

**The Energy Performance of Buildings Directive (EPBD):  
improving the energy efficiency of the existing housing stock**

Optimising the impact of Article 7 on the energy certificate

Research task for the '**40%-House**'

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**Summary**

In 2003 the European Commission introduced the Energy Performance of Buildings Directive (EPBD) in recognition of the importance of energy savings in the urban housing stock. One of the key elements described in the Directive is the introduction of energy certificates in a property transaction. This article discusses the anticipated efficiency and effectiveness of the application of the energy certificate on the existing building stock in the UK. We argue that, although energy certificates as a communication instrument for household appliances have appeared to be relatively successful, the different nature of the building sector can mean their effectiveness here will be rather limited. Incentives need to be introduced to support taking up the improvements recommended by the energy certificate. Effective results can probably be expected from introducing regulations combined with energy certificate standards, but it requires a rather drastic approach and needs time to receive sufficient commitment.

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## 1. Introduction

In 2003 the European Parliament accepted Directive 2002/91/EC on the Energy Performance of Buildings (EPBD), aimed at greenhouse gas emissions reduction and compliance in energy requirements between the Member States. The main requirements of the EPBD are:

- To harmonize energy calculation methods based on an overall energy performance.
- To set minimum energy requirements for new construction and large refurbishments.
- A mandatory energy certificate for new and existing buildings when they are constructed, sold or rented so that the certificate must not be more than 10 years old and carried out by independent and qualified experts. In addition to detailing the current energy efficiency level of the building, the certificate must also include recommendations for cost-effective improvements in energy performance. Energy certificates have to be displayed in public buildings.
- Compulsory boiler/heating and air-conditioning inspections.

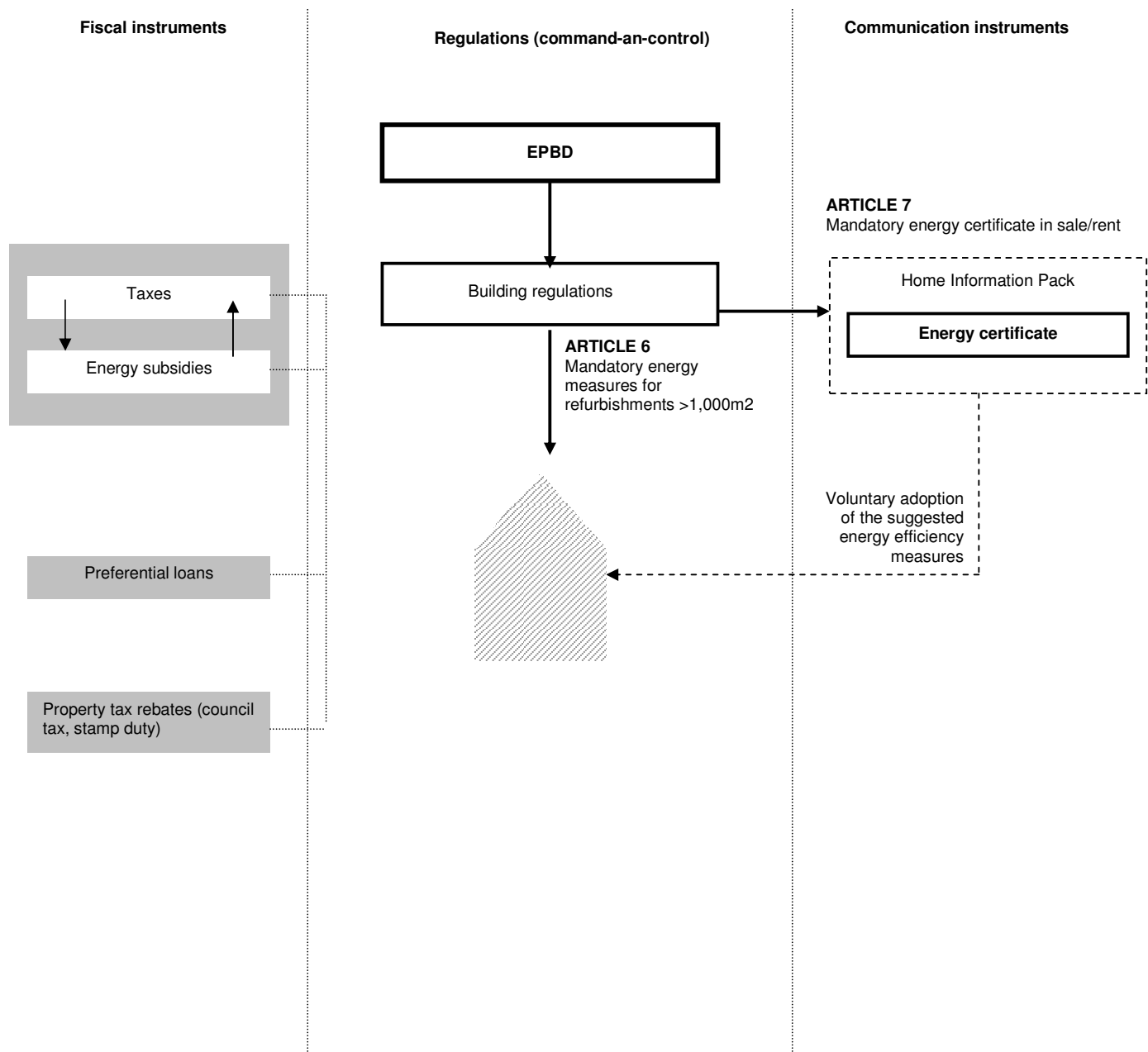
One of the four key elements described in the Directive is the introduction of energy certificates for the existing building stock. The Directive leaves it open for each Member State to decide whether to combine the energy certificate with economic policy instruments, or to use it only for communication purposes. The energy certificate can, therefore, be seen as a tool that can be used in combination with different types of policy instruments. In the description of energy regulations in 11 EU Member States, Beerepoot (2002) concludes that energy regulations for existing buildings hardly exist. European research studies show that voluntary energy certificate schemes for buildings already exist in a number of European Member States (Blaustein, 2000; Van Cruchten, 2003). No study, however, describes the anticipated effects of energy certificates for buildings as a voluntary instrument or when combined with regulations, subsidies or taxes.

This paper focuses on the potential impact of the energy certificate, Article 7 of the Directive. The potential of the energy certificate to motivate incremental, low-cost energy efficient improvements in the existing housing stock and the consequent carbon savings are assessed. The UK, which has one of the oldest and least efficient housing stocks in Europe, is taken as a case study. The UK government has set a target of a 60% reduction in carbon dioxide emissions by 2050. The target cannot be met unless there is a change in the quality of the existing housing stock. The technical potential of the UK stock, irrespective of cost, is estimated to be 40-42% (Defra, 2004). The economic potential, however, is lower because of the long payback times and the fact that it is not generally economic to replace equipment much before the end of its useful lifetime. The estimates for the economic potential for the existing housing stock are 17-21% for 2010 and 28-32% for 2020.

Current policies seem inadequate to the scale and urgency of the task. The Office of the Deputy Prime Minister assumes that the EPBD and the revision of the building regulations in 2005 will bring an improvement of around 25% in the performance of new dwellings and 25 to 27% in the performance of new buildings other than dwellings. An improvement of a 'lesser scale' whenever people carry out work on existing buildings, compared to the regulations in 2002 (ODPM, 2004). The annual carbon savings are expected to be 1.09 Mt per year considering total savings from the amendments to the building regulations. The Regulatory Impact Assessment does not, however, address Articles 6 and 7 of the EPBD on the refurbishment of existing dwellings, or the impact of the new regulations on existing buildings, because of diversity of types and scale of refurbishment work and the difficulty of assessing the likely levels of improvement that will occur.

This paper addresses the research questions: What is the anticipated impact of the energy certificate on existing housing in the UK? How large are the additional savings associated with combining the energy certificate with other policy instruments? The implementation of the Directive is first set in a European context through a comparison of the implementation in the Netherlands and in Finland. Figure 1 presents the current implementation of the EPBD in the existing housing stock in the UK, in relation to fiscal, command-and-control and communicative policy instruments.

**Figure 1** Articles 6 and 7 of the EPBD that address the existing housing stock in relation to policy instruments for the existing housing stock in the UK



## 2. Analysis

In this research, the impact of the energy certificate in the UK was assessed with an excel-based model. There are several factors to be considered while reading the analysis:

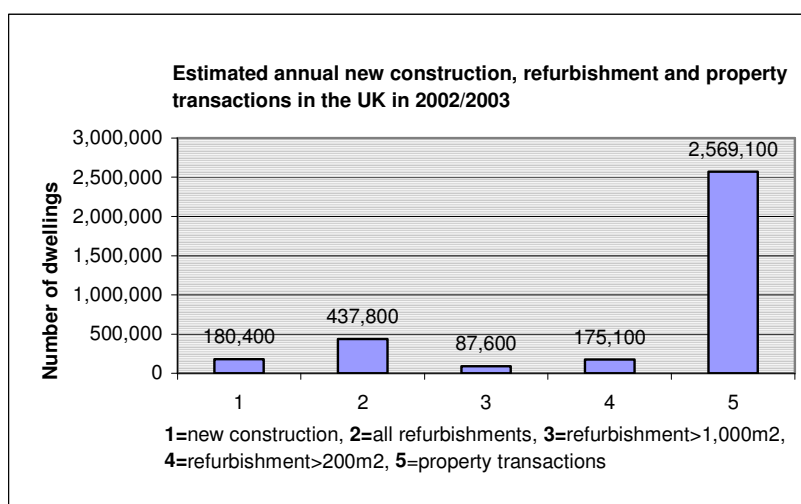
- No firm decisions have been taken about the implementation of the Directive in the UK. The analysis is not a forecast. It is based on probabilities and includes uncertainties like any attempts to describe the future.
- This study is focused on the impact of the energy certificate on motivating low-cost energy efficient improvements in the existing housing stock in the UK. (Article 7 of the EPBD). It is not an impact assessment of the complete Energy Performance of Buildings Directive, nor is it applicable to other countries.
- This study focuses on energy savings in space heating because it is relatively easy to foresee the developments in fabric construction. Domestic hot water or electricity demand for household appliances and lighting are beyond the scope of this analysis. Neither does this study address boiler inspections because in the UK, energy efficient boilers have long payback times compared to insulation and energy reduction produced by replacing an old boiler varies greatly in the existing housing stock being smaller in a better insulated than in a poorly insulated house. The use of low and zero carbon technologies in energy supply is not assumed here.
- All savings are based on delivered energy and presented as carbon. It should be considered that all carbon savings in renovations are always assumptions due to the variety of the housing stock. The savings will be greater if the assumptions in this research are too conservative.
- The established rate in the installations of cavity wall and loft insulation and double-glazing is assumed to continue at the current rate. This autonomous development is referred to as business-as-usual and the carbon savings resulting from the energy certificate are added to it.
- An optimistic assumption has been made that households and owners accept long payback times for energy efficient investments. It is also presumed that there are no capacity problems in the industries supplying insulation and installations, there are enough contractors needed to implement the measures and all inspections and improvements can be done, and that the adopted energy efficiency measures are implemented in a way that enables the planned savings.
- On the basis of other Directives and developments in similar energy audit programs for example in Denmark, it is realistic to presume that the EPBD will be sharpened in the future. This is enabled in Article 11 where it is set out that the Commission shall evaluate this Directive in the light of experience gained during its application and, if necessary, make proposals with respect to, complementary measures referring to the renovation in buildings with a total useful area <1,000m<sup>2</sup> and general incentives for further energy efficiency measures in buildings. Its impact would, therefore, change as well but this has not been assumed in this research.

The impact of the energy certificate depends on the annual property transactions, tenure, compliance (dependent on the supporting policy instruments), the labelled households taking action (dependent on the supporting policy instruments) and comprehensiveness of the adopted energy efficiency measures. These factors that are used in the analysis are explained next.

### 1) Annual property transactions

Since the energy certificate has to be issued when a dwelling is constructed, sold or rented, the number of energy certificates depends on the annual property transactions. Figure 2 shows the annual rates of new construction, refurbishment and property transactions in the UK.

**Figure 2** Annual rates of new construction, refurbishment (if Article 6 is applied in renovations exceeding 1,000m<sup>2</sup>, 200m<sup>2</sup> or all refurbishments) and property transactions in the UK in 2002/2003



source: The National Centre for Social Research, 2003; Petersdorff *et al.*, 2002; Sak and Raponi, 2002.

The number of sales or rentals exceeds the annual new construction and large refurbishment in the UK and, therefore, seems to offer an effective intervention point for improvements in energy efficiency.

## 2) Tenure

Table 1 presents an estimation of the annual property transactions in the UK by tenure.

**Table 1** Annual property transactions by tenure in the UK in 2001/2001

Tenure	Annual transactions (UK)	% of all transactions	% of the housing stock
Owner-occupied	1,215,550	47.3	6.75
Social rental	447,350	17.4	2.49
Private rental	906,200	35.3	5.03
Total	2,569,100	100	14.27

source: The National Centre for Social Research, 2003.

Property transactions can reach around 14% of the housing stock per year, but this share is not directly representative for the dwellings to be labelled annually because an energy certificate is valid for 10 years and a household is not going to act each time an energy certificate is obtained because an average renovation interval for a building is 25-30 years and in most cases even longer. Some properties may also not change hands for a long time.

## 3) Compliance

Compliance with the energy certificate is assumed to differ in the owner-occupied, social rental and private rental sectors in the UK. Three compliance scenarios are examined in this research.

### Scenario 1 – Current policy

In the UK, the energy certificate is likely to be implemented as a part of the Home Information Pack (HIP) that is going to be mandatory when selling a house and has to be provided by the seller. This accounts for the owner-occupied sector, for the rental sector a supporting policy instrument is still missing. An estimate of compliance and adoption rates resulting from the current policy as percentages of the annual property transactions is presented in Table 2.

**Table 2** Estimate of the labelled buildings and households taking action in current policy in the UK

Tenure	Compliance (% of annual property transactions in the UK)	Adoption of energy efficiency measures (% compliance)
Owner-occupied	50.0	5.0
Social rental	60.0	5.0
Private rental	30.0	2.0

source: author.

The figures address the households and owners that, as a result of the energy certificate, are motivated to take action that they would have not taken otherwise. These rates apply for the UK. Compliance is likely to be better in countries like Germany or Finland where public awareness of energy efficiency and willingness-to-pay is higher than in the UK and there are less problems with compliance with building regulations, even over-compliance. The following points assume low compliance with the energy certificate in the UK:

- There are no consequences for not having the energy certificate. It is unlikely that all dwellings will be labelled because buyers or renters are not likely to set an energy certificate as a condition for a property transaction in the UK housing market. Evidence from a similar energy certificate scheme in Denmark suggests 50% compliance in mandatory labelling, if there are no sanctions (COWI consult, 2001). The EU funded project on the Energy Labelling of Existing Buildings (BELAS) concluded on the basis of the existing labelling systems in Denmark, the Netherlands, Ireland, the UK and Vermont, that pure-market based, non-mandatory systems are little used by individual homeowners and a successful labelling system for existing buildings must be 'pulled' by government with regulatory measures (BELAS, 2004).
- There are no direct incentives for the inhabitants to take up the improvement suggestions proposed in the energy certificate. Willingness-to-pay for energy efficient measures are still low in the UK, although public awareness is increasing. According to the 1999/2000 English Housing Survey, 51% of the households were prepared to pay up to £ 50 for energy efficiency improvements, 26% of the households between £ 50-200 and 23% over £ 200, if an annual saving of £ 50 in energy costs was expected (Bates *et al.*, 2001). Developments in energy prices can change the situation in the future but this is not assumed in the analysis.
- The experience from the energy label for household appliances is positive but buildings cannot be compared to household appliances. Improvements in buildings are on a different cost scale than products and often need professional support to be implemented. The technical and economic feasibility of energy efficiency measures needs to be evaluated for each dwelling. Life cycles of buildings are very long and a slow turnover in buildings compared to appliances means also that achieving the savings will take time once the policy is implemented. Moreover, there is a principal agent-problem where the owner who should make the investment does not necessarily benefit from it in the operation phase. In contrast to the need for a new fridge and then opting for an energy labelled one, the inhabitant has to take a conscious purchasing action for insulation and it is easier not to do anything.

### *Scenario 2 – Energy certificate and incentives*

In scenario 2, new fiscal incentives are introduced to shorten payback times and attract more households to take up energy improvements suggested in the certificate. For an estimate of compliance and the adoption rates in the UK, see Table 3.

**Table 3** Estimate of the labelled buildings and households taking action in scenario 2 in the UK

Tenure	Compliance (% of annual property transactions in the UK)	Adoption of energy efficiency measures (%compliance)
Owner-occupied	50.0	30.0
Social rental	60.0	30.0
Private rental	30.0	5.0

source: author.

Long payback time is currently one of the main barriers to energy efficient improvements in the domestic sector (Boon and Sunikka, 2004). Fiscal incentives that could be introduced in order to achieve these compliance and adoption rates in this scenario are:

- Direct subsidies, where energy certification is used as a prerequisite for granting financial incentives for renovation, like in the Dutch EPA (see table 14, below). Subsidies alone, however, do not make a project cost-effective and there should be clear lines in what can be expected, because some investors might wait for the subsidies to increase. Evidence from the Netherlands suggests the risk of a free-rider effect in subsidising home insulation (Beumer *et al.*, 1993; Kemp, 1995).
- Council tax and stamp duty rebates for good energy performance verified in the energy certificate, reduced Value Added Tax (VAT) for the renovation materials. Tax systems, however, can feel complicated for inhabitants and need information to be effective. The Regulatory Energy Tax (REB), applied to Dutch households in 2001, increased energy bills by a third. Yet only half the population is aware of the Regulatory Energy Tax and only 2% take it into account in their electricity use (Van der Waals, 2001).
- Preferential, earmarked loans linked to the energy efficient improvements, possibly with a direct link to a mortgage. Energy cost savings can be used to repay the loan.

### Scenario 3 – Enforced energy certificate

In scenario 3, the energy certificate is enforced and encouraged with incentives. For an estimate of compliance and the adoption rates in the UK, see Table 4.

**Table 4** Estimate of the labelled buildings and households taking action in scenario 2 in the UK

Tenure	Compliance (% of annual property transactions in the UK)	Adoption of energy efficiency measures (%compliance)
Owner-occupied	80.0	60.0
Social rental	90.0	70.0
Private rental	70.0	20.0

source: author.

In order to ensure full compliance with the energy certificate in the UK, regulation is needed. In the owner-occupied sector a sale could not be registered without an energy certificate, and in the social housing sector, housing allowances would not be allocated to tenants living in unlabelled dwellings. In order to reach these rates in the adoption of energy efficient improvements, they need to be enforced as well. A dwelling could not be sold or a new rental contract agreed unless its thermal performance was updated to an acceptable minimum level, set by the government for each building type and tenure.

### 4) Comprehensiveness of the adopted measures

It is assumed that energy efficiency improvements with low payback time, namely cavity wall and loft insulation, and with moderate payback time, namely double-glazing, will be carried out first. It is assumed that half of the owners or households that take will action as a result of their energy certificate adopt one energy efficiency measure and half of the owners or households adopt a package of two energy efficiency measures. Table 5 presents the energy efficiency measures estimated to be adopted as a result of the energy certificate and the related energy savings (kWh/year) (Anderson *et al.*, 2002). Energy savings obtained from each measure are a weighted average saving per dwelling type in the English Housing Condition Survey.

**Table 5** Comprehensiveness of energy efficiency measures adopted as a result of the energy certificate

Measure adopted as a result of the certificate	Saving (kWh/yr)	Measure package adopted (2 measures)	Saving (kWh/yr)
Double-glazing	2049	Double-glazing+cavity wall insulation	7705
Loft insulation	7853	Double-glazing+loft insulation	9902
Cavity wall insulation	5655	Cavity wall insulation+loft insulation	13508
Non-cavity wall insulation	9693	Non-cavity wall insulation+loft insulation	17546
		Energy efficient windows+cavity wall insulation	6033

source: Anderson *et al.*, 2002 (weighted average calculated by author).



The impact of the energy certificate is expected to resemble S-shape curve. During the first 10 years of the implementation (2006-2016) a gradual increase in the adoption of the energy certificate suggestions is assumed from 50% to 100% because some households and owners are going to react to the energy certificate with a delay. The impact of the Directive on the existing stock is assumed to peak in 2016-2026. In 2026-2050, a gradual decrease from 90% to 10% in the adoption of low-cost insulation measures is expected.

Energy savings depend also on which insulation measure a household or an owner is going to choose. Table 6 presents an estimate of which share of households adopt a certain energy efficiency measure in a renovation.

**Table 6** Choice of low cost energy efficiency measures adopted as a result of the energy certificate

Measure adopted	In % of the renovations		Measure package adopted (2 measures)	In % of the renovations	
	2006-2016	2016-2050		2006-2016	2016-2050
Double-glazing	40.0	-	Double-glazing+cavity wall insulation	30.0	-
Loft insulation	40.0	40.0	Double-glazing+loft insulation	40.0	-
Cavity wall insulation	20.0	20.0	Cavity wall insulation+loft insulation	30.0	40.0
Non-cavity wall insulation	-	40.0	Non-cavity wall insulation+loft insulation	-	20.0
			HR windows+cavity wall insulation	-	40.0

source: author.

The long-term level of energy saving depends on the ownership of measures. In 2001, 93% of houses in Great Britain had loft insulation (56% of them more than 100 cm), 32% cavity wall insulation and 75% double-glazing (52.1% of them had at least 60% of rooms double-glazed) (Shorrocks and Utley, 2003). It is assumed that most houses will have cavity wall insulation around 2060 but this can be reached earlier if the annual take-up increases. Solid wall insulation is considered to slowly become more important measure around 2016. Most dwellings are expected have full double-glazing in 2016. Loft insulation has the highest ownership and most of the houses are expected to have it in 2016. In order to keep this level of saving, improvements are expected in the existing loft insulations after 2016, especially in the 44% of the houses that have less than 100 cm of insulation (Shorrocks and Utley, 2003). The number of floor insulation is considered to be small due to complex construction works and costs and, therefore, not assumed in here. As the take-up of double-glazing should ensure draught proofing (81.7% of households in Great Britain in 2001) and its impact on energy demand is relatively small, draught proofing has not been considered in the adopted measures.

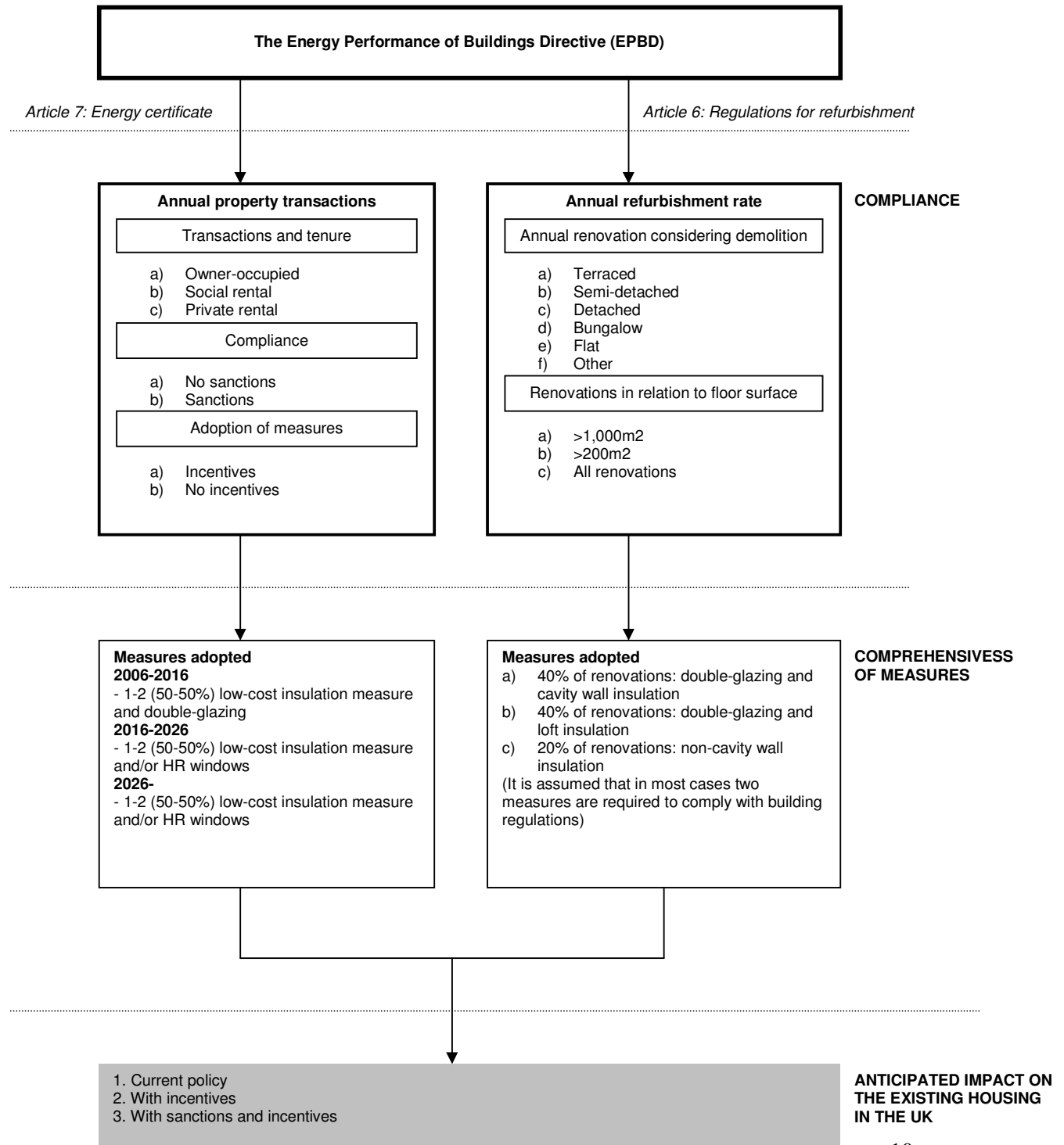
The energy certificate should introduce new measures to improve energy efficiency in order to keep this level of saving feasible. At this moment the use of more complex measures like solar energy is still limited by long payback times. Also new innovations are probably going to be introduced in the market, but due to high costs it is assumed that they are not going to be adopted on a large scale in the existing stock in the UK. If energy prices and willingness-to-pay increase faster than expected then a more optimistic scenario is valid.

### Business-as-usual

In addition to the savings motivated by the energy certificate, it is assumed that business-as-usual will result anyway in energy savings in space heating in the UK. In this research, an established installation rate of cavity wall insulation (280,000 installations per year), full double-glazing (1,200,000 installations per year) and loft insulation (110,000 installations per year) are considered in addition to the improvements initiated by the energy certificate. This autonomous development will lead to an annual saving of 3.3 Mt carbon in space heating in the existing housing in the UK. As the annual property transactions account for around 10% of the housing stock in the UK, it is assumed that in the business-as-usual scenario, this group of dwellings should contribute an annual saving of 0.33 Mt carbon at the very least. In order to distinguish the carbon savings resulting from the energy certificate from the business-as-usual development, an annual saving of 0.33 Mt carbon has first to be reduced from the carbon saving in each scenario.

The total carbon emissions from households' energy consumption in the UK account for 41.4 Mt carbon per year, including domestic hot water, household appliances and lighting (BRE, 2003). According to the Department for Environment, Food and Rural Affairs (2004) demand for energy services such as comfort and home entertainment have increased at over 2% a year in the UK, more than offsetting energy efficiency improvements, so that energy consumption has kept rising. There is no indication that the service demand trend will fall much below the current rate of around 2% per year. Whether energy consumption rises or falls in the next 20 years depends on the energy efficiency rate, around 1.5% per year in 2000, and if it can stay above the service demand trend (Defra, 2004). In this research, a stabilisation of the 2% growth is taken as a reference in the reduction of heating demand in the existing housing in the UK.

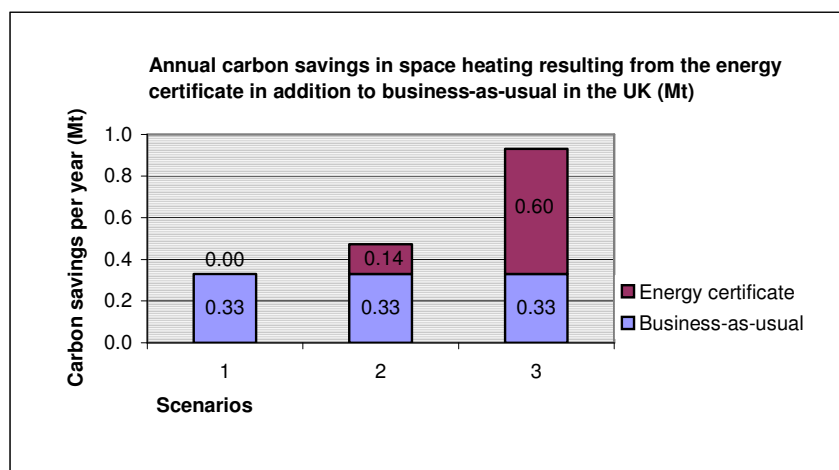
**Figure3** Principles of modeling the impact of the energy certificate



### 3. Results

Figure 4 presents the annual carbon savings that result from the energy certificate based on modelling the conditions presented in the previous section regarding annual property transactions, tenure, compliance, the labelled households taking action and comprehensiveness of the adopted energy efficiency measures. Scenario 1 is the current policy, in scenario 2 the energy certificate is combined with incentives and in scenario 3 the energy certificate is enforced.

**Figure 4** Annual carbon saving (MtC) resulting from the energy certificate in space heating in the existing housing stock in the UK in addition to business-as-usual (0.33 MtC)



source: author.

Table 7 relates the carbon savings resulting from the energy certificate to the space heating demand of households (25.6 MtC per year) and the total energy demand of the households (41.4 MtC per year) in the UK (Building Research Establishment, 2003).

**Table 7** Annual carbon savings (MtC) resulting from the energy certificate in the UK in relation to the households' space heating demand and total energy demand

Scenarios	Carbon savings (MtC) per year			Annual reduction (%)	
	Business-as-usual	Energy certificate	Total saving	Space heating demand in the UK (25.6 MtC)	Total energy demand in the UK (41.4 MtC)
[1] Current policy	0.33	0	0.33	1.29	0.8
[2] Incentives	0.33	0.14	0.47	1.85	1.14
[3] Enforced	0.33	0.60	0.93	3.63	2.25

source: Building Research Establishment, 2003 and author.

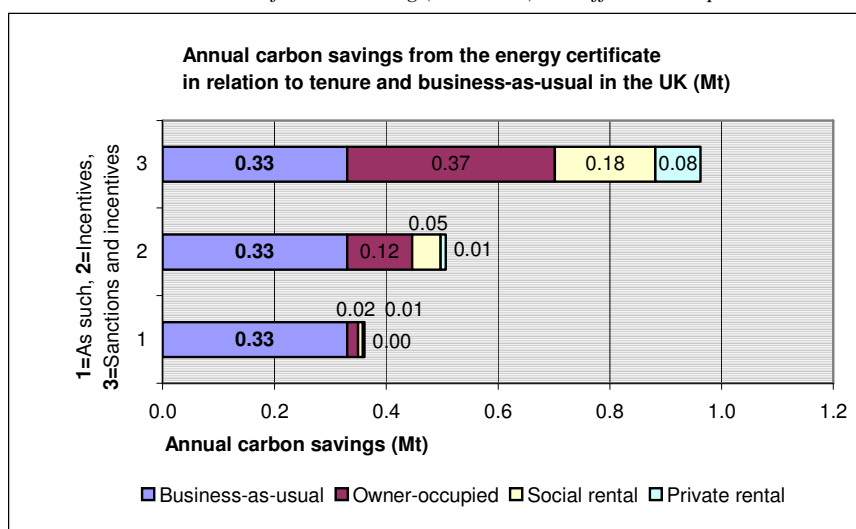
The results show that the implementation of the energy certificate in the UK, as it is planned now, will support the current policy but is not adequate to obtain additional savings that could distinguish from the business-as-usual development.

If the introduction of the energy certificate is to motivate an annual 0.14 Mt carbon reduction, it requires that 30-60% of dwellings, depending on the tenure, will get an energy certificate when sold or rented and in 5-30% of these dwellings one or two low-cost energy efficiency measures, that would not have been taken otherwise, are adopted. This calls for combining the energy certificate with incentives. With savings from the business-as-usual scenario this would ensure a total 0.47 Mt carbon reduction per year in the UK. This accounts for a nearly 2% reduction in households' space heating demand and around 1% reduction in households' total energy demand in the UK (Defra, 2004).

An annual 0.60 Mt carbon saving in the UK requires 70-90% compliance with the energy certificate, depending on the tenure, and 20-70% adoption of one or two low-cost energy efficiency measures in addition to the autonomous development. Combined with the business-as-usual energy savings this approach would ensure a total 0.93 Mt annual carbon reduction in the UK. This would lead to around 3.6% reduction in households' space heating demand and a 2% reduction in households' total energy demand and could stabilize the annual 2% increase in households' energy consumption (Defra, 2004).

In the UK, most savings can be expected from the owner-occupied sector. The rental sector, however, has a great capacity to contribute to the savings if compliance is ensured and the adoption of measures made more attractive in terms of fiscal incentives like in scenarios 2 and 3. Figure 5 presents the annual carbon savings in space heating in the UK housing stock in relation to tenure and business-as-usual.

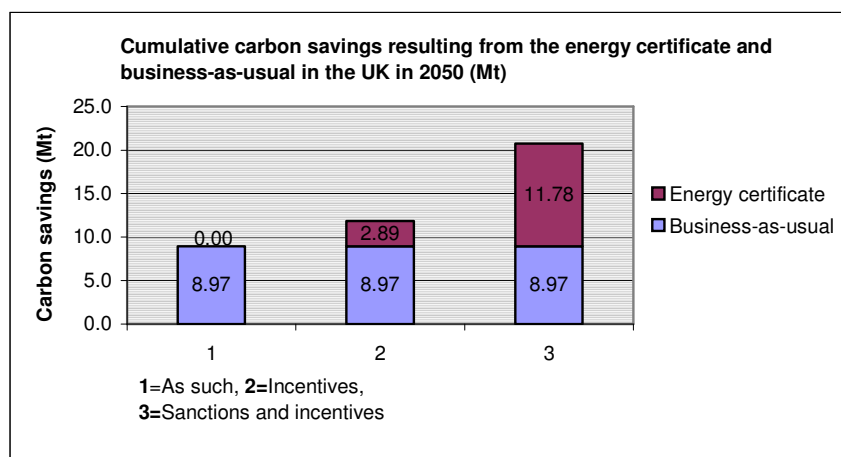
**Figure 5** Annual carbon savings (MtC) in the space heating of the UK housing stock according to tenure, in addition to the reference saving (0.33 MtC), in different compliance scenarios



source: author.

Considering the impact of the energy certificate in the longer run carries obvious risks and uncertainties but some assumptions can be made based on factors described in the previous section. Figure 6 presents an estimation of cumulative carbon savings in the existing housing stock resulting from the implementation of the energy certificate in the UK in 2050.

**Figure 6** Cumulative carbon savings (MtC) resulting from the energy certificate in space heating of the existing housing stock in the UK in 2050, in addition to business-as-usual (8.97 MtC)



source: author.

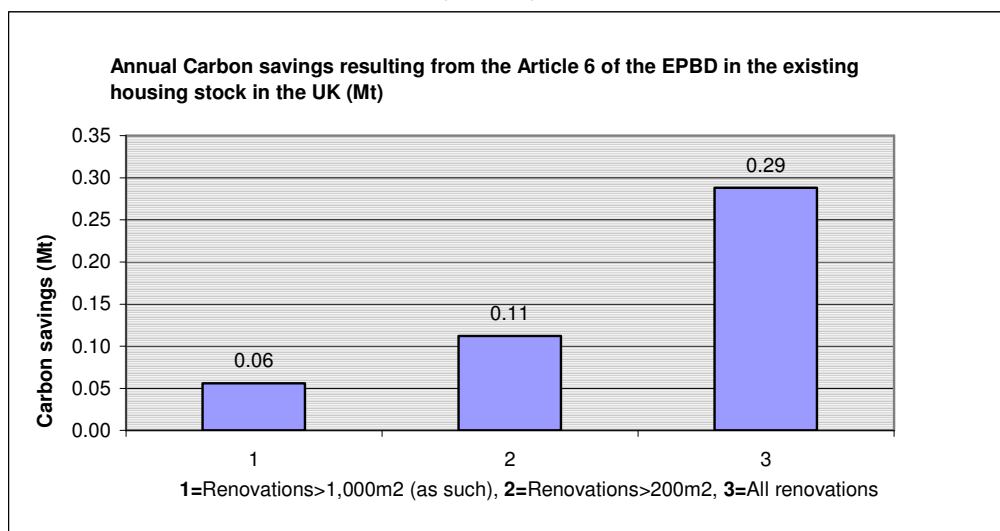
#### 4. Article 6 on the regulations for refurbishment

Article 6 of the Energy Performance of Buildings Directive suggests an introduction of thermal regulations for major renovations exceeding 1,000 m<sup>2</sup>. In addition to Article 7 on the energy certificate and the requirements on boiler inspections, it is the main Article of the Directive to address existing dwellings.

The threshold of 1,000 m<sup>2</sup> means that the requirements mainly apply for the tertiary sector and about a third of multi-family dwellings. In Europe, this accounts for around 28% of the total building stock (Petersdorff *et al.*, 2004). The high threshold is likely to limit the impact of the Article, because the main contributor to carbon emissions is the residential (77%) not the tertiary sector (23%). Furthermore, Article 6 excludes the existing single-family housing stock that represents 45% of the total building stock in Europe and is the largest source of carbon emissions in the building sector.

A rough estimate of the impact of this Article on the existing housing stock in the UK was carried out as a part of the analysis. Based on the annual refurbishment rate in the UK, considering the annual demolition and different dwelling types, and the conditions explained in section 2, it is assumed that annual carbon savings of around 0.06 MtC could be achieved in the existing housing stock in the UK assuming Article 6 is implemented in line with current policy. It is assumed that an average of two low-cost insulation measures are required to comply with the requirements in thermal regulations. If Article 6 was extended to all domestic renovations exceeding 200 m<sup>2</sup>, it would nearly double the savings to 0.11 Mt carbon per year, in the existing buildings in the UK. If Article 6 was applied to all renovations in the UK, an annual 0.29 Mt carbon saving could be achieved. Business-as-usual development has not been considered in these calculations.

**Figure 7** Estimation of the annual carbon savings (MtC) resulting from Article 6, when requirements apply for renovations exceeding 1,000 m<sup>2</sup> (1), if the Article is extended to renovations exceeding 200 m<sup>2</sup> (2) or to all renovations (3) in the existing housing in the UK, without business-as-usual



source: author.

Due to the fact that the annual refurbishment rate is lower than the number of annual property transactions in the UK, and that the building regulations are expected to set a minimum level but do not encourage exceeding it, Article 6 seems to have less potential to address energy efficiency in existing housing than Article 7 on the energy certificate. To a certain extent, Article 6 (regulations) and Article 7 (the energy certificate) overlap but this has not been assumed here.

## 5. Implementation of the EPBD in the UK, Netherlands and Finland

The Netherlands and Finland have been selected as international reference for the situation in the UK because they both have already an established policy system for sustainable building (Sunikka, 2002). Tables 8-13 present some characteristics of the national housing stock (Sak and Raponi, 2002).

**Table 8** Land area, population and population density

	km <sup>2</sup>	Population <sup>1</sup> *1000	Population / km <sup>2</sup>
Nederland	41034	15987	390
Suomi/Finland	338145	5195	15
United Kingdom	242910	59756	246

Source: Sak and Raponi, 2002.

**Table 9** Average household size

	1980	1985	1990	1995	2000	2001
Nederland	2.8	2.5	2.4	2.4	2.3	2.3
Suomi/Finland	2.6	2.6	2.4	2.3	2.2	2.2
United Kingdom	2.7	2.6	2.5	2.4	2.4	-

Source: Sak and Raponi, 2002.

**Table 10** Average useful floor area per dwelling (m<sup>2</sup>)

	Year	In total dwelling stock	Year	In newly built dwellings (year)
Nederland	2000	98.0	1998	115.5
Suomi/Finland	2000	76.5	2000	87.1
United Kingdom (England)	1996	85.0	1996	76.0

Source: Sak and Raponi, 2002.

**Table 11** Age of dwelling stock

	Year	<1919	1919-1945	1946-1970	1971-1980	> 1980
Nederland	2000	7.4	13.3	32.3	18.4	28.6
Suomi/Finland	2000	1.8	9.4	31.2	23.8	32.7
United Kingdom	1996	20.0	21.0	22.0	25.0	13.0

**Table 12** Dwelling stock by tenure (% of total stock) in 2000

	Rented	Of which social rental	Owner Occupied	Other
Nederland	47	75	53	0
Suomi/Finland	31	52	58	11
United Kingdom	31	69	69	0

Source: Sak and Raponi, 2002.

**Table 13** Housing stock, annual new dwellings, stock growth rate and total energy consumption

	Housing stock (Million)	Annual new dwellings	Total energy consumption (PJ/year)	Energy consumption (GJ/year/m <sup>2</sup> )
Nederland	6.6	73,000	389	0.6
Suomi/Finland	2.4	30,600	137	0.7
United Kingdom	25.0	183,000	2,171	1.0

Source: Sak and Raponi, 2002.

Table 14 compares the implementation of the Energy Performance of Buildings Directive in the UK, the Netherlands and Finland (Warren, 2003; Haakana, 2004; Van Ekerschot, 2004).

**Table 14** Readiness for the implementation of the EPBD in the UK, the Netherlands and Finland in December 2004.

UK	NL	FIN
Articles 3-4: Adaptation of a methodology and energy performance requirements		
Partly satisfied. Energy performance based regulations: Standard Assessment Procedure (SAP), an energy cost based rating.	Partly satisfied. Energy performance based regulations: Energy Performance Coefficient (EPC) , including CO <sub>2</sub> emissions.	Not satisfied. The method is being developed, energy performance indicator has not been decided yet. Heat recovery is mandatory in practice.
Article 5: Renewable energy sources		
Partly satisfied.	Partly satisfied.	Not satisfied.
Article 6: Existing buildings		
Partly satisfied. Installation, replacement and substantial alteration/extension of systems are all subject to the provisions of Approved document L2 (for non-domestic/residential buildings).	Partly satisfied. Replaced building elements should comply with minimum insulation level, but in practice this is hard to control, e.g. replacing windows does not require notification to building control.	Not satisfied, but local authorities can demand updating to new construction standards. EPBD is the first to affect existing buildings, requirements depend on the general targets for the existing stock.
Article 7: Energy certificate		
Mandatory energy certification scheme SAP is already in use for new dwellings and linked to building regulations since 1994, but not for other dwellings. 180,000 new dwellings are labelled every year this way. Also the National Home Energy Rating (NHER), BREEAM for office buildings and EcoHomes by BRE.	Most probably now voluntary Energy Performance Advice (EPA) for residential buildings will be the energy certificate. The development of EPA for utility buildings is in the final stage. EPA consists of energy evaluation by the EPA advisor, a suggestion of improvements and costs. Certificate for new dwellings needs to be developed.	Not satisfied, no certification scheme in use. Environmental classification of buildings and energy auditing exists only on a voluntary basis. Development of the certificate has not yet started.
Article 8-9: Inspection of boilers and AC systems		
Does not satisfy. New regulation is being prepared.	Legislation for boilers over 100 kW. Most boilers are gas-fired heating systems. New regulation is needed for few non-gas fired boilers and boilers older than 15 years.	Does not satisfy, but regular chimney sweepings are compulsory and boiler inspections are likely to be connected to it.
Article 10: Independent experts		
Does not satisfy.	Does not satisfy. Will probably be connected to the current systems like EPA advisors.	Does not satisfy. Possibly done by energy auditors (who do audits now) or by condition auditors combined with condition assessments (when buying a house). In new construction one of the design documents, made by a HVAC designer.

source: Warren, 2003; Van Ekerschot, 2004; Haakana, 2004.

#### **Articles 3-4 – Adoption of methodology and energy performance requirements**

The UK, the Netherlands and Finland are all coping with timing problems in the implementation of the Directive and have not taken the final decisions yet. Development of an energy performance based methodology and establishment of energy certificate and boiler inspections has a priority at this stage. The ambitiousness of the energy requirements and the energy performance indicator depend on the national context. Compared to the UK and Finland, the Netherlands seems to be furthest forward in the implementation of the Directive. It has had performance based energy regulations since 1996 and a (non-mandatory) energy labelling system. In the new building regulations, the Energy Performance Coefficient (EPC) includes the CO<sub>2</sub> emissions depending on the energy use. The emission factors used are: for gas 0.056 kg CO<sub>2</sub>/MJ; for electricity 0.0694 kg CO<sub>2</sub>/MJ; for an external supply based on oil or coal 0.0877 kg CO<sub>2</sub>/MJ and for an external supply based on waste incineration 0.0314 kg CO<sub>2</sub>/MJ. The sharpening of the EPC from 1.0 to 0.8 is considered realistic and influential Dutch organisations have agreed that in 2020, an EPC of 0.3 is feasible.

Due to climatic reasons, Finland already has very demanding thermal requirements and the Finnish example suggests that considerable sharpening in thermal regulations in the Netherlands and the UK is feasible (Sunikka, 2002). In the 2004 version of the Finnish building regulations, thermal requirements were sharpened by 30% and heat recovery from exhaust air became mandatory. If the owner does not want to make use of heat recovery, then the amount of energy that would result from recovered air has to be compensated for by improving the thermal insulation of the building. The compensation principle cannot be used the other way, so that thermal insulation could be compensated with more effective heat recovery, only in very special cases in log constructions where the U-value of walls cannot meet the requirements. Depending on the chosen measures and requirements, adjustments in the Finnish legislation might be necessary while some regulatory and technical objectives can conflict. In order to prevent this from happening, the Finland Ministry of Environment is trying to involve different parties of the construction process in the development of the energy certificate and the new methodology.

Cultural differences have indirect impacts on the sharpening of the requirements. In the Netherlands for example, the construction industry is lobbying against the sharpening because of market conditions and the consensus based decision-making culture makes agreeing on the new regulations a long process. Until now, resistance from the construction industry has not been a problem in sharpening regulation in Finland, although adoption of a new methodology might cause some criticism in Finland because a lot of “easy” energy improvements have been done already in the past few years (Haakana, 2004). Compliance with the building regulations is not seen as a problem in Finland and the Netherlands whereas in the UK it is more of an issue.

#### **Article 5 – Renewable energy sources**

At the moment the EPBD focuses on the end-use of energy and cutting space heating by insulation and better installations, but carbon reduction could also be achieved with the use of renewable energy sources in meeting the energy demand. The use of renewable energy sources is dealt with in Article 5 of the Directive, but the requirement accounts only for buildings exceeding 1,000m<sup>2</sup>. Furthermore, the Article suggests that the use of renewable energy sources should be examined, but this is non-mandatory. At the moment, Article 5 is so open that the countries are not giving it any priority in the implementation of the Directive. It might be, however, that the push towards renewable energy sources will come from another Directive than the EPBD.

In the Netherlands, there is already some experience in this kind of practice. The Agency for Energy and the Environment (Novem) has introduced the ‘Optimal Energy Infrastructure’ (OEI) method for feasibility studies on CO<sub>2</sub> reduction using different options for renewable energy sources in new construction locations. The OEI studies are subsidised. Another instrument, the Energy Performance of a Location (EPL) indicates a CO<sub>2</sub> efficiency of a housing development site. Municipalities are the targeted users. These instruments, however, have not been able to solve the problem of economic feasibility. With the “not more than otherwise” -principle (*Niet-Meer-Dan-Anders*), sustainable energy sources must not cost more for a household than a traditional energy supply. The share of energy coming from sustainable energy sources varies greatly between countries and due to district heating it is already high in Finland.

#### **Article 6 – Existing buildings**

Article 6 on setting thermal requirements for existing buildings seems to be one of the most demanding points of the EPBD, and also one of the most important ones in achieving carbon reductions. In principle, some requirements for existing buildings exist already in the building regulations in the UK and in the Netherlands, but they are difficult to control and complex to enforce in the domestic sector.



The requirements for the existing stock set in the EPBD account for large renovations exceeding 1,000m<sup>2</sup> which excludes a lot of buildings in the domestic sector. The Member States can decide themselves whether they wish to set the requirements for a building or for building components. The experience in the Netherlands suggests that if the requirements are set for components like windows, these are very difficult to control because they do not require notification to building control. The implementation of Article 6 is very dependent on the building permit system and how building control is managed. It has to be considered that any enforcement in the existing housing stock will target private households, some of them low-income who cannot make the investment or pay the increased rent.

An Ecofys report suggests that, if the scope of the EPBD were extended, namely if the requirements for refurbishments presented in Article 6 applied to all residential buildings including single- and multi-family dwellings, the CO<sub>2</sub> emissions saving potential could be doubled to 68 Mt per year over the business-as-usual -scenario in Europe in 2010, creating an additional saving potential compared to the current Directive of 36 Mt CO<sub>2</sub> per year (Petersdorff *et al.*, 2004). According to the Ministries of Environment in Finland and the Netherlands, a possible extension of Article 6 of the EPBD towards all renovations or all small buildings has not been planned yet. The Netherlands Ministry for Housing, Spatial planning and the Environment says, however, that there is discussion about applying the EPBD to all buildings. Also the energy certificate could be applied to small commercial buildings and dwellings even where there is no transaction but it may fail the test of cost efficiency (Van Ekerschot, 2004). In Finland, the Ministry of the Environment recognises that the further focus of the EPBD depends on the National Climate Strategy (Haakana, 2004).

#### **Article 7 – Energy certificate**

Article 7 on the energy certificate of buildings has initiated a lot of research and expectations from the EPBD. Encouraged by the successful labelling of household appliances, it is considered as one key policy instrument to achieve energy saving in buildings in the EU. In the Netherlands, Energy labelling is carried out through the Energy Performance Advice scheme (EPA), targeted to encourage energy saving in retrofits and up to now about 50,000 EPA evaluations have been undertaken (0.76% of the total housing stock), conducted by 500 registered EPA consultants. The evaluation costs € 150-200. The energy certificate for existing dwellings is likely to be based on the EPA, while the certificate for new construction has not been developed yet. The EPA is widely known and relatively well used in the Dutch housing sector, but the evaluations do not necessarily motivate the implementation of the suggested improvements in practice. In the beginning, the energy audits and some of the suggested improvements were supported by government subsidies but they were stopped in 2003 because of budgetary reasons and the free-rider effect (Beerepoot and Sunikka, 2004). After cutting the subsidies, the number of EPA evaluations dried up. However, the EPA system can contribute to the development of the energy certificate in terms of process and as an example of a successful policy instrument. The success of the EPA in terms of acceptance can partly be based on the consideration of costs. It is used by large developers, is well marketed and it has been subsidised to make it better known in the market.

In Finland, energy certificates are voluntary, based on piloting systems and mainly used by forerunners in the construction sector and the building regulations account for new construction (Sunikka, 2002). Energy labels for one-family housing, or building components like windows, and an Environmental Classification of Buildings exist but they are voluntary and demonstration-like.

The evidence from the Netherlands and Denmark suggests that, in order to be effective, an energy certificate has to be mandatory and even if it is, it does not mean energy improvements as such unless there is support from other policy instruments and sufficient information (Beerepoot and Sunikka, 2004). Denmark is closest to the full application of the EPBD as it is now, as the EPBD was mainly inspired by the Danish regulation. Yet in

Denmark, only 50% of housing is labelled despite the fact that the certificate is mandatory (COWI consult, 2001). The Ministry in Finland is aware of the Danish experience but does not want to introduce sanctions, mainly because it would interfere with private household economies. In the Netherlands, according to the Ministry, several instruments will be developed in the future and the use of instruments will be established by rules. For example without an energy performance calculation you cannot get a permit for building (Van Ekerschot, 2004). This is also being considered in Finland (Haakana, 2004).

#### **Articles 8-10 – Inspections of boilers and AC systems**

At the moment, none of the countries fully complies with the requirements on boiler and air-conditioning inspections and in the implementation process it seems to be one of the most concerning – and labour intensive - issues. In the Netherlands, there is legislation for boilers larger than 100 kW. Most of the boilers are gas-fired heating systems. New legislation needs to be made for few non-gas fired boilers and boilers over 15 years old. The fitters will make the inspections of installations. National characteristics strongly appear in this Article, in Finland for example, boilers differ from most European countries and cooling is unusual. According to the EPBD, the inspection should include recommendations for replacing the boiler. The replacement is economically more feasible if the incremental costs are considered, but this means interference in the end of the old boiler's life cycle. If the replacement is enforced at a certain pace, it can lead to energy savings but may require subsidies.

Regarding the inspectors as defined in Article 10 of the EPBD, this system has yet to be decided in all countries, but it is likely to be connected to an existing system. Estimates on the target of 60,000 EPA certificates per year require 100 man-years of work. In NL, the Ministry has estimated the need for labour of certified advisors to be 2,500 fte for housing and 400 for utility buildings. Most of the work would be in labelling and boiler inspections (Van Ekerschot, 2004).

In case of a lack of 'qualified and/or accredited experts' the Member States can have an extra three-year transition period to apply Articles 7-9 of the Directive and most countries are likely to use this option.

#### **Regulatory impact assessment**

No overall regulatory impact assessment has been carried out on the implementation of the Energy Performance of Buildings Directive in the Netherlands. Regarding new construction, the EPBD is estimated to affect from 60,000 to 70,000 dwellings a year (Van Ekerschot, 2004). As for new commercial buildings, the Directive is expected to affect 10 Million-m<sup>2</sup> a year and regarding the existing buildings, eventually 500,000 dwellings and 7,500 commercial buildings a year. The Ministry for Housing, Spatial Planning and the Environment estimates that the EPBD, as it is going to be implemented now, is unlikely to have a carbon dioxide reduction effect in the Netherlands. Nevertheless, the Directive is going to increase the effect of the existing policy instruments, which may have to be adapted. They see that there will be a need for a flanking policy in order to change the existing perceptions by citizen's change in investments for energy saving measures. Because of the already present policy instruments in the Netherlands, the Ministry is prepared for some citizens and companies nevertheless seeing the EPBD as increasing their burden by causing more hassle -and possible extra costs- in construction, renovation or property transactions (Van Ekerschot, 2004). Cost implications exist only for the real implementation of the project, which is estimated to be about €5 M. Additional costs for citizens and companies are expected to be 47 M€ a year. The costs for the government are seen to be strongly dependent on certain choices and are, therefore, not calculated (Van Ekerschot). The cost of the assessment is still unknown. In the Netherlands, the EPA evaluation, which the certificate is probably to be based on in the Netherlands, now costs about € 150-200 per assessment. In the Danish energy label system, closest to the certificate, costs account for € 400 per labelled house.

Preliminary evaluations about the impact, and cost implications, of the Energy Performance of Buildings Directive have been made in Finland concerning the inspection of boilers and AC systems and the implementation of the energy certificate. The Finnish Ministry of the Environment considers a cost-benefit analysis of the EPBD essential and emphasise that the energy certificate has to be acceptable for ordinary consumers. According to the Ministry, the current implementation of the Directive is likely to have a small impact on the carbon dioxide emissions in Finland, but it is likely to change design and construction practice because of the new kind of methodology that is based on an overall energy performance (Haakana, 2004). The implementation responsibility will be divided between the Ministry of the Environment and the Ministry of Trade and Industry. The Ministry foresees some tensions between the legislation and technical problems: what is technically feasible is not necessarily possible in terms of regulation and vice versa and it also is prepared for some criticism from the field once the implementation of the EPBD is far enough advanced to be really open for discussion because a lot of investments in energy efficiency have taken place already in recent years. Until now, however, there has not been much lobbying by the construction industry or other parties. The Directive is also expected to have positive economic impacts for example for the insulation and window industries that are likely to increase their sales considerably. Overall costs of the implementation of the Directive were estimated in 2001 but this was done very roughly and since then the Directive has been changed. Preliminary cost estimates exist for boiler inspections and different implementation options of the energy certificates (Haakana, 2004). In addition to compliance costs for the government in establishing the system, information campaigns will be necessary. For the inhabitants, the greatest cost will arise from the energy certificate but a cost of an assessment is not yet known.

### **Monitoring**

Monitoring the success of a policy instrument is important in its development. In current policy the EPBD does not require a national monitoring programme. Monitoring is likely, however, and in the Netherlands it is being developed (Van Ekerschot, 2004). The Dutch EPA monitoring system could be interesting in the development of the Directive for the other countries because it is also linked to higher policy levels like the Energy Performance per Location (EPL) which the municipalities and authorities can use. In Finland, no monitoring system has been planned yet. The Ministry considers this expensive so it may not be possible except for the monitoring of energy certificates (Haakana, 2004).

In all three countries, tools have been developed to project future developments in energy trends in the built environment that could be, and in some instances are, used to determine the impact of the EPBD. In the Netherlands, SAWEC was developed in the Energy Research Centre of the Netherlands (Jeeninga and Volkers, 2003). SAWEC is set for energy trends in 1985-2040 and includes cost aspects in terms of total investment and subsidies. It considers as factors influencing energy saving measures regulation (80% compliance, 20% go higher), subsidies, directing factors that can make energy efficiency choices more attractive in the future like energy price and the pace that brings the innovations to the market, and non-technical factors like living comfort. SAWEC considers emissions and economy in scenarios that are based on energy price and emission factors for example for gas and electricity (kg CO<sub>2</sub> /MJ). In Finland, VTT Building and Transport has developed an energy model in the building sector with Tampere University of Technology.

### **National policy context**

The EPBD is implemented in the national contexts of sustainable building policies, climate strategies and housing policies. In the three countries, government policy for sustainable building is market-led, with some environmental building regulations (Sunikka, 2002). Consensus-based decision-making makes changes slow in the Netherlands, whereas decision-making is authoritative and, therefore, quite effective in Finland.

General subsidies for energy efficiency and/or renovation exist in all countries and they can be combined with the EPBD later. The Netherlands has an already established system of taxes, subsidies and communication instruments to motivate sustainable building. Consumer need is seen as central in the Netherlands policy for sustainable building and energy saving in buildings promoted at all policy levels but not enforced. In 1998, the REB (Regulating Energy Tax), a surcharge to the cost of electricity and natural gas for all consumers, was introduced in the Netherlands. Green electricity is exempted making it more competitive and consequently, in 2001, 13% of Dutch households bought green electricity. The money collected via the REB is redistributed to the consumers via subsidies (Energy Premium Regulation) and tax reductions for the producers of renewable energy sources. The Energy assessment, the EPA method, was earlier promoted in the Energy Premium Regulation. Grants were given for well-specified measures, paid when the invoices are presented, requested from and distributed by the energy companies. The REB should also reduce payback times of energy efficient improvements. Most of the Energy Premium Regulation was stopped in the Netherlands in 2003. According to the Ministry, this was due to controllability and spending cuts in the relevant departments (Van Ekerschot, 2004). The government wants to use increased energy prices instead, as well as comfort gain and increased value of dwellings to promote energy efficiency in housing. In return for a certain amount of points from the list of standard measures in the National Sustainability Package Residential Buildings, a commonly used instrument in the Netherlands, an investor can get a preferential mortgage and qualify for Green Finance. There are also tax reductions for those investing in green projects (with Green Declaration).

In Finland, there are several general subsidies for the renovation of the existing stock. Annually € 15-17 Million are allocated as energy subsidies for apartment blocks. Single-family houses, which account for almost 50% of space heating energy consumption, have been outside the scope of publicly supported energy audit programs. The existing energy subsidies are not likely to increase to motivate improvements suggested in the energy certificate unless single-family housing is included in the program and there is already pressure towards that development. According to the Ministry, subsidies and the Directive follow different paths at the moment, but in the future it would be good to combine them so that subsidies would be allocated only for the improvements suggested in the energy certificate (Haakana, 2004). Information campaigns that can explain the Directive and make it more approachable for normal citizens need funding first. The National Climate Strategy can give insight to whether subsidies will be expanded to include single-family housing and if so, by when.

General trends have direct impacts on households' energy demand. In the Netherlands, the housing policy '*Nota Mensen Wensen Wonen*' expects as main trends by 2030: development from rent to ownership, continuing increase in floor surface per inhabitant, individualisation, upgrading of the existing housing stock including a growing number of insulation measures, higher floor and door heights, more complex constructions, new housing in green areas and increased automation in housing (MVRM, 2000).

Energy trends have been examined in all three countries. An example of this is the 2010 energy prognosis in the Netherlands (Ybema *et al.*, 2002). The energy study regards as uncertainties in the development of CO<sub>2</sub> emissions economic growth (5%), developments in life-styles (3%), policy measures (3%) and energy price (3%), as well as the importance of other political issues, like terrorism, and relative priority of environmental issues. Willingness to save energy is considered to be more dependent on costs than comfort effects. It is expected that during the next 10 years, insulation will increase by 13-21% in the Dutch housing stock, depending on the measure, so that in 2010, double-glazing is present in 90% of the dwellings, insulation in 50% and high efficiency boilers in 50% of the dwellings. Currently extra insulation is implemented in a third of the 55,000 annual renovations. It is assumed that already with better glazing and boiler replacements, it is possible to reach 70% of the 2 Mt carbon reduction target by 2010.

## 6. Conclusions

This report has presented an analysis of the anticipated effectiveness of the application of the energy certificate, Article 7 of the Energy Performance of Buildings Directive (EPBD). The main focus has been modelling how the energy certificate is going to motivate energy efficient improvements in the existing housing stock taking the UK as a case study. The implementation of the Directive was set in a European context in the comparison of the implementation in the Netherlands and in Finland.

Three implementation scenarios have been examined in the model, based on the annual property transactions, tenure, compliance and the labelled households taking action (both depending on the supporting policy instruments) and comprehensiveness of the adopted measures.

### **The energy certificate in current policy is likely to support energy efficiency trends in the existing housing in the UK but is not likely to add savings to business-as-usual.**

The energy certificate is likely to increase public awareness of energy efficiency. The recommendations for cost-effective improvements in energy performance suggested in the certificate can give a signal about the benefits resulting from the better energy standards provided and the certificate may have an impact on what will be done for the dwelling once it is bought, for example double-glazing can be prioritised over a new bathroom in a renovation. Good energy performance verified in the certificate can make energy investments visible when selling or renting a house and therefore, help an owner or a landlord to distinguish the property in the market. However, information on the energy performance alone at the point of renting or selling is not likely to make energy a purchasing or renting factor in the current housing market, given the housing shortage in the UK. Furthermore, a lack of interaction with other policy instruments is likely to limit compliance with the energy certificate and the adoption of measures. The energy certificate in the owner-occupied sector is included in the Home Information Pack provided by the seller, but a similar policy instrument is still missing in the rental sector. Consequently, the energy certificate is likely to support energy efficiency trends in the existing housing stock but alone it is not an adequate policy measure to obtain carbon savings in the UK that would distinguish from business-as-usual. If the housing market improves to allow a potential buyer to 'shop around' more, energy efficiency can become a selection factor for a home but this has not been assumed in the analysis.

### **In order to motivate an annual 0.14 Mt carbon reduction in the existing housing in the UK, new fiscal incentives are needed to support the energy certificate.**

Combining the energy certificate with fiscal incentives, such as subsidies for the improvements suggested in the energy certificate, tax rebates and earmarked, preferential loans could ensure a compliance of 30-60% and 5-30% adoption of the suggested improvements (dependent on tenure) in the UK. This would result in an annual saving of 0.14 Mt carbon in space heating in the existing housing stock. Including the savings from business-as-usual, an annual 0.47 Mt carbon saving could be obtained, accounting for around 1% reduction in households' total energy demand in the UK. It should be considered, however, that although energy taxes are necessary for shortening the payback times of energy investments, energy prices would have to at least double before they would be effective. Professional landlords are more likely to understand the value of energy efficient investments but for owner-occupiers shortening payback time from 14 to even 10 years is unlikely to change their investment behaviour, whereas high energy prices would put an unbearable burden on some households resulting in increased fuel poverty. This would be contradictory with the UK government policy that has focused on reliable energy supply and ensuring low energy prices. A more regulatory approach is needed.

**In order to motivate an annual 0.60 Mt carbon reduction in the existing housing in the UK, the energy certificate has to be enforced and combined with fiscal incentives.**

A compliance rate of 70-90% with the energy certificate and 20-70% adoption of the suggested improvements (dependent on tenure) would lead to an annual saving of 0.60 Mt carbon in space heating in the existing housing stock in the UK, and 0.93 Mt if business-as-usual is considered. This 2% reduction would be sufficient to stabilise the increase households' total energy demand in the UK (Defra, 2004). If the energy certificate is enforced as in this scenario, it changes from a communicative policy instrument towards regulations and has cost implications. However, in housing market failure where housing demand exceeds the supply an introduction of new criteria from the consumer side is very difficult without government support. If energy efficiency is left to the households that make a renovation decision at very long intervals, compared to institutions, they may not be well informed enough to make a change. If considerable carbon savings are wanted from the residential sector, then the enforcement of the energy certificate needs to be considered as one alternative.

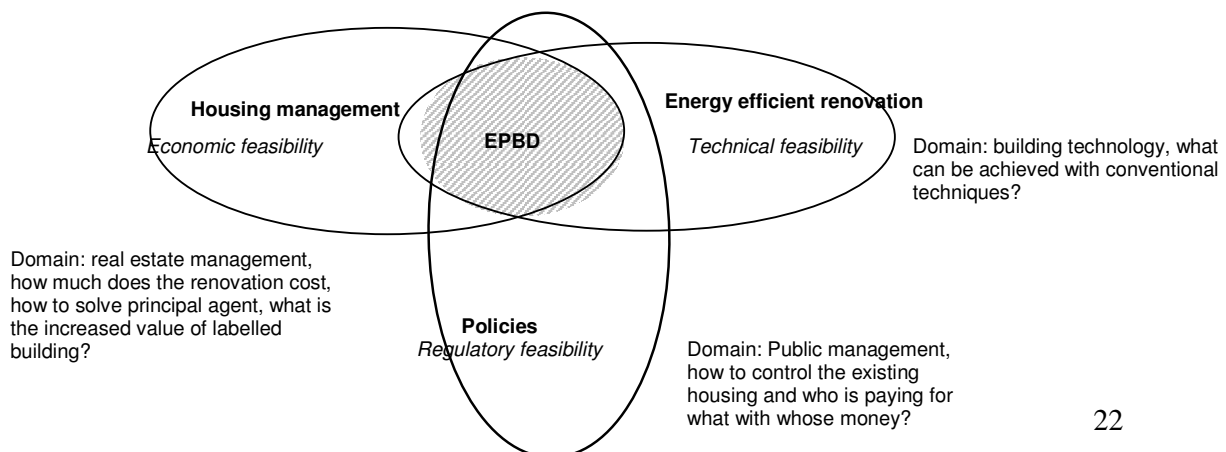
### **Generalisation of the research findings**

A comparison of the implementation of the Directive in the Netherlands, Finland and the UK shows that the implementation of the EPBD varies greatly by national context and is likely to be based on the existing systems. The assumptions made in the analysis apply to the UK. The analysis can, in principle, be adjusted to other European countries, but this requires input data on the characteristics of the national housing stock, tenure and savings achieved with standard energy efficiency measures. National building culture defines compliance with the energy certificate and policy instruments required to support the uptake of the suggested improvements. In Finland, for example, construction practice usually complies with building regulations so more effective results can be expected with less policy measures.

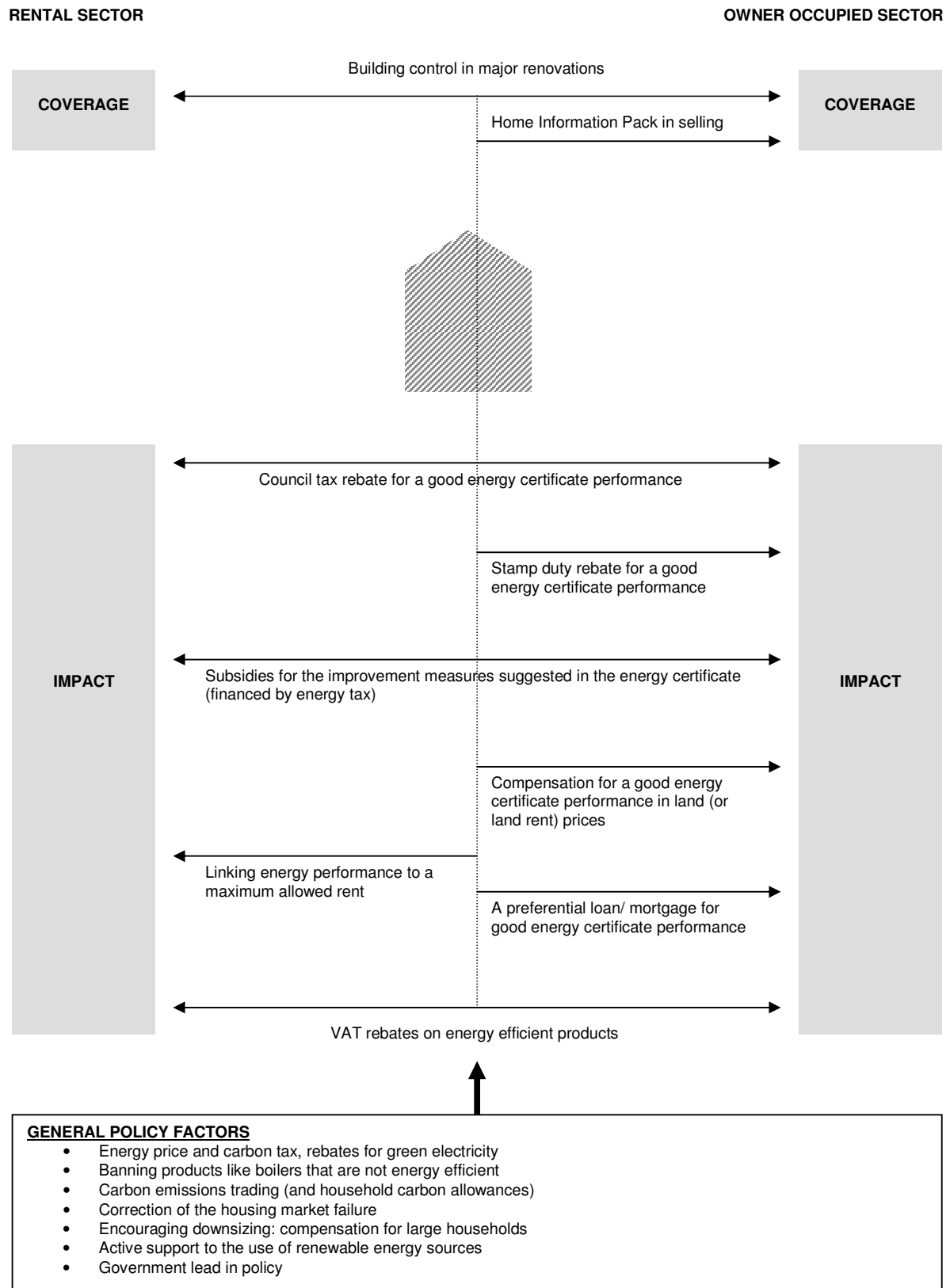
### **Future development of the EPBD**

The Directive is likely to alter in the future in order to motivate continuous development in the existing housing stock. Further development of the EPBD will be linked to post-Kyoto climate strategies, development of the other European Directives and more general policies for sustainable building at European and national levels determining a mandatory or voluntary policy approach. Article 5 on renewable energy sources, now suggestive and accounting for large projects only, may gain importance in the future. If building products like windows or boilers were rated according to the energy certificate system as well, it could make it easier for consumers to choose energy efficient products in the market. Whatever the direction, for the investor's security, the implementation and future directions of the EPBD should be clearer than it is now in order to attract investment and motivate research and development. It should be considered, however, that the EPBD interacts with economic, technical and policy domains and in order to make the improvements feasible, the Directive and the supporting policy instruments have to take all these aspects into consideration. This is illustrated in Figures 8 and 9.

**Figure 8** *Economic, technical and regulatory feasibility in the implementation of the EPBD*



**Figure 9** Supporting policy instruments in compliance and adoption of measures in the implementation of the EPBD in the existing housing stock in the UK by tenure



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### **Energy Performance of Buildings Directive related internet sites**

- BELAS on the creation of cost-effective labelling for the existing buildings, <http://belas.jrc.it/>
- DG Tren, [www.europa.eu.int/comm/energy/demand/index\\_en.htm](http://www.europa.eu.int/comm/energy/demand/index_en.htm)
- DIAG-BRE, Directive Implementation Advisory Group, <http://www.diag.org.uk/>
- ENPER on Energy Performance regulations in Europe and their harmonisation of the EPBD, [www.enper.org](http://www.enper.org)
- EPA-ED, Energy Performance Assessment Method for Existing Dwellings, [www.epa-ed.org](http://www.epa-ed.org)
- EuroACE the European Alliance of Companies for Energy Efficiency in Buildings, [www.euroace.org/bdirective.htm](http://www.euroace.org/bdirective.htm)
- EUROPROSPER, Establishing quality assured and harmonised building energy certification methods, [www.europrosper.org](http://www.europrosper.org)
- FRAMES, Framework innovation for building renovation, including optimising the implementation process of the EPBD and what is the need for complementary incentives in the residential sector, [www.eva.ac.at/frames](http://www.eva.ac.at/frames)
- OPET, the European network for the promotion of energy technologies in the building sector, <http://www.opet-building.net/>

### **Links to other Directives**

- The relevant directives on energy efficiency of the building sector are (Euroace, 2004):
- The indication by labelling and standard product information of the consumption of energy and other resources by household appliances (92/75/EEC)
- Energy labelling of domestic electric fridges, freezers and their combinations (94/2/EEC) and their energy efficiency requirements (96/57/EC), clothes washers (95/12/EC), clothes dryers (95/13/EC), household dishwashers (96/6/EC), household lamps (92/75/EEC), household electric ovens (92/75/EEC), household air-conditioners (92/75/EEC) and energy efficiency requirements for ballasts for fluorescent lighting (2000/55/EC).
- To limit carbon dioxide emissions by improving energy efficiency (SAVE) (93/76/EEC).
- Eco-design (forthcoming)

## Annex 1

### FACT-SHEET: Existing buildings & the directive on the energy performance of buildings

#### A. Which kind of existing buildings does the EU directive on the energy performance of buildings primarily address?

- All existing buildings should have an **Energy Performance Certificate** when sold or rented out.
- Existing buildings subject to major renovation and a total useful floor area more than 1000 m<sup>2</sup>, will have to meet **Energy Performance requirements**.
- Existing buildings with an useful floor area over 1000 m<sup>2</sup>, occupied by public authorities and by institutions providing public services visited by a large number of persons, should **display an Energy Performance Certificate** in a prominent place.

#### B. What is a major renovation ?

Major renovations are cases such as those where the total cost of the renovation related to the building shell and/or energy installations such as heating, hot water supply, air-conditioning, ventilation and lighting is higher than 25 % of the value of the building, excluding the value of the land upon which the building is situated, or those where more than 25 % of the building shell undergoes renovation.

#### C. Which kinds of requirements have to be set for existing buildings referring to point A and B?

For all of these buildings a set of minimum energy performance requirements will be set by the national and/or regional governments in the member states. The official deadline for the definition of this requirements is January 4, 2006. If there is a lack of qualified and/or accredited experts, the member states have an additional period of three years to apply the directive.

The most important requirement is related to the "energy performance of a building" (EPB). This EPB can be expressed as a numeric indicator. The EPB is defined as the amount of energy actually consumed or estimated to meet the different needs associated with a standardised use of the building, which may include, inter alia, heating, hot water heating, cooling, ventilation and lighting.

#### D. What does point C stands for in practice?

The fulfillment of these requirements will include the calculation and assessment of the EPB before and after renovation. Measures in renovation have to improve the energetic quality of existing buildings.

#### E. Which kinds of energy saving measures are thinkable?

Possible measures in existing buildings include insulation of the building shell; improving technical systems in heating, cooling, and/or ventilation of the building; installation of energy supply systems using renewable energy resources (solar, biomass, ...); and/or improving the quality of the energy consumption system(s) of the building (e.g. lighting). The effects on different measures have to be discussed and communicated between experts (e.g. consultants, building owners) and users (e.g. dwelling owners, tenants). Therefore the "Energy Performance Certificate" will be the most important instrument.

#### F. What is an Energy Performance Certificate (EPC) that should be issued ?

An energy performance certificate is a certificate on the energy performance of a building. It includes the EPB expressed in a numeric indicator and reference values (e.g. current legal standards and benchmarks) in order to make it possible for consumers to compare and assess the energy performance of the building. The certificate shall be accompanied by recommendations for the cost-effective improvement of the energy performance.

For each building, which should be sold or rented out, an EPC has to be available to the owner or by the owner to the prospective buyer or tenant. The validity of the certificate shall not exceed 10 years.

#### G. Are there any special measures designed on boilers, and/or air-condition systems in existing buildings?

**Boilers:** regular inspections (fired with non-renewable resources) for boilers with an effective output rate of 20kW to 100 kW; output rate >100 kW – inspection every two years (gas: max. four years). For heating installations with boilers of an effective rated output of more than 20 kW which are older than 15 years, the Member States shall lay down the necessary measures to establish a one-off inspection of the whole heating installation (including assessment of the boiler efficiency, boiler size,...). On the basis of this inspection, the experts shall provide advice to the users on the replacement of the boilers, other modifications to the heating system and on alternative solutions.

**Air-condition systems:** regular inspection of systems of an effective rated output of more than 12 kW. This inspection (including assessment of the air-conditioning efficiency and the sizing) shall be provided to the users on possible improvement or replacement of the air-conditioning system and on alternative solutions.

Source: Lechner, R., 2004.