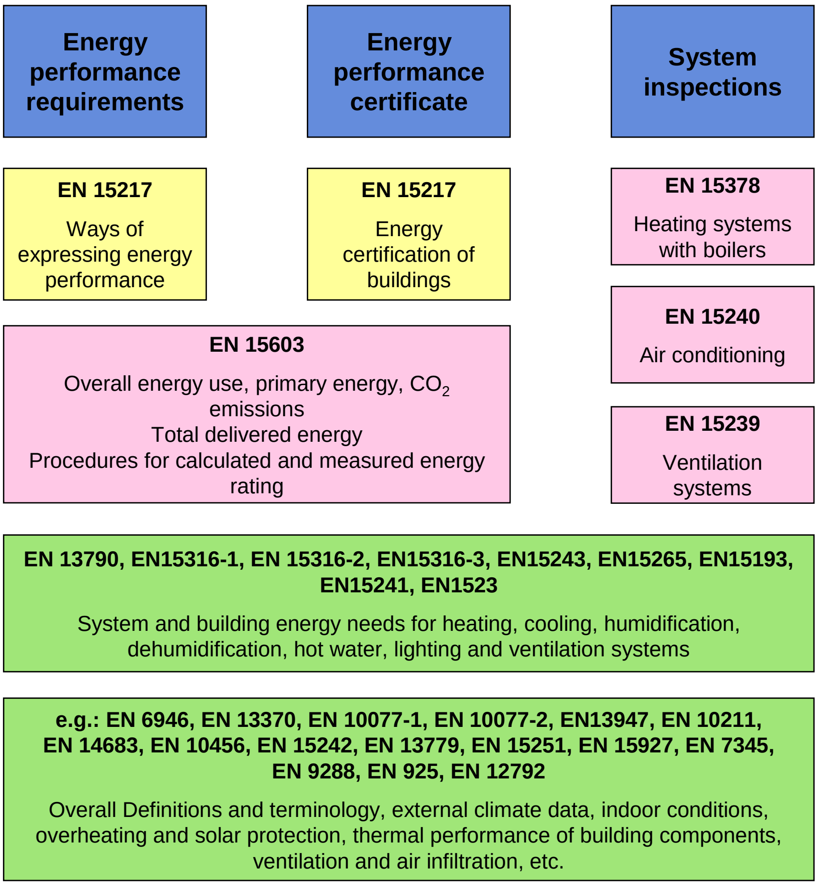
- building physics standards (e.g. calculation of heat transfer by transmission and ventilation, load and summer temperature, solar transmittance and the calculation of the energy need for heating and cooling of the building);

([15]) See http://www.buildingsplatform.eu/epbd_publication/doc/2008publicconsultationbackground_p3112.pdf

- description and properties (classification) of ventilation systems plus cooling and air conditioning systems;
- description of space heating and domestic hot-water systems (e.g. generation or emission efficiency);
- standards on lighting systems, controls and automation, classification of the indoor environment, financial economic evaluation of sustainable energy applications;
- standards on inspection of boilers and heating systems, cooling and AC systems, ventilation systems;
- two key standards on expressing energy performance and for energy certification of buildings, the overall energy use, primary energy and CO_2 emissions, the assessment of energy use and the definition of energy performance ratings.

To date, all standards are already completed although some single standards are still in the publishing process. Four standards are only available as draft standards (Hogeling and van Dijk, 2008). A CEN Technical Report (TR 15615) was prepared as a guidance document which gives an overview of all standards concerning the EPBD and shows the relation between the single standards (see Figure 4).

Figure 4: Basic scheme of CEN standards related to the EPBD
Source: (Hogeling and van Dijk, 2008)



As the standards have been in place for only a short time, there is no assessment of the impacts of the standards on the energy efficiency in buildings or the environmental performance of the building sector available yet. The main difficulties are expected for the years 2008 to 2010 when the standards will be implemented at Member State level (i.e. design and adoption of national standards).

The existence of harmonised standards in Europe will alleviate the implementation of new technologies, energy-efficient appliances and energy systems. Some of the CEN standards may lead to ISO standards which are widely accepted and might 'increase the market opportunities of European Industry' (Hogeling, 2006).

4.2.3 Directive on energy end-use efficiency and energy services

As mentioned before, the energy consumption in the European Union is higher than expected due to the energy efficiency gap (see Sections 1.2 and 2.1). Energy services and end-use efficiency measures could help to close this gap.

Council Directive 93/76/EEC of 13 September 1993 to limit carbon dioxide emissions by improving energy efficiency (SAVE) asked the Member States to set up programmes in several fields of energy use in the building sector (OJL 237, 1993). The directive already included measures on third-party financing for energy efficiency investments in the public sector and energy audits. The 'directive was more a kind of declaration of intent rather than binding legislation' (David, 2007). Little action was undertaken. In 2001 the Commission proposed to adopt the directive to technical progress and to reinforce it (COM (2001) 226, final). The Commission proposal was then adopted by the EBPD Directive 2002/91/EC in 2002 (see Section 4.2.1). Directive 93/76/EEC was repealed in 2006 by Directive 2006/32/EC on energy end-use efficiency and energy services (OJL 114, 2006).

Directive 2006/32/EC on energy end-use efficiency and energy services is intended to provide the 'necessary targets, mechanisms, incentives and institutional, financial and legal frameworks to remove existing market barriers and imperfections for the efficient end use of energy' (OJL 114, 2006) ([16]).

The directive obligates the Member States to adopt and to aim to achieve an overall energy-saving target of 9 % by 2016 through energy services and other measures that improve the energy efficiency. Another key element of the directive is the obligation for Member States to provide national energy efficiency action plans every three years.

The directive asks for measures that will result in energy-savings that can be clearly measured and verified (or estimated) and the impacts of the measures should not be accounted in other specific measures. The directive also includes a list of energy efficiency improvement measures that could be used to reach the target for specific sectors. For the residential and tertiary sector, the following issues are included:

- heating and cooling;
- insulation and ventilation;
- hot water;

([16]) See http://ec.europa.eu/energy/demand/legislation/end_use_en.htm

- lighting;
- cooking and refrigeration;
- other equipment and appliances;
- domestic generation of renewable energy.

Besides setting the target for energy-savings, the directive includes other actions to be taken by the Member States. For example, energy distributors and retail energy sale companies shall provide competitively priced energy services to their final costumers. The Member States shall 'ensure that there are sufficient incentives' for ESCOs, energy consultants or energy advisors to offer and implement energy services, energy audits and energy-efficient improvement measures.

The directive also asks for the dissemination of information on energy efficiency mechanisms and financing options. The Member States shall as well ensure that qualification, accreditation and certification schemes are available for providers of energy services, or energy audits (OJL 114, 2006).

The directive will tackle the main barriers towards energy efficiency in the European Union: the lack of standardised information and measurement concerning energy efficiency and energy services; and an energy services market hampered by various obstacles (e.g. market fragmentation, split incentives, lack of information, and access to capital).

Directive 2006/32/EC is seen as an 'umbrella' directive which complements the existing EU legislation in this field, like the EPBD (see Section 4.2.1), the combined heat and power directive, and the energy labelling directive (see Section 4.2.6).

The European Council for an Energy-efficient Economy (eceee) states that the targets set in the directive are indicative and not mandatory ([17]). Nevertheless, the Member States are obliged to aim at achieving the target. It will be very important to measure and verify the energy-savings achieved by the Member States.

The directive offers a high potential to overcome the barriers to energy efficiency but the impact of the directive will highly depend on the specific implementation and the ambition of the single Member States.

4.2.4 Eco-design directive

The eco-design directive 2005/32/EC, often also called the EuP directive, establishes a framework for eco-design requirements for any group of products which use energy except for means of transport (OJL 191, 2005). The eco-design directive itself does not include binding requirements for specific products. An implementing measure which will establish the eco-design requirements can be adopted when an EuP meets the following criteria:

- significant volume of sales and trade (approx. 200 000 units per year) within the EU;
- significant environmental impact;

([17]) See http://www.eceee.org/european_directives/EEES

- significant potential for cost-efficient improvement.

When an implementing measure is planned, the Commission has to perform an impact assessment to analyse the impacts on environment, consumers, and manufacturers. The Commission should take into account existing national legislation and should consult the relevant stakeholders. The implementing measures have to meet several criteria:

- no significant negative impact on product functionality;
- no adverse effects on safety, health, and environment;
- no significant negative impact on consumers (affordability and life-cycle cost of the EuP);
- no significant negative impact on the industry's competitiveness;
- not imposing a proprietary technology;
- not imposing excessive administrative burdens on manufacturers.

The first step towards an implementing measure is a preparatory study which should recommend options to improve the environmental performance of the product. The next steps are the impact assessment, the stakeholder consultations and the drafting of a possible implementing measure. Currently, there are preparatory studies ongoing for the following 15 single products (see Table 2).

Table 2: Preparatory studies under the eco-design directive framework

Preparatory study	Website	Status
Boilers and combi-boilers (gas/oil/electric)	http://www.ecoboiler.org	ongoing
Water heaters (gas/oil/electric)	http://www.ecohotwater.org	ongoing
PCs (desktops and laptops) and computer monitors	http://www.ecocomputer.org	completed
Imaging equipment: copiers, faxes, printers, scanners, multifunctional devices	http://www.ecoimaging.org	ongoing
Televisions	http://www.ecotelevision.org	completed
Standby and off-mode losses of EuPs	http://www.ecostandby.org	completed
Battery chargers and external power supplies	http://www.ecocharger.org	completed
Office lighting	http://www.eup4light.net	completed
(Public) street lighting	http://www.eup4light.net	completed
Residential room conditioning appliances (AC and ventilation)	http://www.ecoaircon.eu	ongoing
Electric motors 1–150 kW, water pumps, circulators in buildings, ventilation fans (non-residential)	http://www.ecomotors.org	ongoing
Commercial refrigerators and freezers	http://www.ecofreezercom.org	ongoing
Domestic refrigerators and freezers	http://www.ecocolddomestic.org	ongoing
Domestic dishwashers and washing machines	http://www.ecowet-domestic.org	ongoing
Solid fuel small combustion installations	http://www.ecosolidfuel.org	ongoing
Laundry driers	n.a.	ongoing
Vacuum cleaners	n.a.	ongoing
Simple converter boxes for digital television	http://www.ecostb.com/	ongoing
Complex set top boxes	http://www.ecocomplexstb.org	ongoing
Domestic lighting	http://www.eup4light.net	ongoing

Ecodesign and labelling implementing measures will probably be adopted for five product groups in 2008: street lighting products, office lighting products, stand-by and off-mode losses, external power supplies, and simple set top boxes.[18] In July 2008, the Committee on the Ecodesign and Energy Labelling of Energy-Using Products endorsed the first draft proposal for an implementing measure (concerning the standby power consumption of appliances) (European Commission, 2008a). The proposal was submitted to the European Parliament for examination and will then formally be adopted by the European Commission. It can be foreseen that the vast majority of the implementing measures will be adopted in 2009. Some ecodesign implementing measures will also be complemented by measures under the framework of the energy labelling directive (see Section 4.2.6).

In general, products that carry the EU eco-label will be considered as compliant with the implementing measures when the eco-label standards meet the requirements of the implementing measure.

So far, no impact assessment concerning the environmental impacts and costs of this policy measure is available. It is expected that the eco-design directive will be an important element to combat climate change and towards sustainability.[19] It is hoped that the eco-design directive and the implementing measures will increase the effectiveness and synergies of other EU legislative acts and initiatives like the waste from electrical and electronic equipment directive (WEEE), the energy labelling directive (see Section 4.2.6) or the directives on minimum energy efficiency requirements.

A recast of the eco-design directive is currently prepared. The revised eco-design directive is seen as ‘the essential building block for an integrated sustainable environmental product policy’ and will be completed by labelling schemes, green public procurement and taxation incentives (COM(2008) 399). The European Commission has proposed to broaden the scope of the directive by including also energy-related products into the eco-design directive (COM(2008) 399). First proposals suggest covering e.g. water-using devices to reduce hot water demand (water-saving taps, shower heads), building insulation materials, and windows.

The proposal to review the eco-design directive also establishes that the Commission shall review the appropriateness of extending the scope of the directive to non-energy-related products no later than 2012.

4.2.5 Eco-label regulation

An eco-label presents a market-based instrument of environmental policy. The eco-label marks environmental friendly products (or products which have a lower impact on the environment than similar products). Consumers can now choose to buy environmental friendly products. The demand for eco-labelled products should increase thus putting an incentive in place towards the manufacturing of environmental friendly products.

There have been eco-labels in place in several Member States for quite some time (Jackson and Snowdon, 1999). These include e.g. ‘Blauer Engel’ in Germany, the ‘Milieukeur’ in The Netherlands, or the ‘Swan’ label in the Nordic countries (Figure 5). The eco-label regulation

[18] See also: http://ec.europa.eu/energy/demand/legislation/eco_design_en.htm

[19] See http://ec.europa.eu/enterprise/eco_design/ecodesign.htm

(OJL 237, 2000) sets up a European eco-label which should supplement the national eco-label schemes.[20]

Figure 5: Examples of eco-labels of EU Member States and the European eco-label

Germany France Austria Nordic countries The Netherlands European Union

The European eco-label's aim is 'to promote products which have the potential to reduce negative environmental impacts, as compared with the other products in the same product group' (OJL 237, 2000). The scope of the eco-label regulation is broad and covers both products and services. Only product groups can be included into EU eco-label scheme that fulfil the following conditions:

- significant volume of sales and trade;
- significant environmental impact (assessed on a life-cycle basis);
- significant potential for environmental improvement;
- significant part of the sales volume should be sold for final consumption or use.

The EU eco-label is a voluntary scheme. The product groups and the labelling criteria are defined by the EU eco-label board (EUEB). In general, the European Commission or the EUEB propose the definition of a product group and the set up of the eco-label criteria. Next, a working group will draft the eco-label criteria and the assessment and verification requirements. Market studies, as well as life cycle assessments and an improvement analysis will be performed. The finalised labelling criteria will be proposed to a committee of national authorities. If the committee agrees, the European Commission adopts and publishes the proposal. So far, eco-label requirements have been adopted for a range of product groups and products (see Table 3).

The eco-label regulation requires a review of the labelling scheme including a stakeholder consultation (OJL 237, 2000). The evaluation of the eco-label scheme and the results of the stakeholder consultation conclude that the EU eco-label actually improved the environmental performance of products and it induced an improvement in companies of the supply chain of the manufacturers of eco-labelled products (European Commission, 2007; IEFE, 2005). In July 2008 the European Commission announced that the eco-labelling scheme will be extended to cover a wider range of products (including energy using and energy-related products). The eco-label will also cover products and services which will not covered by the

[20] The Environment DG of the European Commission hosts the EU eco-label website where additional information can be found (http://ec.europa.eu/environment/ecolabel/index_en.htm).

EuP and energy labelling legislation. The scheme will remain a voluntary label and the cost of the system will be reduced (COM(2008), 397).

Table 3: Product groups and products included into the eco-label scheme

Product group	Product
Cleaning products	All purpose cleaners and cleaners for sanitary facilities
	Detergents for dishwashers
	Hand dishwashing detergents
	Laundry detergents
	Soaps and shampoos
Appliances	Dishwashers
	Heat pumps
	Light bulbs
	Personal computers
	Portable computers
	Refrigerators
	Televisions
	Vacuum cleaners
	Washing machines
Paper products	Copying and graphic paper
	Printed paper
	Tissue paper
Home and garden	Bed mattresses
	Wooden furniture
	Hard and soft floor coverings
	Indoor paints and varnishes
	Soil improvers and growing media
Clothing	Footwear
	Textile products
Tourism	Campsite service
	Tourist accommodation service
Lubricants	Lubricants

The most important drivers to apply the eco-label are the competition and marketing potential of the EU eco-label. In contrast, the improvement of environmental performance is by far a less important driver (IEFE, 2005). A slight majority of the eco-label companies observed an increase in market share of their eco-labelled product after adoption of the Flower.

Still, information, knowledge and recognition of the Flower by all stakeholders (e.g. consumers, manufacturers, retailers) are low in the European Union (Rubik et al., 2007). Thus, concerning the review of the eco-label, information and promotion campaigns and other actions to increase the knowledge of the Flower are the most important issues to support the schemes (IEFE, 2005).

4.2.6 Energy labelling directive

Council Directive 92/75/EEC on the indication by labelling and standard product information of the consumption of energy and other resources by household appliances was already passed in 1992 (OJL 297, 1992). The intention of the directive is to harmonise the labelling and product information schemes of the following household appliances:

- refrigerators, freezers and their combinations;
- washing machines, dryers and their combinations;
- dishwashers;
- ovens;
- water heaters and hot-water storage appliances;
- lighting sources;
- air-conditioning appliances.

All suppliers that place a household appliance which was specified in implementing directives on the market are asked to supply a label which has to be attached to the appliance. The implementing directives shall specify:

- the exact definition of the type of appliances to be included;
- the measurement standards and methods to be used in obtaining the information relating to energy consumption;
- details of the technical documentation required;
- the design and content of the label;
- the location where the label shall be fixed to the appliance;
- the content and where appropriate the format of the fiche, which must contain the information appearing on the label;
- the information details to be provided in the case of mail-order offers for sale.

The goal of the directive is to influence the choice of household appliances in favour of energy-efficient ones by providing ‘accurate, relevant and comparable information on the specific energy consumption’ which is supposed to make manufacturers produce more energy-efficient appliances (OJL 297, 1992). The implementing measures adopted so far are shown in Table 4. The directive allows for the addition of further household appliances to the list when significant energy-savings are likely to be achieved.

In addition to the energy labelling of household appliances, some directives on compulsory minimum efficiency requirements were adopted. These aim at encouraging manufacturers of appliances to improve the design of the products to reduce the energy use of the appliances. So far, three directives were adopted setting minimum efficiency requirements for hot-water boilers fired with liquid or gaseous fuel; electric refrigerators, freezers and combinations; and ballasts for fluorescent lighting.

According to the European Commission (2008b) the energy labelling directive contributed to the production and use of more energy-efficient household appliances. There are only a few other policy measures towards energy efficiency that have been as successful as the appliance labelling (Lebot et al., 2001). It is estimated that for cold appliances, dish washers and washing machines, the electricity savings could reach up to 700 TWh from 1996 to 2020. Today, the 'energy label is an integral part of industry's marketing of appliances' (European Commission, 2008b). The energy label has also been successfully introduced in other countries outside the EU, and other countries have sometimes even broadened the scope of their labelling scheme by including products which are currently not covered by the EU directive.

Table 4: Implementing directives with regard to energy labelling of household appliances

Year	Product	Directive
1994	Electric refrigerators, freezers and combinations	Commission Directive 94/2/EC of 21 January 1994 implementing Council Directive 92/75/EEC with regard to energy labelling of household electric refrigerators, freezers and their combinations Amended by Commission Directive 2003/66/EC of 3 July 2003
1995	Washing machines	Commission Directive 95/12/EC of 23 May 1995 implementing Council Directive 92/75/EEC with regard to energy labelling of household washing machines Amended by Directive 96/89/EC of 17 December 1996
	Electric tumble driers	Commission Directive 95/13/EC of 23 May 1995 implementing Council Directive 92/75/EEC with regard to energy labelling of household electric tumble driers
1996	Combined washer-dryers	Commission Directive 96/60/EC of 19 September 1996 implementing Council Directive 92/75/EEC with regard to energy labelling of household combined washer-driers
1997	Dishwashers	Commission Directive 97/17/EC of 16 April 1997 implementing Council Directive 92/75/EEC with regard to energy labelling of household dishwashers Amended by Commission Directive 1999/9/EC of 26 February 1999
1998	Lamps	Commission Directive 98/11/EC of 27 January 1998 implementing Council Directive 92/75/EEC with regard to energy labelling of household lamps
2002	Air-conditioners	Commission Directive 2002/31/EC of 22 March 2002 implementing Council Directive 92/75/EEC with regard to energy labelling of household air-conditioners
	Electric ovens	Commission Directive 2002/40/EC of 8 May 2002 implementing Council Directive 92/75/EEC with regard to energy labelling of household electric ovens

The energy labels have almost all achieved their target because most of the products sold today belong to the class 'A' (Europe Economics, 2007; European Commission, 2008b). Thus, the efficiency classification should be updated to encourage the development of new and more energy-efficient technologies ([21]). The revision of the energy labelling directive is

([21]) Directive 94/2/EC concerning the energy labelling of household electric refrigerators, freezers and their combinations was amended in 2003 by including two additional efficiency classes (A+ and A++) because between 20 % and 50 % of the sold products already belonged to efficiency class A in 2000 and the market share of this class was increasing rapidly.

foreseen by the Commission's 2008 legislative and work programme and the first priority action in the Energy Efficiency Action Plan COM (2006)545 from October 2006 (European Commission, 2008b). In principle, there are three ways to proceed and improve the energy labelling of products:

- strengthening implementation of the current provisions of the framework directive without amending the directive;
- amending the directive in order to broaden the scope and reinforce its provisions;
- implementing the provisions of the directive within other existing legislative frameworks.

Several studies found that energy efficiency could be further increased, especially for household appliances that are not yet included into the energy labelling directive (e.g. boilers, water heaters) and for non-household appliances (e.g. motors). Also, energy efficiency could be improved by including products that do not use energy themselves during the use phase but are energy-related such as, for example, building elements (European Commission, 2008b) ([22]).

Concerning the revision of the directive, a stakeholder consultation was performed from December 2007 to February 2008 and, in addition, a stakeholder consultation workshop was held. All stakeholders agreed to the general principle of reinforcing the use of energy labelling and the majority of stakeholders wished to extend the scope of the directive (both to non-household energy using products and energy-related products).

4.2.7 Environmental technology verification

Environmental technology verification (ETV) programmes were developed in the mid 1990s in North America. The aim of ETV programmes is to increase the acceptance of new technologies by providing the costumer (or user) with credible and understandable performance information (Calleja and Delgado, 2008). ETV programmes thus attempt to tackle market barriers related to uncertainty regarding the performance of technologies (see Section 2.4), bounded rationality and inadequate information (see Section 2.5).

ETV systems are currently being used in the USA, Canada, and South Korea. In Japan, the ETV system is still in a pilot phase. Today, there 'is no national system in Europe comparable to the existing ETV systems outside Europe. However, a vast range of systems presenting characteristics similar to ETV exists' (Merkourakis et al., 2007). Most of the existing ETV schemes base on the ETV system of the USA or Canada. We will thus shortly describe these two systems more in detail below.

The US ETV programme targets the verification of the performance of 'innovative technologies that have the potential to improve protection of human health and the environment' ([23]). The programme aims at accelerating the market entrance of new environmental friendly technologies. The US ETV system is based on a public–private partnership and includes a broad stakeholder consultation process (Merkourakis et al., 2007).

([22]) In the United Kingdom and in Finland, windows are already included into the eco-labelling or energy labelling schemes (European Commission, 2008).

([23]) See http://www.epa.gov/etv

Currently, six verification centres are operating. The criteria for a technology to be submitted to the ETV process are the following: the technology must be ready commercially; the vendor should anticipate that the technology will perform well under ETV testing, and the vendor should anticipate that the time, cost, and effort involved will be justified by increased sales. The verification procedure includes several steps. First, area-specific technology categories are defined and prioritised by the verification centres (e.g. according to the importance of the environmental problem). Next, the verification parameters are set up by stakeholder consultation processes. Vendors are contacted and can now apply for verification of their products. A verification protocol for the technology category is developed and a test/quality assurance plan for the verification process is established. Now, the verification organisation tests the technology according to the verification protocol and the test/quality assurance plan. A verification report and statement are produced and finally published.

The Canadian ETV programme is run by the independent verification organisation ETV Canada. The ETV system 'provides the marketplace with the assurance that environmental performance claims are valid, credible and supported by quality independent test data and information' ([24]). The verification process includes four steps: First, the pre-screening checks for eligibility (e.g. technology has to be an environmental technology or service, technology has to offer an environmental benefit, technology has to be commercially available). Next, the formal application has to be submitted including information about the technology, the environmental claim to be verified, and supporting data and information. To verify the claim, the verification entity uses the data submitted but can also collect additional data. Upon acceptance, the applicant receives a verification report and a verification certificate.

The idea of setting up an EU scheme for ETV builds on the communication establishing the environmental technologies action plan (COM(2004) 38 final; COM(2005) 16 final). As part of the environmental technologies action plan and to support the introduction of the ETV system, four networks of testing centres were launched: Eurodemo, Testnet, Promote and AIRTV (COM(2004) 38 final) ([25]). A public consultation on an EU ETV system was performed from November 2007 to February 2008. The Commission will adopt a legislative proposal to establish a European ETV system in principle before the end of 2008.

4.2.8 Energy taxation

The Council Directive 2003/96/EC (energy taxation directive) from 2003 defines minimum taxation rates for motor and heating fuel, and electricity. The respective tax levels in the Member States should not be lower than the levels set by the directive (OJL 283, 2003). The directive aims to reduce market distortions (e.g. competition between mineral oil and other fuels) and to support energy efficiency measures.

According to (OECD/IEA 2008a), the impact of the directive concerning the residential sector has been low due to the fact that the minimum taxation rates set by the directive are small when compared with the taxes already introduced in most Member States. The directive is expected to show some impact in new Member States (e.g. where no energy tax existed

([24]) See http://www.etvcanada.ca/overview.asp

([25]) See also the website of the four testing networks at: http://www.eu-etv-strategy.eu before). However, in general, the minimum tax levels set by the directive have to be raised significantly before an effect on energy efficiency in the building sector can be seen.

The Green Paper on market-based instruments for environment and related policy purposes from 2007 discusses the possibility of a revision of the energy taxation directive in order to contribute to energy efficiency and a more environmental friendly use of energy (COM(2007) 140 final). However, the OECD/IEA (2008a) argues that taxation measures or a further development of the directive would be difficult to agree upon in the EU because of taxation issues traditionally being a domain left to individual Member States. Instead, it is proposed that VAT reductions should be awarded to energy-efficient products and thus demand for these products should be stimulated.

The Allen Consulting Group (2004) regards the removal of existing distortions in taxation as justified but considers energy taxation as an inappropriate and ineffective means to encourage energy efficiency. The support of energy services is seen as a more flexible and effective measure (see Section 3.4.2 and Section 4.2.3).

4.2.9 Structural and cohesion funds (SCF) and European Investment Bank (EIB)

The European cohesion policy supports the regions through financial instruments called 'European funds'. European funds comprise the Structural Funds (including the European Regional Development Fund and the European Social Fund) and the Cohesion Fund. They are always a supplement to national funding whether from the state, local authorities or other bodies.

The EU cohesion policy identified the support to energy efficiency as an important objective. The EU Member States and regions are called, when preparing their national strategic reference frameworks and operational programmes for 2007–13, to make effective use of the possibilities provided for by the cohesion policy in support of energy efficiency. Structural Funds which could potentially be used to finance energy efficiency improvements in the residential sector are the European Regional Development Fund (ERDF) and the European Social Fund (ESF).

However, in the financing period 2007–13 refurbishments of the housing stock — and related energy efficiency measures — can be financed from the European funds only in those Member States that acceded to the EU on or after 1 May 2004 under the following circumstances:

- expenditure is programmed within the framework of an integrated urban development operation or priority axes for areas of physical deterioration or social exclusion;
- the allocation to housing expenditure is either a maximum of 3 % of the ERDF allocation to the operational programme concerned or 2 % of the total ERDF allocation;
- expenditure is limited to multi-family housing, or buildings owned by public authorities or non-profit operators for use as housing designated for low-income households or people with special needs.

Approximately half of the structural and cohesion funds will go to the EU-10 central and eastern European countries. The OECD/IEA (2008a) stresses the potential they offer for initiating energy efficiency improvements in residential buildings, given the often older buildings and equipment in these countries. Energy intensity (energy use per unit of GDP produced) is also on average 30 % higher in the EU-10 countries than the EU average.

The role of the European Investment Bank (EIB), an autonomous EU institution, is to finance investment projects contributing to the balanced development of the Union. The EIB operates as a bank and raises on the capital markets the bulk of the resources that it deploys to finance projects meeting the Union's broad objectives. The EIB's shareholders are the Member States of the European Union, which have all subscribed to its capital. The Bank mobilises large volumes of capital on highly favourable terms and subsequently advances loans at interest rates that reflect its borrowing costs. The EIB is financially autonomous and does not come under the EU budget.

The EIB's contribution to EU energy policy concentrates on five priority areas (European Investment Bank, 2007a):

- renewable energy;
- energy efficiency;
- research, development and innovation (RDI) in energy;
- security and diversification of internal supply (including trans-European energy networks);
- security of external supply and economic development (neighbour and partner countries).

Within its Corporate Operational Plan (COP) the Bank has established challenging targets for its contribution to energy lending: in 2007, a global lending target of EUR 4 billion for projects belonging to at least one of the five priority areas.

Energy efficiency investments are often individually small, and to finance such investment the EIB works through appropriate financial intermediaries, whether in the banking sector or through specialised energy agencies and energy service companies. The Bank is also developing specific financing instruments to better support EE projects, including risk-sharing instruments, blending loans with grants and the provision of technical support, such as energy audits, to the financial intermediary or the final beneficiaries. This normally involves developing partnerships with the European Commission or national authorities, particularly concerning grants or information provision (energy agencies for instance).

During a meeting of the Board in June 2007, the European Investment Bank (EIB) committed itself to a reinforced contribution to 'clean energy", including increasing EIB financing to 75 % of the total cost of renewable energy projects and for investments which significantly contribute to energy efficiency.

Unfortunately, there are no detailed figures on the total expenditure available, with which the Union supports the improvement of energy efficiency as such. 'The EIB wants to increase the focus on energy efficiency concerns in all areas of economic activity (industry, transport, housing, services, etc.)' (European Investment Bank, 2007b). In 2006, a total of EUR 317 million were lent for investments in energy efficiency. A main focus of the investments was in combined heat and power generation and district heating networks.

4.2.10 'Intelligent energy Europe' (IEE) programme

The 'intelligent energy Europe' (IEE) programme is a funding tool of the EU. It is managed by the Executive Agency for Competitiveness and Innovation (formerly the Intelligent Energy

Executive Agency — IEEA). The goal of the programme is to tackle the market barriers towards energy-saving and the use of renewable energy ([26]). The IEE programme was established in 2003 and replaced the previous programmes SAVE (1996 to 2002) and Altener (1993 to 2002). The first IEE programme (until 2006) included a budget of 200 million euro. The second IEE programme runs until 2013 and is a sub-programme of the 'competitiveness and innovation' framework programme (CIP). The budget foreseen is about 730 million euro.

Participation is possible for any legal or private person in the EU, the EFTA and the EEA. The IEE programme only funds a limited share of the total costs of a project (75 % of eligible costs in the 2008 call for project proposals). The IEE programme does not support technical R & D projects or infrastructure projects. Instead, it focuses on the funding of information and capacity building projects.

Concerning the energy efficiency in existing buildings, the IEE projects 'are the most relevant within the CIP' (OECD/IEA, 2008a). From the 2003 to 2006 calls, a total of about 40 projects were funded dedicated to energy efficiency issues in the building sector. The funded projects relate to (IEEA, 2006):

- assisting implementation of legislation;
- supporting outcomes of research;
- transforming markets (market adoption, market penetration of innovative technologies);
- knowledge-based society (education, raising awareness);
- local action (municipalities, sustainable energy communities, voluntary mechanisms).

Concerning the impact of the IEE programme, the OECD/IEA (2008a) concludes that the total funding budget of the programme is quite small. The overall impact of the projects funded was not assessed so far. 'The IEE does however explicitly disburse funding to programmes [...] which are more relevant for improving energy efficiency in existing residential buildings. Its integration within the CIP also weighs funding disbursements towards market transformation and projects that may have positive long-term economic effects' (OECD/IEA, 2008a). The IEEA states that the projects funded 'are playing a role in increasing awareness in energy conservation and the use of renewable energies in the built environment' (IEEA, 2006). The impacts could be seen in the adoption of methodologies and recommendations concerning the implementation of the EPBD, the number of municipalities, companies, universities, training organisations, associations and market actors that are involved in e.g. labelling and auditing schemes, educational activities, or market transformation projects (IEEA, 2006).

([26]) See the IEE website (http://ec.europa.eu/energy/intelligent).

4.3 Examples of policies in Member States

4.3.1 Subsidies, grants and preferential loans

4.3.1.1 France

The French national agency for the improvement of housing (ANAH) subsidises the refurbishment of old houses (older than 15 years). The aim of the subsidies is to improve privately owned buildings which are either occupied by the owner or rented (OECD/IEA, 2008a). In principle, subsidies can be obtained for buildings that exhibit deficits with respect to safety, health issues, housing quality, or energy efficiency improvements. When the following works are performed, an extra bonus can be obtained:

- improvement of the thermal insulation of buildings;
- insulation and regulation of heating and/or hot-water systems;
- window replacement satisfying minimal energy-efficiency requirements;
- air exchange improvement;
- implementation of systems using new or renewable energy;
- complete implementation of individual and collective heating or hot-water systems;
- adjustment or upgrade of existing heating system to the RT 2000 standard.

The insulation of the building envelope is not eligible for the extra bonus. The level of the extra bonuses is shown in Table 5.

Table 5: Extra bonus levels of ANAH subsidies for energy efficiency measures

Measure	Extra bonus (euro)
Individual window	80
Individual boiler (condensation technology)	900
Individual boiler (wood energy)	900
Individual thermal solar plant for hot water	900
Thermodynamic system (heat pump), air/water	900
Thermodynamic system (heat pump), geothermal	1 800
Combined solar systems	1 800

Source: (ANAH, 2008; OECD/IEA, 2008a)

According to (OECD/IEA, 2008a), ANAH subsidies for energy efficiency measures amounted to EUR 7.4 million in 2006 (EUR 4.6 million in 2005). About 26 300 grants were provided in total in 2006 (20 900 in 2005).

Besides the ANAH programme, several other funding schemes exist in France. For instance, the Palulos subsidy programme is comparable to the ANAH scheme but funds improvement measures in the social housing stock, not in privately owned buildings. Its main goal is the improvement of housing conditions, not energy efficiency measures (OECD/IEA, 2008a).

4.3.1.2 Germany

In Germany, the KfW banking group has provided preferential loans and grants for energy efficiency measures in the building sector since 1996. The KfW offers long-term low-interest financing and applicants do not have to repay their credit during the first years. It is assumed that the reduction of the interest rate leads to savings of about 7 % to 12 % of the loan (OECD/IEA, 2008a). In general, the KfW bank raises funds from the financial market and passes the capital on to the programme applicants. As the KfW is AAA-rated, it faces low-interest rates on the market. Funding from the federal government is also used to reduce the interest rates.

The main KfW programme for investments in energy efficiency is the CO_2-Gebäudesanierungsprogramm (‘CO_2 building rehabilitation’ programme). Between 1996 and 2004, the programme covered 56.8 million m^2 in 685 000 dwellings (OECD/IEA, 2008a). Funding is provided for investments in owner-occupied or rented residential buildings. Applicants receive a long-term loan with redemption-free grace years at a clearly reduced interest rate. The interest rate is fixed for the first 10 years ([27]). In addition, a repayment bonus can be granted if minimum energy performance requirement for new buildings according to the ‘energy-saving ordinance’ (EnEV). The owners of single-family or two-family houses or private apartments in home ownership associations may apply for the grant variant (see below).

The programme mainly aims at old buildings (built before 1995) which require extensive investments in energy efficiency. The loan can be received only when the EnEV standards for new buildings are met (OECD/IEA, 2008a). The loan can be provided for up to 100 % of the investment costs with an upper limit of EUR 50 000 per dwelling unit.

For buildings which were built before 1984, the repayment bonus is 5 % if new building standards are met after the rehabilitation. If the energy consumption level is at least 30 % below the new building standard according to EnEV, the bonus is 12.5 %. For buildings built between 1984 and 1995, no repayment bonus is granted.

Between 2001 and 2003, the majority of the loans of the programme were used for thermal insulation measures. 20 % were used to install energy-efficient boilers and about 14 % for renewable energies and district heating (OECD/IEA, 2008a).

The KfW has also provided direct grants in the framework of the CO_2 building rehabilitation programme since 2007. The grants are awarded for modernisation and refurbishment measures of both owner-occupied and rented residential buildings. The level of the grant depends on the reduction of the energy consumption and ranges from 5 % to 17.5 % of the investment. A grant cannot be combined with a KfW loan programme.

The KfW programme ‘Wohnraum modernisieren’ (housing modernisation) funds refurbishment and modernisation measures of owner-occupied and rented residential buildings. The programme provides long-term, low-interest loans with a fixed interest rate and redemption-free grace years. Basic promotion is offered for standard measures. Favourable interest rates are provided for investments in climate protection (‘Öko-Plus’

([27]) See http://www.kfw-foerderbank.de/EN_Home/Housing_Construction/KfWCO2Buil.jsp measures) ([28]). The financing share can be up to 100 %; the maximum level amounts to EUR 100 000 (EUR 50 000 for Öko-plus measures). According to the OECD/IEA (2008a), the interest rates were up to 2 % lower than market rates for the period 1990 to 2002. Standard measures include:

- improvement of the functional value (e.g. changes in sanitary installations, water supply);
- repair or replacement of defective building components;
- improvement of the general housing conditions;
- barrier-free living;
- renewal of the heating technology on the basis of fossil fuels including directly related measures;
- renewal of the heating technology on the basis of renewable energies;
- upgrading of remaining building parts after partial demolition.

The Öko-plus measures of the modernisation programme have to fulfil the minimum requirements of the German energy-saving ordinance. Eligible measures include the thermal insulation of the exterior walls of buildings including directly related measures (e.g. improvement of the thermal insulation of the exterior walls, the roof, or the ceilings of top floors) or the renewal of the heating technology on the basis of renewable energies, combined heat and power and local and district heating (e.g. installation of heat pumps, solar thermal systems, biogas or biomass systems).

The energy efficiency improvement programmes of the KfW covered about 73 million m^2 of living space in existing buildings in 2004. The energy efficiency of about 880 000 dwellings (2.2 % of the total building stock) was improved (OECD/IEA, 2008a).

The information on energy-savings due to the KfW programmes vary. According to (OECD/IEA, 2008a), the annual energy-savings amount to about 24 PJ (final energy) in the case of the housing modernisation programme (2003–05 period) and 20 PJ per year for the CO_2 building rehabilitation programme (2001–05 period). According to (Bremer Energie Institut, 2008), the CO_2 building rehabilitation programme led to savings of 2.4 PJ in 2005, 5.5 PJ in 2006, 3.4 PJ in 2007. The cumulative saved energy costs from the measures in 2005 to 2007 amount to EUR 500 million by 2008 (Bremer Energie Institut, 2008).

The annual CO_2 reduction of the programmes amounts to about 2.7 Mt CO_2 for the period 2000 to 2004, 1 Mt CO_2 in 2006 and 0.7 Mt CO_2 in 2007 (OECD/IEA, 2008a). The emission savings due to the CO_2 building rehabilitation programme added up to 0.4 Mt CO_2 in 2005, 0.7 Mt CO_2 in 2006 and 0.3 Mt CO_2 in 2007 (Bremer Energie Institut, 2008).

According to KfW, the further impacts due to all measures of the promotion initiative ‘Wohnen, Umwelt, Wachstum’ (housing, energy, growth) which also includes not only the CO_2 building rehabilitation programme and the housing modernisation programme but also some measures that fund housing construction, social and municipal investments, led to the protection of approximately 500 000 jobs in 2006 due to market stimulation mainly in the

([28]) See: http://www.kfw-foerderbank.de/EN_Home/Housing_Construction/KfWHousing.jsp.

construction and craft sector (Testorf, 2008) ([29]). The employment effects due to the CO_2 building rehabilitation programme amount to 27 000 in 2005, 65 000 in 2006 and 35 000 in 2007 (Bremer Energie Institut, 2008).

4.3.1.3 United Kingdom

The main grant scheme in the United Kingdom, the ‘warm front’ scheme is designed to reduce fuel poverty ([30]). The scheme provides grants to private households which receive some kind of social benefit and focuses on households with members that are over 60 years or under 16 years old. Every home is visited by an assessor who suggests the appropriate measures (e.g. loft insulation, draught proofing, cavity-wall insulation, energy-efficient light bulbs). The ‘warm front grant’ provides grants up to a maximum of GBP 2 700 (GBP 4 000 if oil central heating is involved). Since the scheme was introduced in 2000, about 1.5 million households were provided with a grant. It is assumed that the average CO_2 emission reduction of a household was between 6.2 to 7.0 tonnes per year for the period 2006 to 2007 (6.0 to 7.4 tonnes during 2004 to 2005).

For the period 2005 to 2008, over GBP 850 million were supplied to tackle fuel poverty in the United Kingdom (GBP 350 million for the warm front scheme in 2007 to 2008). Total greenhouse gas reductions are assumed to reduce carbon emissions by 0.4 Mt C which corresponds to about 1.47 Mt CO_2 (OECD/IEA, 2008a).

4.3.2 Eco-labelling and energy labelling of building elements

4.3.2.1 BFRC energy rating of windows

The British Fenestration Rating Council (BFRC) operates a rating system for the thermal performance of windows in the United Kingdom ([31]).

The window energy rating (WER) that is applied measures the total energy performance of windows by taking into account the material composition of the window, the air tightness and the solar gain of the window. The results are than ranked into energy efficiency classes from A to G (as it is the case of an energy label for e.g. a refrigerator). The label gives an overall energy index in kWh/m^{2}a. In addition, the U-value, the g-value (solar factor) and the L-value (air leakage) of the window are displayed (Figure 6) ([32]).

According to (ECOLAS/TNO/GMV, 2007), the BFRC system is probably ‘the most ambitious labelling activity’.

([29]) See also press release from KfW banking group from 18 June 2008 (in German): http://www.kfw-foerderbank.de/DE_Home/KfW_Foerderbank/Aktuellesa62/Eine_halbe_Milliarde_EUR_weniger_Heizkosten_.jsp.

([30]) A household is assumed to be in fuel poverty when it has to spend more than 10 % of its income on household fuel use.

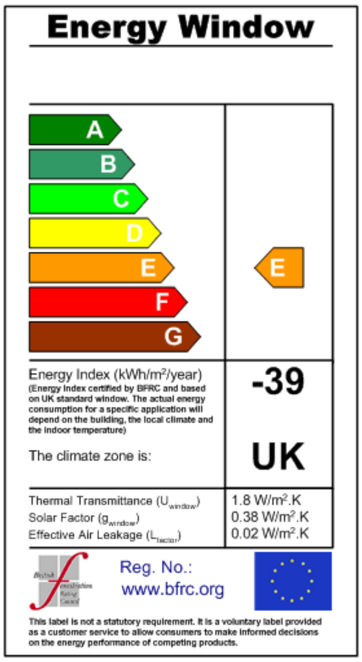
([31]) See http://www.bfrc.org

([32]) See http://www.bfrc.org/pdf/GGF%20calculations%20leaflet.pdf

4.3.2.2 Nordic Swan eco-labelling of windows

The Nordic Swan eco-label also includes windows. To obtain an eco-label, the U-value of the window has to be equal or lower than 1.3 W/m^{2}K. In addition, the solar energy transmittance has to be at least 52 % to increase the heating of the building due to solar radiation ([33]).

Figure 6: BRFC energy label for windows in the United Kingdom



4.3.2.3 Austria eco-labelling of insulation material panels

The Austrian eco-label is available for insulation materials made from fossil, mineral, or renewable resources ([34]). For each of these three product groups, individual requirements — according to the main environmental impacts of each respective group — have been established to obtain the eco-label. For all three groups, the label is only issued for insulation material panels which show a thermal conductivity equal to or below 0.1 W/mK. The eco-label asks for a detailed product declaration which should aid proper installation. Above-average heat losses should be avoided thanks to the label pointing out, for example, installations free of thermal bridges.

The most important eco-label requirements for insulation material panels from fossil resources include a ban of halogenated organic compounds (e.g. HFC, PFC, CFC, HCFC) for foaming/expanding procedures and the prohibition of the use of certain persistent flame retardants that exhibit high environment hazards (Österreichisches Umweltzeichen, 2008).

([33]) See http://www.svanen.nu/sismabmodules/criteria/getfile.aspx?fileid=98499001

([34]) See http://www.umweltzeichen.at/article/archive/18139

Insulation materials from mineral resources have to comply with the following criteria to be awarded the eco-label: the use of specific substances that are dangerous for human health (carcinogenic substances) and substances that are hazardous to water is forbidden. Insulation materials made from glass should consist of 51 % (by mass) or 70 % (by volume) recycled glass (Österreichisches Umweltzeichen, 2008).

The eco-label for insulation material panels from renewable resources is awarded upon the following conditions: the content of renewable resources has to be at least 75 %. The environmental friendliness has to be proven by a life-cycle analysis. For several environmental impact categories, thresholds have been defined which have to be met. These categories include, for example, greenhouse warming potential, ozone depletion potential, photosmog, acidification potential, and eutrophication potential (Österreichisches Umweltzeichen, 2008).

4.3.3 Tax deductions and tax exemptions on energy-saving goods and services

4.3.3.1 France

In France, tax deductions and tax credits are important parts of energy policy measures (OECD/IEA, 2008a). The main tax instruments concerning the building sector are:

- income tax reduction and tax credits for maintenance, retrofit and renovation of dwellings;
- tax incentives for investments in the rental sector;
- VAT reductions;
- property tax exemption.

Income tax reductions and tax credits have been in place since the 1970s. The main goal is to encourage the maintenance and the improvement of the building stock. Different schemes existed which varied in scope, intention and the applied tax instruments. The actual scheme (since 2005) grants tax credits when energy efficiency measures are implemented in existing buildings that are older than two years and which are the primary residence of the applicant. The tax credit is given only for material costs but not the labour or installation costs (which can be 50 % of the costs or more). The upper limit of the tax credit is EUR 16 000 per couple. Eligible investments include:

- low-temperature boiler for heating and hot water;
- insulation material (including windows);
- heat pumps;
- renewable energy technologies and equipment.

Tax credit rates range from 15 % to 50 %. Apparently, the technical requirements to obtain the tax credits are quite modest compared with the state of the art (OECD/IEA, 2008a). All owners that reside in the dwelling, but also tenants can apply for the tax credits. Due to the upper limit, it may be the case that large refurbishment measures will not be undertaken or expensive energy efficiency equipment will not be bought (OECD/IEA, 2008a). The reduced

VAT rate for energy equipment and services (including installation of energy efficiency equipment) might offset this disadvantage (see below).

In addition to the tax credits offered, a reduced VAT rate of 5.5 % (the normal rate is 19.6 %) is applied for renovation and building works and materials since 1999. The first phase (1995–05) of the VAT scheme the measure did not focus on energy efficiency (or renewable energy). In the second phase (2006–10), the reduced VAT rate is extended to energy efficiency services and equipment as well as renewable energy systems such as, for example, heating system installations, biomass heating systems, heat pumps, façade insulation.

The VAT scheme excludes major renovations (change in building size), increases in floor area greater than 10 %, the renewal of foundations, and the refurbishment or renovation of more than two thirds of the building (OECD/IEA, 2008a). Due to these constraints, the reduced VAT scheme reduces the potential energy performance improvements.

The OECD/IEA (2008a) concludes that a VAT scheme as a stand-alone instrument would show some serious drawbacks concerning energy efficiency improvements. The combination of the VAT scheme with a tax credit which poses requirements concerning energy performance could improve the results of the VAT scheme.

4.3.3.2 United Kingdom

In the UK, the ‘landlord’s energy saving allowance’ (LESA) is in place since 1994. LESA provides tax deductions to landlords who make investments in certain energy-saving measures (a deduction against profits of up to GBP 1 500 per property for energy efficiency installations). Initially, LESA included cavity wall and loft insulation. The scheme was extended step-by-step and now tax deductions are also granted for wall insulation, draught proofing, hot water system insulation, and floor insulation (OECD/IEA, 2008a).

The government is awaiting state aids clearance to extend LESA by including also corporate landlords, which would mean that the tax deductions would be available to an additional 25 % of properties.

Since 1998, a reduced VAT rate of 5 % also exists (the normal VAT rate is 17.5 %). The VAT reduction is applied in the UK for the installation of energy-saving materials in the homes of elderly, less well off and vulnerable households. The scheme was extended and now covers also central heating systems, heating appliances, factory-insulated hot water tanks, heat pumps, and micro generation technologies.

4.4 Identification of policy gaps

In order to identify policy gaps in the current EU policy framework, we first contrasted the barriers towards energy efficiency in buildings on the one hand with the policy measures that have been identified as suitable for addressing them on the other hand (Table 6).

Table 6: Matrix of barriers towards energy efficiency and identified measures

		Financial measures			Regulatory framework and standardisation				Capacity building and market transformation	
		Providing financing	Grants and subsidies	Fiscal measures	Minimum performance requirements — building codes and standards	Standards for calculation, M & V of energy performance	Energy certification of buildings	Eco-design requirements for building components	Information programmes	Support to energy service companies
Problems of financing	Initial cost barrier, insufficient access to capital	XXX	XXX	XXX	--	--	--	--	--	X
	Transaction costs for building owner/tenant	X	X	X	--	X	X	--	X	X
	Transaction costs for financier	X	X	X	--	X	X	--	--	X
	Economic uncertainties	--	--	X	X	X	--	--	--	X
	Lack of information on financing options	--	--	--	--	--	--	--	XXX	X
	Inappropriate evaluation of cost efficiency	--	--	--	X	X	X	--	X	X
Unclear performance of energy efficiency technologies	Uncertainty regarding measurement and verification of energy-savings	--	--	--	X	XXX	X	X	X	--
	Mistrust of information on technologies	--	--	--	--	--	--	--	XXX	X
	Operational risks	--	--	--	--	X	--	X	X	--
Bounded rationality and inadequate information	General lack of information and knowledge about energy efficiency measures	--	--	--	--	--	X	--	XXX	--
	Bounded rationality constraints	--	--	--	X	X	X	--	X	--
	Insufficient and incorrect information on energy features	--	--	--	--	X	X	--	XXX	--
Split incentives		X	X	X	X	--	X	X	--	XXX
Other barriers	Lack of technical skills	--	--	--	--	--	--	--	XXX	--
	Barriers to technology development	--	--	--	--	--	X	--	X	X

XXX Main concern of measure
X Concern of measure
-- Not concerned by measure

The analysis of the matrix shows that all barriers towards energy efficiency are more or less tackled. However, some barriers seem to be not addressed directly and for some barriers no specific measure has the respective barrier as the main focus. This concerns certain problems of financing, bounded rationality barriers, and the barrier towards technology development.

All identified measures target more than one barrier. Especially information programmes, the support of energy service companies and the energy certification of buildings seem to be efficient measures in tackling several barriers at the same time.

In the following Sections, we will elaborate which of the measures are addressed by the different EU policy instruments. Subsequently, we will assess how effective the policy instruments can be expected to be again along a number of criteria. Table 1 displays an overview of the measures analysed and the EU policy instruments currently in place.

Table 7: Matrix of measures and policy instruments in place in the European Union

	Financial measures			**Regulatory framework and standardisation**				**Information, capacity building and market transformation**	
	Providing financing	Grants and subsidies	Fiscal measures	Minimum performance requirements — building codes and standards	Standards for calculation, M & V of energy performance	Energy certification of buildings	Eco-design requirements for building components	Information programmes	Support to energy service companies
Energy performance of buildings directive	--	--	--	**XXX**	**XXX**	**XXX**	--	**X**	**X**
EPBD-related CEN mandate to develop a set of standards	--	--	--	**XXX**	**XXX**	--	--	--	**X**
Directive on energy end-use efficiency and energy services	**X**	--	--	--	--	--	--	--	**XXX**
Eco-design directive	--	--	--	--	--	--	**X**	--	--
Eco-label regulation	--	--	--	--	--	--	--	**X**	--
Energy labelling directive	--	--	--	--	--	--	--	**X**	--
Environmental technology verification	--	--	--	--	--	--	--	**X**	**X**
Energy taxation	--	--	**X**	--	--	--	--	--	--
Structural and Cohesion Funds and European Investment Bank	**X**	**X**	--	--	--	--	--	**X**	--
'Intelligent energy Europe' programme	--	--	--	--	**X**	--	--	**X**	--
Potential for reinforcing policy	*X(a)*	*X(a)*	*X(b)*	*X(c)*	--	*X(c)*	--	--	*X(d)*

XXX Main concern of policy instrument
X Concern of policy instrument
-- Not concerned by policy instrument

(a) Some instruments used in some Member States; (b) Reduced tax rates or tax deductions are applied in some Member States; (c) Recast of EPBD (e.g. 1000 m^2 threshold for minimum performance requirements); (d) Depends on the development of the energy service sector

Concerning the measures towards energy efficiency in the building sector, the most important EU policy instruments in place are: the 'energy performance of buildings' directive (EPBD), the EPBD-related CEN mandate to develop a set of standards and the directive on energy end-use efficiency and energy services. One has to keep in mind that the recast of the EPBD is currently ongoing and that the European Commission proposed further strengthening of the directive (Section 4.2.1). The standards developed under the CEN mandate are available now but not yet fully applied in the Member States. Similarly, the potential impacts of the energy end-use efficiency and energy services directive (Section 4.2.3) will depend on the implementation by the single Member States.

The environmental labelling and eco-design policy instruments (eco-design directive, eco-label regulation, energy labelling directive) so far do not include building elements but only single energy systems of buildings and household appliances. Revisions or recasts of these instruments are currently ongoing aiming at broadening the scope and also including e.g. windows, or insulation materials.

There are almost no EU instruments in place with regard to provision of financing, grants and subsidies. Currently, these measures are provided by policies at Member State level (and only by some Member States) and some SCF and EIB measures (which appear to be quite limited with regard to financial setting and funding conditions that have to be met).

Regulatory framework and standardisation issues are well covered by existing policy instruments (depending on the recast of the EPBD, and the development and implementation of the standards and codes in the individual Member States). Concerning the eco-design for building components, there are almost no policy instruments in place except for the eco-design directive which so far only includes energy systems, but not single building components like windows, doors, insulation materials, etc. It was proposed by the Commission to extend the eco-design directive to include also energy-related products such as water-using devices, building insulation materials, and windows. The current proposal also specifies that the eco-design directive shall be reviewed concerning the extension of the scope to non energy-related products no later than 2012 (see Section 4.2.4).

With respect to information and capacity building, there are quite some policies in place (especially information programmes). The support to ESCOs mainly depends on the directive on energy end-use efficiency and energy services which offers a high potential but again depends on the national implementation.

Table 8 shows a matrix of the barriers and the EU policy instruments in place. Some general conclusions can be derived from this matrix: first, almost all EU policy instruments are quite new instruments. For these instruments, no impact assessment is available yet (e.g. eco-design directive). Some legislation is even only available at EU level but not yet implemented at Member State level (e.g. energy end-use efficiency and energy services directive).

The contrasting of the barriers towards energy efficiency with the existing policy measures yields similar conclusions as the analysis of the matrix of measures and policy instruments: the directive on energy end-use efficiency and energy services, the EPBD, and the EPBD-related CEN mandate are the most important EU policy instruments in place. The labelling schemes and the eco-design directive currently do not aim at building elements but only household appliances. They will become more relevant when their scope will be broadened. Energy taxation and the IEE programme are of minor importance concerning the barriers towards energy efficiency in the building sector.

Almost all barriers are addressed — at least partly — by the policy instruments in place, with the exception of the transaction cost for financiers, and the operational risk barrier. The majority of barriers are tackled partly. The barriers appropriately addressed comprise bounded rationality problems (e.g. insufficient and incorrect information on energy features) and lack of information concerning the performance of EE technologies (Table 8). The problems of financing will need to be addressed, despite the fact that these problems have been recognised quite early and that there are already measures in place — both at European and Member State levels (see Section 2.3, Section 4.3.1, and Section 4.3.3).

Table 8: Matrix of barriers and policy instruments in place in the European Union

		EPBD([a])	EPBD-related CEN mandate	Energy end-use efficiency and ES directive	Eco-design directive	Eco-label regulation ([b])	Energy labelling directive([c])	ETV([d])	Energy taxation([e])	SCF and EIB	IEE programme
Problems of financing	Initial cost barrier, access to capital			MS ensure that there are sufficient incentives for ESCOs, creation of a functioning ES market						SCF funds EE and refurbishment measures; EIB finances EE investments	
	Transaction costs for financier										
	Transaction costs for building owner/ tenant			Indirect information and capacity building by stimulating the demand side		Clear, reliable, and free information on environmental performance of products					
	Economic uncertainties			Creation and promotion of a stable ES market						EIB supports development of specific financing instruments, e.g. risk-sharing instruments	
	Lack of information on financing options			Dissemination of information on EE mechanisms and financing options							IEE funds projects aiming at market adoption and market penetration of energy-efficient technologies
	Inappropriate evaluation of cost efficiency	Establishment of a method-ology for calculating the energy performance of a building	Standards on calculation of energy need for heating and cooling; standards on energy performance rating	Indirect information and capacity building by stimulating the demand side							
Unclear performance of energy efficiency tech nologies	Uncertainty regarding M & V of energy-savings			MS ensure that qualifi-cation, accredit-ation and certification schemes are available for ES providers	MPR; M & V procedures set by implement-ing measures	Assessment and verification requirements are defined by the eco-label criteria	Reliable information on energy performance of products	ETV provides credible and understandable performance information			
	Mistrust of information on technologies			Indirect information and capacity building by stimulating the demand side		Eco-label provides reliable information on environ-mental performance		ETV provides credible and under-standable performance information		EIB supports capacity building through provision of technical support and information	IEE funds information and capacity building projects
	Operational risks		Standards could lead to reliable monitoring and diagnostics procedures					ETV provides credible and understand-able performance information			

<table>
<tr><th></th><th></th><th>EPBD(a)</th><th>EPBD-related CEN mandate</th><th>Energy end-use efficiency and ES directive</th><th>Eco-design directive</th><th>Eco-label regulation (b)</th><th>Energy labelling directive(c)</th><th>ETV(d)</th><th>Energy taxation(e)</th><th>SCF and EIB</th><th>IEE programme</th></tr>
<tr><td rowspan="3">Bounded rationality and inadequate information</td><td>General lack of information and knowledge about EE measures</td><td></td><td></td><td>Indirect information and capacity building by stimulating the demand side</td><td></td><td>Eco-label provides clear and reliable information on energy performance of product</td><td></td><td></td><td></td><td></td><td>IEE increases awareness in energy conservation and EE by supporting e.g. educational activities</td></tr>
<tr><td>Bounded rationality constraints</td><td>MEPR</td><td rowspan="2">Standards on calculation of energy need for heating and cooling; standards on energy performance rating</td><td></td><td>MPR</td><td rowspan="2">Eco-label provides clear and reliable information on energy performance of product; labelled and non-labelled products can be compared easily</td><td rowspan="2">Energy label provides clear and reliable information on energy performance of product</td><td>ETV provides credible and understandable performance information</td><td></td><td rowspan="2">SCF provides information on successful projects, highlight and best-practices; EIB supports capacity building through provision of technical support and information</td><td rowspan="2">IEE funds information and capacity building projects</td></tr>
<tr><td>Insufficient and incorrect information on energy features</td><td></td><td></td><td>MPR; technical documentation on energy features</td><td></td><td></td></tr>
<tr><td>Split incentives</td><td></td><td>MEPR; development of certification for buildings to make energy consumption levels visible</td><td></td><td>MS should ensure that there are sufficient incentives for ESCOs, creation of a functioning ES market</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td rowspan="2">Other barriers</td><td>Lack of technical skills</td><td></td><td></td><td>Indirect information and capacity building by stimulating the demand side</td><td></td><td></td><td></td><td></td><td></td><td></td><td>IEE supports information and capacity building</td></tr>
<tr><td>Barriers to technology development</td><td></td><td></td><td>Demand-side stimulation</td><td>Demand-side stimulation</td><td>Demand-side stimulation</td><td>Demand-side stimulation</td><td>ETV increases acceptance of new technologies</td><td></td><td></td><td></td></tr>
</table>

Colour code for row heading	Colour code for column heading	Colour code for cell entry
Barrier appropriately addressed	Instrument has already reached full potential	Existing measures, no need to modify
Barrier partly addressed	Instrument has further potential if revised	Existing measure, could be reinforced
Barrier not or hardly addressed	New instrument/no assessment available yet	New measure suggested

(a) Recast of the EPBD is currently ongoing

(b) Could be reinforced (as envisaged) by broadening the scope and by reinforcing the requirements of the label

(c) Could be reinforced (as envisaged) by broadening the scope and by reinforcing the requirements of the label

(d) Proposed measure

(e) Measure tackles market distortion between different energy carriers

After having contrasted the policy instruments in place with the barriers towards energy-efficient buildings, we also analyse them according to the level they reached their respective potential. Other criteria to assess the potential of the policy instruments in place include e.g. the importance of the main barrier the instrument tackles, the clarity or understandability of the instrument, the possibility of combining the instrument with other instruments, or the possibility of a further development of the instrument. The results of this qualitative assessment are shown in Table 9.

The policy instruments which offer the highest potential are the EPBD directive, the directive on energy end-use efficiency and energy services, the eco-design directive, and the labelling instruments.

Table 9: Assessment of the policy instruments in place in the European Union

	Importance of the main barrier the policy instrument aims at ([a])	Policy instrument already in place/ implemented by the MS ([b])	Impact/expected impact of policy instrument ([c])	Policy instrument focuses a specific barrier or tackles several barriers ([e])	Clarity/understandability/ appropriateness regarding target/barrier ([c])	Compatibility of policy instrument with other instruments or measures ([c])	Increased impact by further broadening or strenghtening ([c])	Compatible with MS instruments/ appropriate as EU instrument ([c])
Energy performance of buildings directive	4	3	5	2	4	3	4	5
EPBD-related CEN mandate to develop a set of standards	3	2	4	2	4	3	4	4
Directive on energy end-use efficiency and energy services	5	1	5	4	3	3	3	4
Eco-design directive	3	2	3	2	3	4	4	4
Eco-label regulation	3	5	2	3	5	3	3	3
Energy labelling directive	2	5	3	3	4	4	4	4
Environmental technology verification	2	1	3	2	3	2	n.a.	3
Energy taxation	1	5	1	1	3	1	2	1
Structural and Cohesion Funds and European Investment Bank	3	5	2	2	3	1	2	3
'Intelligent energy Europe' programme	2	5	2	3	3	1	n.a.	4

([a]) 1 = not or hardly important, 5 = very important; ([b]) 1 = not implemented yet/not in place, 5 = fully implemented on MS level/in place; ([c]) 1 = low, 5 = high; ([d]) 1 = high, 5 = low; ([e]) 1 = tackles only one barrier, 5 = tackles several barriers at the same time

To conclude, the recast of the EPBD which suggests reducing the limit above which existing buildings undergoing major renovations must comply with minimum energy performance requirements shows a high potential to reap the energy-saving potential in the building sector (Section 4.2.1). It will contribute to economic growth and job creation by providing additional employment and business opportunities. The EPBD thus ‘remains the instrument with most potential impact on energy efficiency in existing residential buildings’ both in the short and the medium term (OECD/IEA, 2008a).

A promising measure is the broadening of the scope of the eco-design directive from energy-using to energy-related products (Section 4.2.4). The eco-design directive is seen as the cornerstone of future IPP. It will be completed by labelling schemes like the eco-label and offers a high potential by increasing the effectiveness and synergies of other EU legislative acts and initiatives (e.g. energy labelling directive, directives on minimum energy efficiency requirements). The first proposals of the review of the eco-design directive also include building envelop elements like windows or insulation materials. However, it still has to be clarified if EU-wide performance standards for building envelop elements like windows are reasonable (e.g. under an eco-design directive).

Another important issue is utilising the potential of using structural or cohesion funds for energy efficiency in building projects. However, SCF funding is limited to new Member States and to multi-family housing or buildings owned by public authorities or non-profit operators (Section 4.2.9). The impact on the whole building stock of the EU-27 will thus remain low because the major fraction of the building stock is excluded from the SCF funding.

When we assess the policy instruments in place, we see that most instruments focus on new buildings or new energy appliances while some of the instruments also concern existing buildings or parts of the existing building stock. For example, the EPBD applies to the application of minimum requirements on the energy performance of new buildings, and the application of minimum requirements on the energy performance of large existing buildings ‘that are subject to major renovation’ (OJL 001, 2003).

The majority of the EU policy instruments do not aim at accelerating the refurbishment cycles of existing buildings or the replacement of inferior energy appliances, heating systems, or building elements that show low thermal performance compared with the best available (or even average new) technologies on the market.

From an economic point of view, it is reasonable to aim at first improving the energy efficiency of the building envelope (e.g. by addition of insulation material) when major refurbishment takes place anyway (Ecofys 2005, Nemry et al., 2008). There may, however, be an additional potential to improve the environmental performance of the existing building stock and if this potential could be reaped in a cost-effective way. These measures could consist in an enhanced replacement of single building components. Also, the provision of minimum performance requirements for single building elements could be an option, which would then apply when building elements are replaced and the average performance of the respective elements on the market would be enhanced compared with the base case without minimum performance requirements.

Obviously, apart from energy appliances, the exchange of windows seems to be a measure that can be performed without affecting much other parts of the building. Windows could also be replaced one after another thus decreasing the initial costs. In the European Union, the heat losses due to windows account for 5 % to 16 % of the environmental impacts of the building stock, depending on geographical zone and building type (Nemry et al., 2008). Both the accelerated replacement of windows and the introduction of minimum performance requirements for windows thus could offer a considerable potential for improvement.

According to (Ecofys, 2005), besides windows, also the (additional) insulation of roofs is a cost-effective measure (in southern and central Europe). The addition of insulation material (or the improvement of thermal performance of the roof insulation) needs relatively low investment compared with additional façade or floor insulation and could lead to considerable energy-savings (Nemry et al. 2008; Ecofys, 2005). The heat losses due to windows can reach up to 30 % of the environmental impacts of the total building stock in the European Union for some regions and building types (Nemry et al., 2008).

5 CONCLUSIONS

The assessment has shown that there are a great many existing and planned policies at EU and national levels that address the energy efficiency, and thus the environmental impacts, of residential buildings. Financial instruments and information measures are mainly offered by Member States and it can be expected that they will be further reinforced. Market transformation and technology verification instruments are being developed as European policy initiatives.

At the EU level there is already a regulatory framework for energy performance standards and certificates of buildings, mainly in the form of the 'energy performance of buildings' directive (EPBD). The European Commission has already taken action to ensure the full implementation of this directive (infringement cases against Member States) and to further reinforce it, for example by including small buildings fully in the scope and by addressing the potential of 'low or zero energy' or 'passive' houses. Overhauls have also been prepared for the eco-design and energy labelling directives. Together these measures may achieve an important part of the potentially available cost-effective energy-savings in buildings. However, there are a few important aspects that need to be addressed in order to be successful.

The main target of the EPBD is to ensure energy efficiency investments when new buildings are constructed or when existing buildings undergo major renovations. The advantage of this approach is that it allows to make the energy efficiency investments when they cost least, i.e. as part of the 'natural' construction and renovation cycles. However, major renovations of a building are not made often, only about every 40 years on average, and there are certain energy efficiency measures that are cost-effective also outside the major renovation cycles. In particular, the retrofitting of windows and roof insulation to reduce energy losses may allow energy cost savings that outweigh the investment costs, without the need to carry these measures out at the same time as a general major renovation of the building.

Furthermore, much can be gained by simply assuring that window and door fittings are maintained regularly in order to avoid excessive ventilation losses. Currently there is no European legislation that would address the retrofitting of building elements such as windows and roofs. Potentially, this appears to be the most important area for additional policies in the EU to improve the environmental performance of buildings.

In the case of windows, for example, an acceleration of the replacement rate of windows in the existing building stock may offer a substantial environmental improvement potential. Acceleration of replacement could be achieved by providing incentives for faster window replacement (with better performing windows). There could also be the requirement to set up national targets for the installation of energy-efficient windows (percentage of windows complying with certain performance requirements installed by a certain year).

Another way of improvement could be the introduction of minimum performance requirements for new windows. This measure would not aim at accelerating the replacement rate but improve the thermal performance of the average windows on the market. The relevant policy instruments for these issues are the eco-design directive for minimum performance requirements and maybe also the energy labelling directive (energy labelling is already applied to windows in some Member States). Incentives to accelerate the replacement could be tax incentives, direct subsidies, etc. A further possible option could be the introduction of an eco-label for windows that show high thermal performance (above average). The label could make some costumers switch to windows that perform even better than average new windows on the market which means that the thermal performance of the replaced window is increased even more.

Also the additional insulation of roofs may be a cost-effective measure even outside the normal renovation cycles (in southern and central Europe). The addition of insulation material (or the improvement of the thermal performance of the roof insulation) needs relatively low investment compared with additional façade or floor insulation and could lead to considerable energy-savings. The heat losses due to roofs can reach up to 30 % of the environmental impacts of the total building stock for some regions and building types in the European Union.

The exact size of the additional energy-savings to be obtained by retrofitting building elements, the associated environmental gains, as well as the economic costs and benefits are not yet known. There are also important variables for retrofitting that would have to be optimised, such as the thermal insulation levels of the building elements to be attained (which will certainly depend of the climatic conditions) and the pace of retrofitting. These are all important questions that need to be addressed before concrete proposals of additional policies can be made.

Given the wide range of possible technical and policy solutions regarding the retrofitting of buildings elements, it is suggested that different scenarios of ambition and of policy formulation are studied with regard to energy-saving potentials and socio-economic impacts. Since the energy-saving effects occur over many years (generally more than a decade) research has to have a sufficiently long time horizon. It will require modelling the development of the building stock and the stock of building elements of different energy efficiency levels.

Ideally, the research should also explore the indirect socio-economic effects of the energy-savings and the initial required investment expenditures. It should also investigate the socio-economic effects of the different policy approaches for enforcing or stimulating the investments, for offsetting additional costs and for distributing the benefits.

6 REFERENCES

ANAH (2008), 'Conditions d'attribution des subventions pour l'amélioration des logements privés — propriétaires bailleurs ou occupants', Agence national de l'habitat (ANAH), Paris, available at: http://www.anah.fr/nos-aides-aux-travaux/quelles-subventions/pdf/Cond-attrib-2008.pdf

Australian Greenhouse Office (1999), 'Scoping study of minimum energy performance requirements for incorporation into the building code of Australia', Australian Greenhouse Office, Canberra, available at: http://www.environment.gov.au/settlements/energyefficiency/buildings/publications/pubs/s_study.pdf

Bertoldi P. and Rezessy S. (2005), *Energy service companies in Europe — Status report 2005*', EUR 21646 EN, European Commission, DG JRC, Institute for Environment and Sustainability, Renewable Energies Unit, available at: http://re.jrc.ec.europa.eu/energyefficiency/pdf/ESCO%20report%20final%20revised%20v2.pdf

Bertolddi P., Boza-Kiss B. and Rezessy S. (2007), *Latest development of energy service companies across Europe — A European ESCO Update*, EUR 22927 EN, European Commission, DG JRC, Institute for Environment and Sustainability, Renewable Energies Unit, available at: http://www.energy.eu/publications/LBNA22927ENC_002.pdf

Bremer Energie Institut (2008), 'Effekte des CO_2-Gebäudesanierungsprogramms 2007', Institut Wohnen und Umwelt GmbH, Universität Bremen, Bremen, available at: http://www.kfw.de/DE_Home/Research/Sonderthem68/PDF-Dokumente/Studie_Effekte_KfW_CO2_Sanierungsprogramm2007.pdf

Brown M. (2001), 'Market failures and barriers as a basis for clean energy policies', *Energy Policy* 29, pp. 1197–1207, 2001, DOI, 10.1016/S0301-4215(01)00067-2

Caird S., Roy R. and Herring H. (2008), 'Improving the energy performance of UK households, Results from surveys of consumer adoption and use of low- and zero-carbon technologies', *Energy Efficiency*, available at: http://dx.doi.org/10.1007/s12053-008-9013-y

Calleja I. and Delgado L. (2008), 'European environmental technologies action plan (ETAP)', *Journal of Cleaner Production* 16, pp. 181–183, available at: http://dx.doi.org/10.1016/j.jclepro.2007.10.005

COM(2004) 38 final, 'Stimulating technologies for sustainable development, An environmental technologies action plan for the European Union', Communication from the Commission to the Council and the European Parliament, available at: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2004:0038:FIN:EN:PDF

COM(2005) 16 final, 'Report on the implementation of the environmental technologies action plan in 2004', Communication from the Commission, available at: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2005:0016:FIN:EN:PDF

COM(2007) 140 final, 'Green Paper on market-based instruments for environment and related policy purposes', Communication from the Commission, available at: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2007:0140:FIN:EN:PDF

COM(2008) 397/3, European Commission, Communication on the sustainable consumption and production and sustainable industrial policy action plan, available at: http://ec.europa.eu/environment/eussd/pdf/com_2008_397.pdf

COM(2008) 399, European Commission, proposal for a directive of the European Parliament and of the Council establishing a framework for the setting of eco-design requirements for energy-related products (presented by the Commission), available at: http://ec.europa.eu/environment/eussd/pdf/com_2008_399.pdf

DeCanio S. (1993) 'Barriers within firms to energy-efficient investments', *Energy Policy* 21 pp. 906-914, DOI:10.1016/0301-4215(93)90178-I

Dewulf W. and Duflou J. R. (2004), 'Integrating eco-design into business environments — A multi-level approach', Department of Mechanical Engineering, Katholieke Universiteit Leuven, Belgium, available at http://dpr.unitbv.ro/adept/asi/C1-3.pdf

EnergieAgentur.NRW (2008), 'Der Feldversuch für Wohngebäude', available at: http://www.energieagentur.nrw.de/energieausweis/page.asp?TopCatID=&CatID=3332&RubrikID=3332

Ecofys (2005), 'Cost-effective climate protection in the EU building stock', report prepared by Ecofys for Eurima, Brussels, 2005, available at: http://www.eurima.org/uploads/ModuleXtender/Documents/94/documents/ecofysIII_report_EN.pdf

Ecolas/TNO/GMV (2007), service contract on ETAP performance targets — benchmarking report windows (70402/2005/426106/MAR/G3), European Commission, Environment DG, Brussels.

EuroACE (Ed.), Janssen R. (2004), 'Towards energy-efficient buildings in Europe', London 2004, available at: http://circa.europa.eu/Public/irc/env/action_climat/library?l=/efficient_buildings/_EN_1.0_&a=d

Europe Economics (2007), 'Impact assessment study on a possible extension, tightening or simplification of Framework Directive 92/75 EEC on energy labelling of household appliances, a report by Europe Economics and Fraunhofer-ISI with BSR Sustainability and FfE, London, available at: http://ec.europa.eu/energy/demand/legislation/doc/2008_02_22/2008_consultation_energy_labelling_mainreport_en.pdf

European Commission (2007), 'Report on the public consultation, Revision of the EU eco-label Regulation (EC) No 1980/2000', European Commission, Environment DG, available at: http://ec.europa.eu/environment/ecolabel/pdf/revision/revision_report2007.pdf

European Commission (2008a), draft Commission regulation implementing Directive 2005/32/EC of the European Parliament and of the Council with regard to eco-design requirements for standby and off mode electric power consumption of electrical and electronic household and office equipment, available at: http://ec.europa.eu/energy/demand/legislation/doc/regulatory_committee/2008_06_03_standby_post_vote_en.pdf

European Commission (2008b), consultation document on the revision of the energy labelling directive — Directive 92/75/EEC of 22 September 1992 on the indication by labelling and standard product information of the consumption of energy and other resources by household appliances, working document presented by Energy and Transport DG, European Commission, Brussels, available at: http://ec.europa.eu/energy/demand/legislation/doc/2008_02_22/2008_consultation_energy_labelling_document_en.pdf

European Investment Bank (2007a), *EU energy policy and the EIB*, Luxembourg 2007, available at http://www.eib.org/attachments/thematic/energy_policy_en.pdf

European Investment Bank (2007b), *Annual report 2006 — Volume I — Activity report*, Luxembourg, available at http://www.eib.org/attachments/general/reports/ar2006en.pdf

Eurostat (2008a) Eurostat (Ed), Data (population and social conditions/living conditions and welfare/income and living conditions/non-monetary poverty and social exclusion/housing/type of housing by tenure status and socio-economic status), Statistical Office of the European Communities, Luxembourg, available at: http://epp.eurostat.ec.europa.eu/portal/page?_pageid=0,1136184,0_45572595&_dad=portal&_schema=PORTAL

Eurostat (2008b), *Europe in figures, Eurostat yearbook 2008, Eurostat newsrelease* 75/2008, 2 June 2008, available at: http://epp.eurostat.ec.europa.eu/pls/portal/docs/PAGE/PGP_PRD_CAT_PREREL/PGE_CAT_PREREL_YEAR_2008/PGE_CAT_PREREL_YEAR_2008_MONTH_06/1-02062008-EN-AP.PDF

Ford M., Gurney A., Heyhoe E. and Gunasekera D. (2007), *Energy security, clean technology development and climate change — Addressing the future challenges in APEC*, ABARE research report 07.14, Australian Bureau of Agricultural and Resource Economics (ABARE), Canberra 2007, available at: http://www.abareconomics.com/publications_html/climate/climate_07/apec_security.pdf

Golove W. H. and Eto J. H. (1996), 'Market barriers to energy efficiency — A critical reappraisal of the rationale for public policies to promote energy efficiency', University of California, Lawrence Berkeley National Laboratory, Energy and Environment Division, Berkeley, available at: http://eetd.lbl.gov/EA/emp/reports/38059.pdf

Haas R., Auer H., Biermayr P. (1998), 'The impact of consumer behaviour on residential energy demand for space heating', *Energy and Buildings* 27, pp. 195–205, available at: http://dx.doi.org/10.1016/S0378-7788(97)00034-0

Hall N. P., Best C., Roth J., Jacobs P. and Lutzenhiser L. (2005), 'Assessing markets to design programmes that more fully attack key market barriers and take advantage of market opportunities — Why do we continue to miss so many opportunities?', International Energy Program Evaluation Conference, 17–19 August 2005, New York, available at: http://www.caenergy.com/events/iepec/abstracts2005/TOCAbstract.pdf

Hogeling J. and van Dijk D., 'More information on the set of CEN standards for the EPBD — Information on standardisation', P60 (10-03-2008), EPBD Buildings Platform, Energy and Transport DG, Brussels 2008, available at: http://www.buildingsplatform.eu/epbd_publication/doc/P060_EN_EPBD_CEN_March2008_p3031.pdf

Hoogeling J. (2006), 'The set of CEN standards developed to support the implementation of the EPBD in the EU Member States — Information on standardisation', P02, EPBD Building Platform, available at: http://www.buildingsplatform.eu/epbd_publication/doc/P02_EPBD_CEN_Standards_p2370.pdf

IEEA (2006), 'Multiplying success in buildings — 21 Innovative Projects supported by the IEE Programme', Intelligent Energy Executive Agency, available at: http://ec.europa.eu/energy/intelligent/library/doc/ka_reports/buildings.pdf

IEFE (2005), 'EVER — Evaluation of EMAS and eco-label for their revision', executive summary, Adelphi Consult, IOEW, SPRU, Valør and Tinge, available at: http://ec.europa.eu/environment/ecolabel/pdf/revision/executive_summary.pdf

IPMVP (2002), 'International performance measurement and verification protocol — Concepts and options for determining energy and water savings — Volume I — Revised March 2002', International Performance Measurement and Verification Protocol Technical Committee, U.S. Department of Energy, Office of Scientific and Technical Information, Oak Ridge, DOE/GO-102002-1554, available at: http://www.nrel.gov/docs/fy02osti/31505.pdf

ISO/TR 14062:2002 (2002), 'Environmental management — Integrating environmental aspects into product design and development', International Organization for Standardization

Jackson P. and Snowdon K. (1999), 'Eco-labels, boon for the environment or confusion for the consumer?' *Engineering Science and Education Journal* 8, pp. 20–22, available at: http://ieeexplore.ieee.org/xpl/freeabs_all.jsp?arnumber=756471

Jakob M. (2007), 'Essays in economics of energy efficiency in residential buildings — An empirical analysis', dissertation, DISS. ETH NO. 17157, ETH Zürich, available at: http://e-collection.ethbib.ethz.ch/view/eth:29755

Jolley A. (2006), 'Technologies for reducing stationary energy use', *Climate Change Project Working Paper Series* 6, Centre for Strategic Economic Studies, Victoria University, Melbourne 2006, available at: http://www.cfses.com/documents/climate/06_Jolley_Technologies_for_Reducing_Stationary_Energy_Use.pdf

JRC-IPTS (2006), Eder P. and Delgado L. (Ed), *Environmental impact of products (EIPRO) — Analysis of the life cycle environmental impacts related to the final consumption of the EU-25*, technical report EUR 22284 EN, European Commission, Joint Research Centre, available at http://ec.europa.eu/environment/ipp/pdf/eipro_report.pdf

Keoleian G. and Menery D. (1993), 'Life cycle design guidance manual — Environmental requirements and the product system', EPA600/R-92/226, US Environmental Protection Agency, Washington 1993

Lebot B., Waide P. and Newman J. (2001), 'The European appliance labelling programme', Regional Symposium on Energy Efficiency Standards and Labelling — Lessons learned in Asia, 29–31 May 2001, Bangkok, available at: http://www.un.org/esa/sustdev/sdissues/energy/op/clasp_lebot.pdf

Levine M. D., Koomey J. G., McMahon J. E., Sanstad A. and Hirst E. (1995), 'Energy efficiency policy and market failures', *Annual Review of Energy and the Environment* 20 (1995), pp. 535–555, available at: http://dx.doi.org/10.1146/annurev.eg.20.110195.002535

Merkourakis S., Calleja I., Delgado L., Oçafrain A. and Laurent S. (2007), *Environmental technologies verification systems*, technical report EUR 22933 EN, European Commission, Joint Research Centre, available at: http://ftp.jrc.es/EURdoc/eur22933en.pdf

Mills E., Kromer S., Weiss G. and Mathew P. A. (2006), 'From volatility to value, analysing and managing financial and performance risk in energy-savings projects', *Energy Policy* 34 (2006), pp. 188–199, available at http://dx.doi.org/10.1016/j.enpol.2004.08.042

Nemry F., Uihlein A., Makishi Colodel C., Wittstock B., Braune A., Wetzel C., Hasan I., Niemeier S., Frech Y., Kreißig J. and Gallon N. (2008), *Environmental improvement potentials of residential buildings (IMPRO-building)*, European Commission, JRC — Institute for Prospective Technological Studies, EUR 23493 EN, JRC46667, Office for Official Publications of the European Communities, Luxembourg, available at: http://ftp.jrc.es/EURdoc/JRC46667.pdf

OECD/IEA (Ed.) (2007), *Mind the gap — Quantifying principal-agent problems in energy efficiency*, in support of the G8 plan of action, OECD/IEA, Paris, available at: http://www.iea.org/Textbase/publications/free_new_Desc.asp?PUBS_ID=1954

OECD/IEA and AFD (Ed.) (2008a), *Promoting energy efficiency investments — Case studies in the residential sector*, Paris, available at: http://www.iea.org/w/bookshop/add.aspx?id=326

OECD/IEA (Ed) (2008b), *Energy efficiency requirements in building codes — Energy efficiency policies for new buildings*, IEA information paper, in support of the G8 plan of action, OECD/IEA, Paris, available at: http://www.iea.org/g8/2008/Building_Codes.pdf

OTA — Office of Technology Assessment (Ed.) (1993), *Industrial energy efficiency*, US Congress, US Government Printing Office, Washington DC, available at: http://govinfo.library.unt.edu/ota/Ota_1/DATA/1993/9330.PDF

Office of the Australian Buildings Codes Board (2000), *International survey of building energy codes*, Australian Greenhouse Office, Canberra, available at: http://www.environment.gov.au/settlements/energyefficiency/buildings/publications/pubs/international_survey.pdf

OJL 001 (2003), Directive 2002/91/EC of the European Parliament and of the Council of 16 December 2002 on the energy performance of buildings, Official Journal of the European Union L 001 (2003), pp. 65–71, available at http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32002L0091:EN:HTML

OJL 114 (2006), Directive 2006/32/EC of the European Parliament and of the Council of 5 April 2006 on energy end-use efficiency and energy services and repealing Council Directive 93/76/EEC, Official Journal of the European Union L 114 (2006), pp. 64–85, available at http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2006:114:0064:0085:EN:PDF

OJL 191 (2005), Directive 2005/32/EC of the European Parliament and of the Council of 6 July 2005 establishing a framework for the setting of eco-design requirements for energy-using products and amending Council Directive 92/42/EEC and Directives 96/57/EC and 2000/55/EC of the European Parliament and of the Council. Official Journal of the European Union L 191 (2005) pp. 29–58, available at http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2005:191:0029:0058:EN:PDF

OJL 237 (1993), Council Directive 93/76/EEC of 13 September 1993 to limit carbon dioxide emissions by improving energy efficiency (SAVE), Official Journal of the European Union, L 237 (1993), pp. 28–30, available athttp://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:31993L0076:EN:HTML

OJL 237 (2000), Regulation (EC) No 1980/2000 of the European Parliament and of the Council of 17 July 2000 on a revised Community eco-label award scheme, Official Journal of the European Union, L 237 (2000), pp. 1–12, available athttp://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2000:237:0001:0012:EN:PDF

OJL 283 (2003), Council Directive 2003/96/EC of 27 October 2003 restructuring the Community framework for the taxation of energy products and electricity. Official Journal of the European Union, L 283 (2003) pp. 51–70, available at http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2003:283:0051:0070:EN:PDF

OJL 297 (1992), Council Directive 92/75/EEC of 22 September 1992 on the indication by labelling and standard product information of the consumption of energy and other resources by household appliances, Official Journal of the European Union L 297 (1992) pp. 16–19, available athttp://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:31992L0075:EN:HTML

Österreichisches Umweltzeichen (2008), Bundesministerium für Land- und Forstwirtschaft, Umwelt und Wasserwirtschaft (Ed.), Aktuelle Umweltzeichenrichtlinien. Bundesministerium für Land- und Forstwirtschaft, Umwelt und Wasserwirtschaft, Wien 2008, available at http://www.umweltzeichen.at/filemanager/list/15672/

Penney J. (2007), 'Skills for energy-efficient construction — A report on trades training for energy-efficient buildings in the greater Toronto area', Clean Air Partnership, Toronto 2007, available at http://ttb.on.ca/downloads/SEEC.pdf

Ramesohl S. and Dudda C. (2001), ‘Barriers to energy service contracting and the role of standardised measurement and verification schemes as a tool to remove them’, summer study proceedings, European Council for an Energy-efficient Economy (eceee), Stockholm 2001, available at: http://www.eceee.org/conference_proceedings/eceee/2001/Panel_5/p5_1

RICS — Royal Institution of Chartered Surveyors (Ed.) (2008), *Can building codes deliver energy efficiency? — Defining a best practice approach*, A report for the Royal Institution of Chartered Surveoyors by the Building Research Establishment, London, June 2008, available at http://www.rics.org/NR/rdonlyres/4DF412BC-9F95-4A79-AF88-923E670BE718/0/Canbuildingcodesdeliverenergyefficiency.pdf

Rubik F., Frankl P., Pietroni L. and Scheer D. (2007), ‘Eco-labelling and consumers — Towards a re-focus and integrated approaches’, *International Journal of Innovation and Sustainable Development* 2 (2007), pp. 175–191, available at: http://dx.doi.org/10.1504/IJISD.2007.016932

Sanstad A. H. and Howarth R. B. (1994), ‘Consumer rationality and energy efficiency’, proceedings of the ACEEE 1994, summer study on energy efficiency in buildings, available at http://enduse.lbl.gov/Info/ACEEE-Efficiency.pdf

Schleich J. and Gruber E. (2008), ‘Beyond case studies — Barriers to energy efficiency in commerce and the services sector’, *Energy Economics* 30 (2008), pp. 449–464, available at http://dx.doi.org/10.1016/j.eneco.2006.08.004

SEH —Survey of English Housing (2008), live tables —‘Trends in tenure and cross tenure topics (general)’, Communities and Local Government, London, available at: http://www.communities.gov.uk/housing/housingresearch/housingsurveys/surveyofenglishhousing/sehlivetables

Sorrell S., O’Malley E., Schleich J. and Scott S. (2004), *The Economics of Energy Efficiency — Barriers to Cost-Effective Investment*, Edward Elgar, Cheltenham.

Stein J. R. (1997), ‘Accuracy of home energy rating systems’, LBNL report No 40394, Building Energy Analysis Group, Environmental Energy Technology Division, Lawrence Berkeley National Laboratory, Berkeley 1997, available at: http://eetd.lbl.gov/EA/Reports/40394/40394.PDF

Testorf (2008), ‘Personal communication for Testorf L (KfW)’, KfW Bankengruppe, Frankfurt am Main, 2008.

The Allen Consulting Group (2004), ‘The energy efficiency gap — Market failures and policy options’, report to the Business Council for Sustainable Energy, the Australasian Energy Performance Contracting Association and the Insulation Council of Australia and New Zealand, Melbourne 2004, available at: http://www.aepca.asn.au/documents/EnergyEfficiencyGapFinalReport.pdf

WBCSD (Ed.) (2007), *Energy efficiency in buildings — Business realities and opportunities — Facts and trends — Summary report*’, World Business Council for Sustainable Development, Conches-Geneva, available at: http://www.wbcsd.org/plugins/DocSearch/details.asp?type=DocDet&ObjectId=MjU5MTM

Weber L. (1997), ‘Some reflections on barriers to the efficient use of energy’, *Energy Policy* 25 (1997), pp. 833–835, available at http://dx.doi.org/10.1016/S0301-4215(97)00084-0

Wilson C. and Dowlatabadi H. (2007), ‘Models of decision making and residential energy use’, *Annual Review of Environment and Resources* 32 (2007), pp. 169–203, available at http://dx.doi.org/10.1146/annurev.energy.32.053006.141137

European Commission

EUR 23775 EN – Joint Research Centre – Institute for Prospective Technological Studies
Title: Towards additional policies to improve the environmental performance of buildings
Authors: Andreas Uihlein and Peter Eder
Luxembourg: Office for Official Publications of the European Communities
2009
EUR – Scientific and Technical Research series – ISSN 1018-5593
ISBN 978-92-79-11633-9
DOI 10.2791/86422
ISSN 1018-5593

Abstract

This report supports EU policymaking on sustainable consumption and production (SCP) in the area of buildings, which were indentified as being particularly relevant for environmental improvements. While the objective of SCP policies is to address all the different types of environmental impacts in a balanced way, previous research by the JRC-IPTS (IMPRO-Buildings study) has shown that the energy consumption during the use phase of the buildings is by far the most important factor to take into account for the life cycle environmental impacts of buildings. Moreover, residential buildings are responsible for 27 % of final energy demand in the EU.

The report reviews the barriers towards energy efficiency and the measures to overcome. It then compiles an overview over existing and planned EU policy instruments dealing with the environmental and energy performance of buildings, building elements and equipment. Finally, barriers, available measures and policy instruments are assessed against each other to find out what more could be done and to assess if there are additional policies to the existing ones that could lead to further improvements.

The mission of the JRC is to provide customer-driven scientific and technical support for the conception, development, implementation and monitoring of EU policies. As a service of the European Commission, the JRC functions as a reference centre of science and technology for the Union. Close to the policy-making process, it serves the common interest of the Member States, while being independent of special interests, whether private or national.

LF-NA-23775-EN-C

EUROPEAN COMMISSION

ISBN 978-92-79-11633-9

Publications Office
Publications.eu.int