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PROPOSAL FOR A RECAST OF THE ENERGY PERFORMANCE OF BUILDINGS DIRECTIVE (2002/91/EC)

IMPACT ASSESSMENT

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ANNEX IV

Preparatory Study for the Recasting of the Energy Performance of Buildings Directive (EPBD) 2002/91/EC
Under DG TREN Framework Contract

This document should be used as background information. The content of this document remains under the sole responsibility of the consultant.

Preparatory Study for the Recasting of the Energy Performance of Buildings Directive (EPBD) 2002/91/EC

Under DG TREN Framework Contract
TREN/A2/143-2007

Final Report

10 October 2008



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1 Introduction

This report presents the findings of a consortium of partners led by ECORYS NL on the Preparatory Study for the Recasting of the Energy Performance of Buildings Directive (EPBD) 2002/91/EC. The consortium was composed of Ecorys NL, Ecofys and BioIntelligence Service. The structure of this breaks down into four main chapters:

- Chapter 2 focuses on different threshold options for energy efficiency in buildings. In addition chapter 2 touches on energy performance requirements;
- Chapter 3 focuses on options relating to energy performance certificates;
- Chapter 4 analyzes options related to the inspection of boilers and air-conditioning systems;
- Chapter 5 delves into energy performance requirement options in buildings. As mentioned above, these issues are also tackled in chapter 2 (see section 2.3)

Given that sections of the following report were undertaken separately by different consortium partners, and that each section of this report is a stand alone product, each chapter is presented in its original form done by each consortium partner so as to provide the clearest presentation for interpretation by DG TREN.

2 Effects from different options for the EPBD Information provided for Impact assessment.

2.1 Background and methodology

The information described in the following chapters was assessed within the context of the preparatory study for the recasting of the EPBD under DG TREN framework contract TREN/A2/143-2007. The content was prepared by use of the Ecofys built environment analysis model (BEAM).

BEAM – Built environment analysis model

Ecofys GmbH developed over the last years a model for the European building stock (covering the EU-15 and Eastern European countries), called BEAM (Built Environment Analysis Model). Results of the model are energy demand, CO2-emissions and energy costs for space heating in the built environment which then can be presented for different types of buildings, building ages, climate zones etc. Input to the model calculation is a database containing the EU-27 building stock distinguished by climatic regions, building type/size, building age, insulation level, energy supply, energy carrier, energy costs and emission factors. This can be applied in a scenario tool used for calculating the development over time of the building stock as a function of demolition rate, new building activity, renovation and energy-efficiency measures in retrofits.

The complexity of the building stock had to be simplified by examining five standard buildings with eight insulation standards, which are assigned to building age and renovation status. Furthermore, 6 climatic regions (3 for Western and Central Europe, 3 for Eastern Europe) were distinguished for the calculation of the energy demand for space heating. For these building types the energy demand and CO2 -emissions from space heating were calculated according to the principles of the European Norm EN 832. The resulting model describes the building stock in a complex but still simplified manner. This has to be taken into account when evaluating the accuracy of the results. However, the results provide safe indicators for the size of energy-saving potentials. For the modelling of the European building stock 6 standard houses can be taken into account:

Model house 1: Two-storey terrace-end-house (living area: 120m2);
Model house 2: small apartment house (200 – 500 m²);
Model house 3: medium apartment house (500-1,000m²)
Model house 4: large apartment house (larger than 1,000m²)
Small office building (<500m²), medium (500-1,000m²) and large office building (> 1,000m²)

The building stock is subdivided into three building age groups, which differ substantially due to the respective national or regional regulations and the insulation standard connected to them.

Buildings erected before 1975 (subdivided into buildings that have already been energetically improved and buildings still in their initial condition).
Buildings erected between 1975 and 1990.
Buildings erected after 1990.

According to climatic zone and building age groups, different insulation standards and their respective U-values can be applied. For the different model buildings which were subdivided according to building type, building age group, insulation standard and weather condition, the respective saving potentials can be determined. In order to calculate CO2-emissions, the average annual efficiency of heating systems is taken into account for each energy carrier depending whether it is an old or new system and CO2 emission-factors of the global-emissions-model GEMIS are applied. The factors used describe the direct CO2-emissions from fuel combustion. This is in line with approaches according IPCC/Kyoto, where CO2-emissions (and other greenhouse gases) during extraction, conversion, transport etc. of the fuels are assigned to the energy supply sector. A difference was made for electricity, where emissions for electricity production are taken into account. The BEAM-tool was developed and used e.g. in the following projects:

U-values for better energy performance of buildings. Study for European mineral wool association EURIMA, Boermans, Petersdorff et al., November 2007.

Energy efficiency in the existing building stock in the BEEN countries – Synopsis providing overview on energy consumption and saving potentials in the BSR building stock. Study in the framework of the Baltic energy efficiency network (BEEN) for German Federal Ministry of Transport, Building and Urban Affairs, Petersdorff 2007

HVAC-market in Europe – energy demand and supply systems, for European manufacturer, Thomas Boermans et al., 2007

Cost-Effective Climate Protection in the Building Stock of the New EU Member States
Report for EURIMA-European insulation manufacturers association
Carsten Petersdorff, Thomas Boermans et al. 2005

Cost-Effective Climate Protection in the EU Building Stock
Report for EURIMA-European insulation manufacturers association
Carsten Petersdorff, Thomas Boermans et al. 2005

Mitigation of CO2-emissions from the building stock –
beyond the EU directive on the energy performance of buildings
Report for EURIMA and EuroACE, Carsten Petersdorff, Thomas Boermans et al. 2004

The input of the model and methodology used is based on previous studies on the EU15 and Eastern Europe (Ecofys 2004, 2005a and 2005b) and is described in full in the mentioned reports.

However during the current analysis on possible impacts from a revised EPBD, the following adaptations and updates to the model where made.

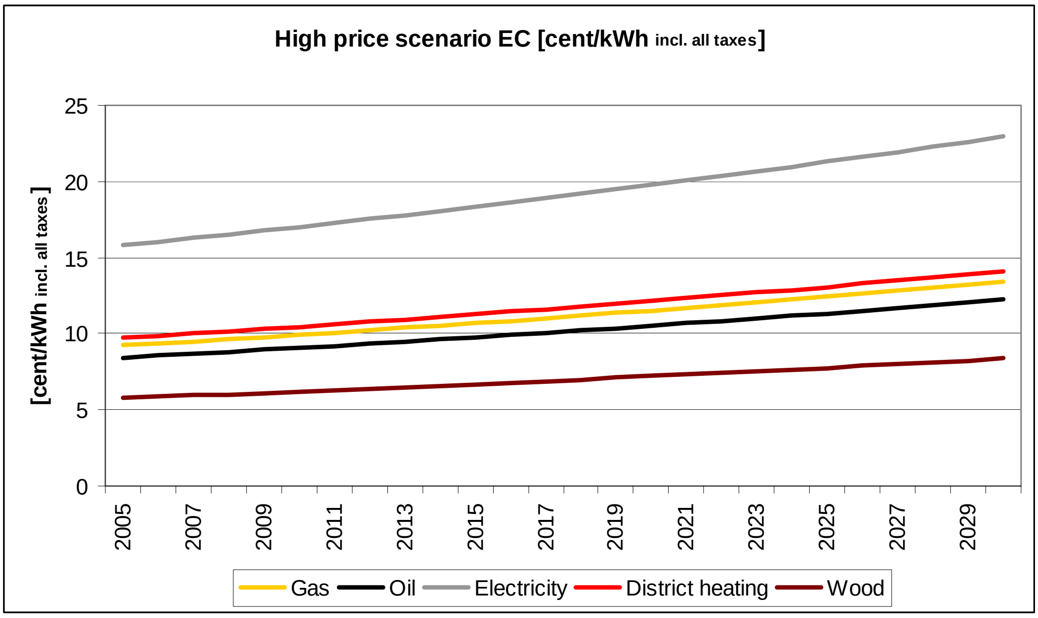
Scope enlarged
In previous studies for EURIMA (Ecofys 2004, 2005a and 2005b), the building stocks of the EU15 and NEW8 countries have been assessed. For this impact assessment, the scope of the countries was enlarged to the EU27.

Additional division in size classes
The category 200 – 1.000 m², as assessed in above mentioned reports, was split into size classes 200-500 and 500-1.000m² on basis of information derived from several country statistics as far as available.

Update of investment costs
The increase in construction prices of the last years was taken into account by use of price indices for the construction sector supplied by EUROSTAT. The investment costs reflect the average situation in the building stock (differentiated by climate zones) regarding insulation of external surfaces (facade, roof, ground floor), replacement of windows and upgrade of heating systems, depending on the targeted efficiency level.

Update of price scenario
The price scenarios used in studies Ecofys 2004 and 2005 was updated to the high price scenario supplied by the EC (55$ per barrel oil in 2005, 100$ in 2020 and 119 $ in 2030 in year 2005 prices which results at an average of approximately 97$ per barrel for the period 2009-2030). The dollar exchange rate is assumed to equal 1.25 $/EURO during the whole time horizon). This results in the following scenario:

Figure 2.1 Price scenario used for the impact assessment



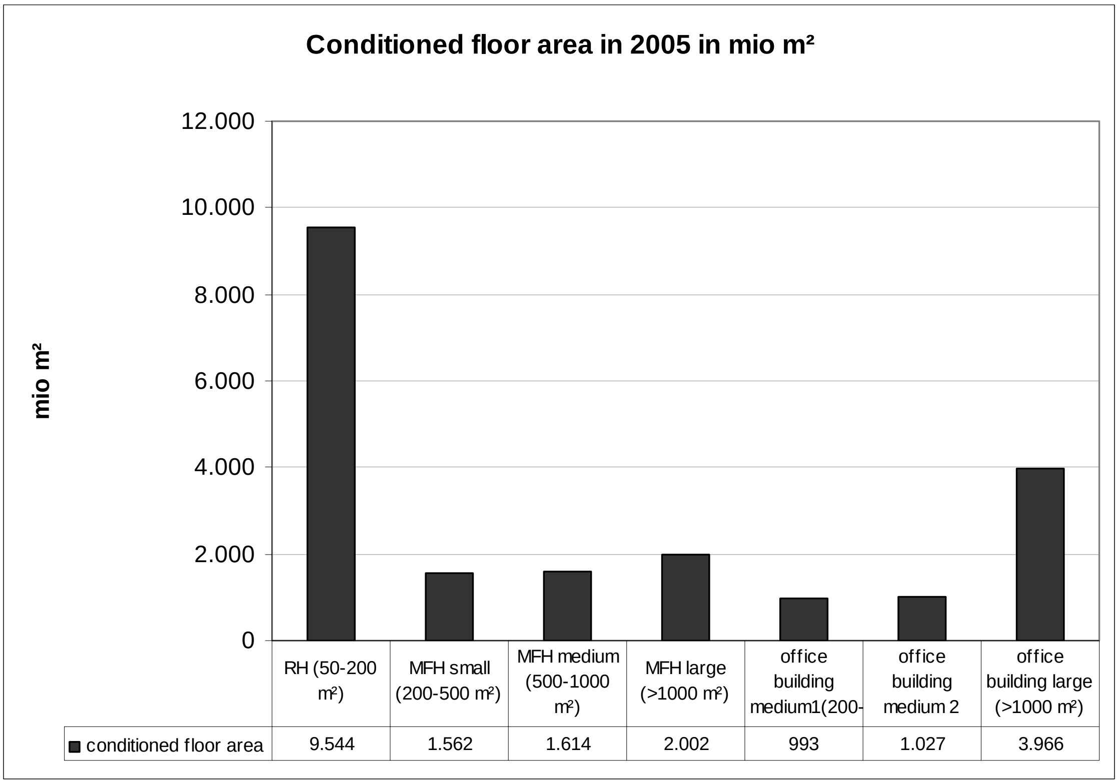
Adaption to PRIMES data
Input data regarding end energy consumption of residential and tertiary sector were adapted to data supplied from PRIMES for 2005.

2.2 Description of building stock

2.2.1 Current building stock EU27

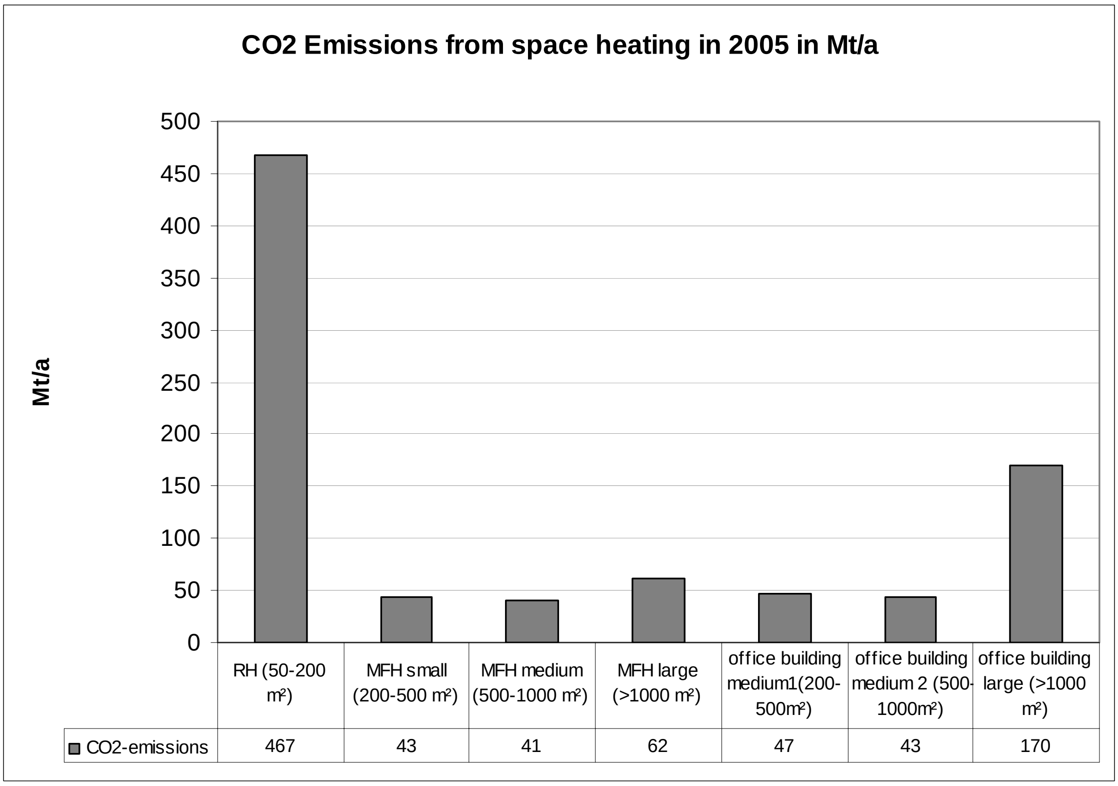
The total number of dwellings in the EU 2007 was 207 million in 2005 according to PRIMES. The following graph describes the conditioned floor area of different building types and size classes (residential and non-residential) as used in the BEAM model.

Figure 2.2 Areas residential and non-residential buildings in the EU27 in 2005



The CO_2-emissions from space heating of the stock in 2005 are described in the following figure.

Figure 2.3 CO_2-emissions from space heating, residential and non-residential buildings in the EU27 in 2005



2.2.2 Development of the building stock

The building stock develops over time due to new building activities, demolition and retrofit. The according changes can be described as % rates for the respective changes in the building stock per year related to the overall stock. According rates vary significantly in different countries. The following table described the average rates in two clusters, as used in the BEAM model.

Table 2.1 Development rates of the EU27 building stock

	EU15	Eastern EU
New building rate	1%	1%
Demolition rate	0,5%	0,5%
Retrofit rate of buildings not affected by the current EPBD	0,7%	0,4%
Retrofit rate of buildings affected by the current EPBD	1,8%	1,0%

The model also takes into account that a share of the existing stock is subject to limitations regarding energy efficient refurbished due to ornamental facades etc. The share of these buildings was assumed with 15% (EU15) respective 10% (Eastern EU) of the total existing stock.

2.3 The assessed scenarios

During the impact assessment, 3 groups of scenarios have been assessed with the Ecofys Built Environment Analysis Model (BEAM).

Scenarios on different threshold options:
The scenarios on different threshold options assume different size classes to be included in the scope of the directive, esp. regarding retrofit requirements.

Table 2.2 Scenarios threshold options

Scenario	Description
Original EPBD >1000 m²	Original EPBD as from 2006 with 1.000 m² threshold
EPBD >500 m²	Original EPBD in 2006, threshold of 500 m² as from 2009
EPBD >200 m²	Original EPBD in 2006, threshold of 200 m² as from 2009
EPBD >50 m²	Original EPBD in 2006, threshold of 50 m² as from 2009

Scenarios with higher retrofit rates due to improved certification and compliance
The scenarios assume a higher retrofit rate of 2,5% per year to be achieved by improved certifications schemes and compliance measures.

Table 2.3 Scenarios high retrofit rate

Scenario	Description
EPBD >500 m², high retrofit	As according scenario above, with improved retrofit rate
EPBD >200 m², high retrofit	As according scenario above, with improved retrofit rate
EPBD >50 m², high retrofit	As according scenario above, with improved retrofit rate

Scenarios with improved thermal standards due to cost optimal requirements
The scenarios assume that a benchmark system and/or methodology to assess cost optimal energy performance requirements can lead to cost optimal requirements for buildings in the future.

Such an effect has been calculated by assuming cost optimal U-values (as assessed for a 100$ per barrel oil scenario during the project “U-values for better energy performance of buildings” for EURIMA, see Ecofys 2007) to be applied in retrofit actions and new buildings. The values assumed in the different scenarios are described in the following table:

Table 2.4 Overview U-values

U-values [W/m²K] assumed for EPBD implementation (new buildings and retrofit)						
	EU 15			EU Eastern		
	north	moderate	south	north	moderate	South
roof	0,13	0,23	0,43	0,20	0,23	0,23
wall	0,17	0,38	0,48	0,26	0,18	0,35
floor	0,17	0,41	0,48	0,29	0,60	0,46
Cost optimum requirements 100$ per barrel scenario (new buildings and retrofit)						
	EU 15			EU Eastern		
	north	moderate	south	north	moderate	South
roof	0,12	0,14	0,20	0,15	0,16	0,18
wall	0,15	0,18	0,26	0,17	0,18	0,20
floor	0,18	0,22	0,58	0,21	0,23	0,26

Cost optimal requirements on building level would additionally affect energy supply systems, windows, ventilation systems with heat recovery, improved regulation and other energy efficiency measures. Cost optimal requirements for these parameters and/or packages of measures have not been assessed yet on EU level (this would be the results of an EU benchmarking system). Therefore the current assessment on cost optimal requirements is limited to thermal insulation which however represents one of the crucial measures for energy efficient buildings.

Table 2.5 Scenarios improved thermal standards

Scenario	Description
EPBD >500 m², high retrofit, low energy	As according scenario above with improved thermal standards
EPBD >200 m², high retrofit, low energy	As according scenario above with improved thermal standards
EPBD >50 m², high retrofit, low energy	As according scenario above with improved thermal standards

The BEAM model calculates the theoretical potential of these options regarding end-energy and CO_2-emissions, investments and energy costs for space heating. According results are described in tables and graphs of the following chapters. It can be assumed that additional effects of the EPBD and possible revisions are also achieved for household electricity, domestic hot water and space cooling. However these effects can be considered as minor in comparison to the effects on space-heating, which puts the results described hereinafter on the save side.

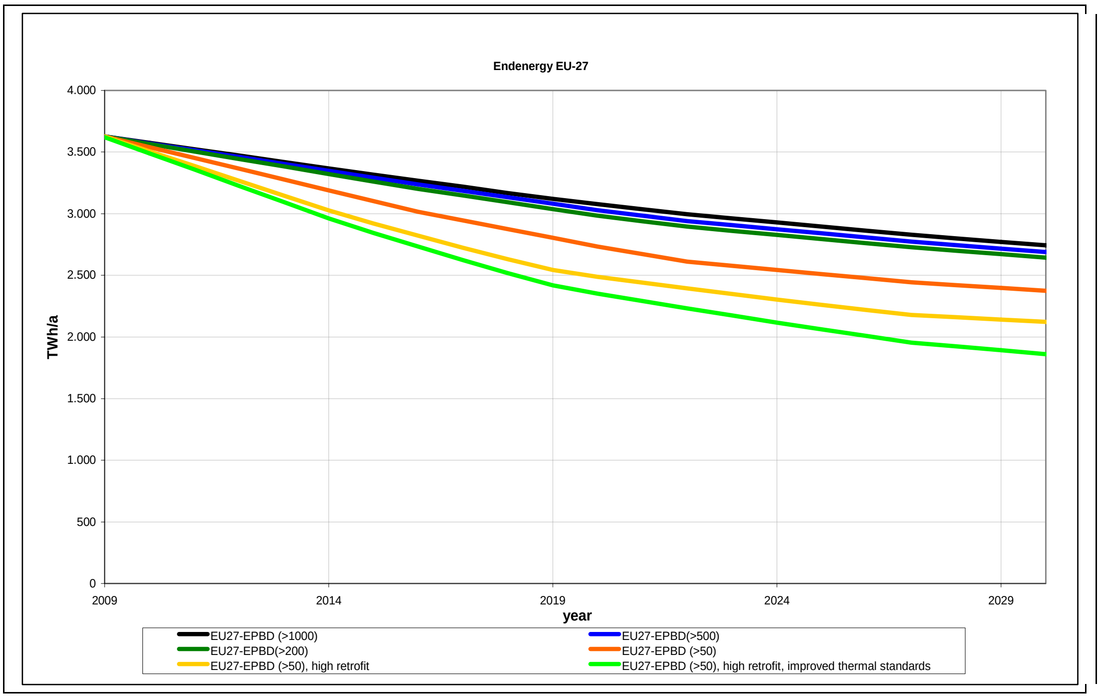
Several countries do not have (or abolished) the threshold of 1.000 m² in case of retrofits, such as Germany, Denmark, Portugal, Finland, Czech Republic, Latvia etc. These countries represent ca. 1/3 of the EU27 emissions from the household and tertiary sector. Accordingly the additional savings for the Scenarios with a lowered threshold are actually reduced. This effect has been estimated in a simplified approach. According results for the threshold scenarios are described below the figures on the theoretical potential.

Please note:
For the scenarios concerning higher retrofit rates and improved thermal requirements, only the results that take into account that some countries already did abolish the threshold are described in the following chapters.

2.4 Environmental effects

The following graph shows an overview of the effects of the scenarios in terms of total end energy consumed in the EU 27. To arrive at primary energy, the value can be multiplied with an average primary energy factor of 1,35[1].

Figure 2.4 End energy consumption of different scenarios



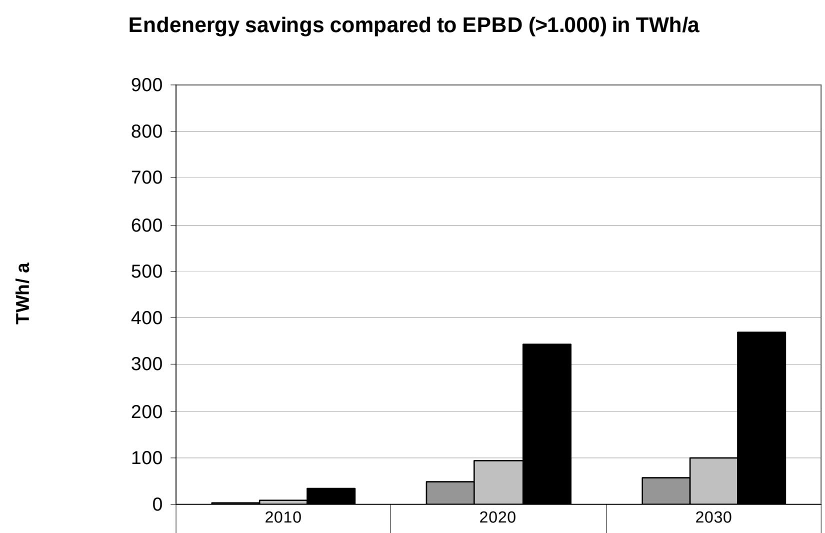
It is visible, that lowering the thresholds and an increase of the retrofit rate result in considerable savings. Additional effects can be achieved by improved of thermal standards.

The effects on end energy consumption and related CO_2-emissions in the EU27 compared to the current EPBD (> 1000 m²) in the years 2010, 2020 and 2030 are described in the following graphs.

[1] Calculated on basis of the assumed energy mix and data from GEMIS.

2.4.1 Effect of different threshold options

Figure 2.5 End energy savings compared to current EPBD from different threshold options

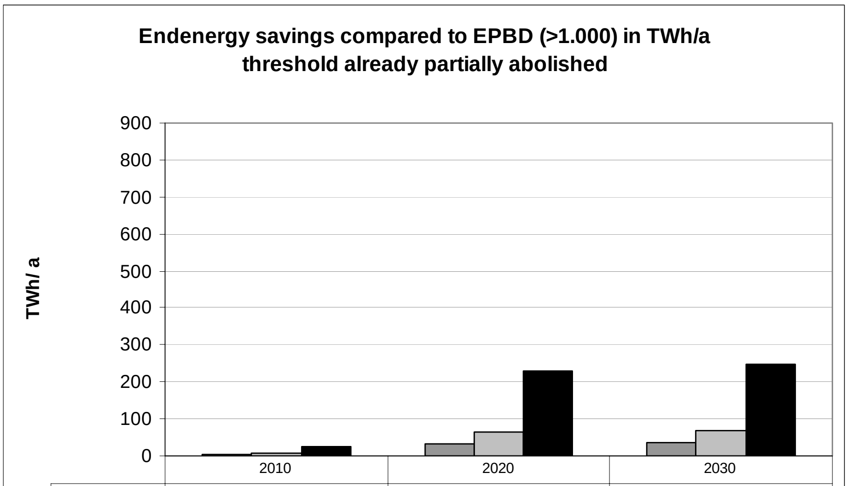


	2010	2020	2030
EPBD >500 m²	4	50	56
EPBD >200 m²	9	94	100
EPBD >50 m²	35	344	369

The effects of lowering thresholds are clearly visible and also increase during the years with the number of buildings refurbished.

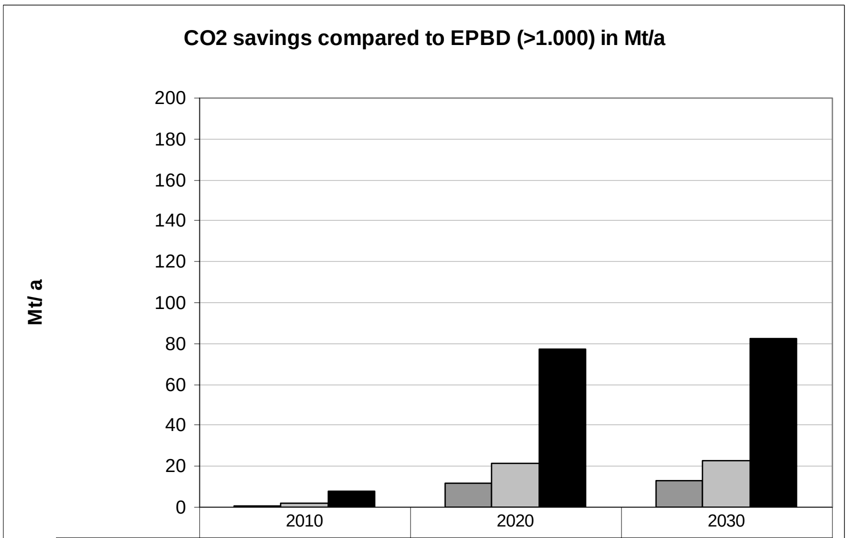
When looking at the situation in 2030 compared to 2020, the gap between the current EPBD and the assessed scenarios does not develop that fast any more. This is caused by the fact, that by then the eldest part of the building stock of the building size classes that are included in the directive has been renovated, and further renovations deal with buildings that have been already built at higher standards, e.g. in the 80s or 90s whereas the scenario of the current EPBD (only affecting regarding retrofit buildings beyond 1000 m²) is mainly still dealing with elder buildings that show higher savings potentials. However when looking at Figure 2.4, it is clearly visible which option can be preferred to reduce the total energy demand in the EU27.

Figure 2.6 End energy savings compared to current EPBD from different threshold options, threshold already partially abolished



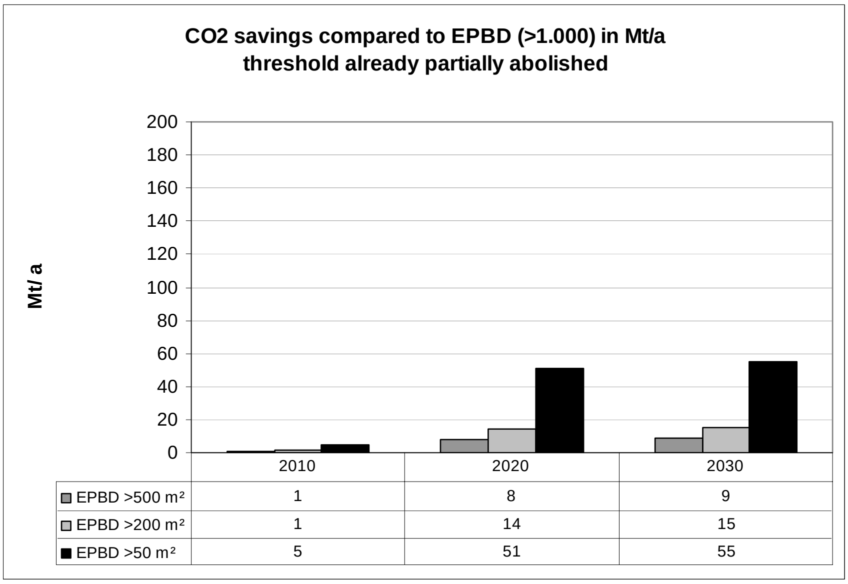
	2010	2020	2030
EPBD >500 m²	3	33	37
EPBD >200 m²	6	63	66
EPBD >50 m²	23	230	246

Figure 2.7 CO_2 savings compared to current EPBD from different threshold options



	2010	2020	2030
EPBD >500 m²	1	12	13
EPBD >200 m²	2	22	23
EPBD >50 m²	8	77	82

Figure 2.8 CO_2 savings compared to current EPBD from different threshold options, threshold already partially abolished

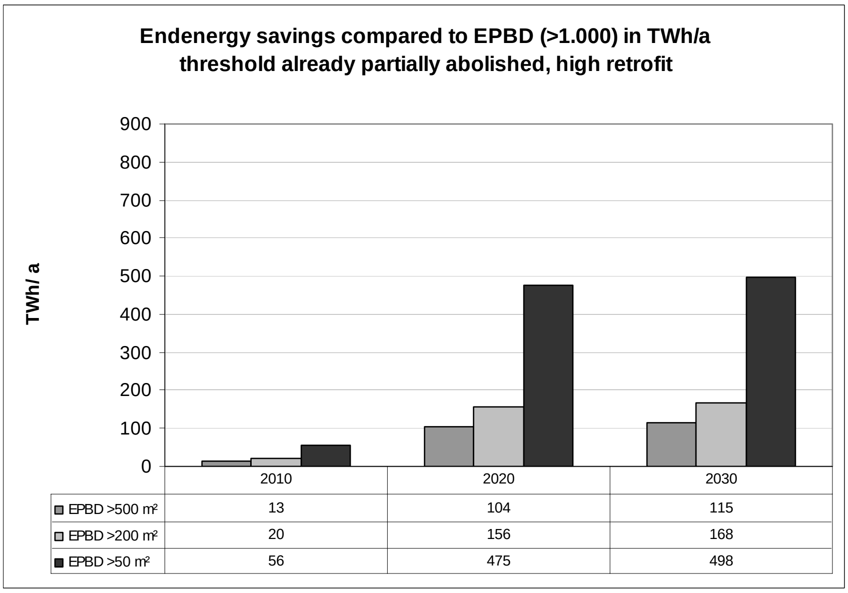


	2010	2020	2030
EPBD >500 m²	1	8	9
EPBD >200 m²	1	14	15
EPBD >50 m²	5	51	55

2.4.2 Effect of high retrofit rates due to improved certification and compliance

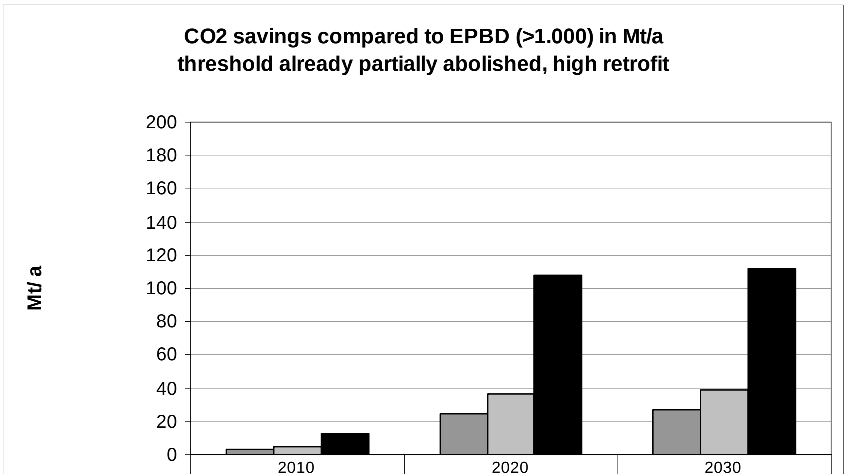
The effect of higher retrofit rates is described in the following graphs.

Figure 2.9 End energy savings compared to current EPBD from higher retrofit rates, threshold already partially abolished



	2010	2020	2030
EPBD >500 m²	13	104	115
EPBD >200 m²	20	156	168
EPBD >50 m²	56	475	498

Figure 2.10 CO_2 savings compared to current EPBD from higher retrofit rates, threshold already partially abolished

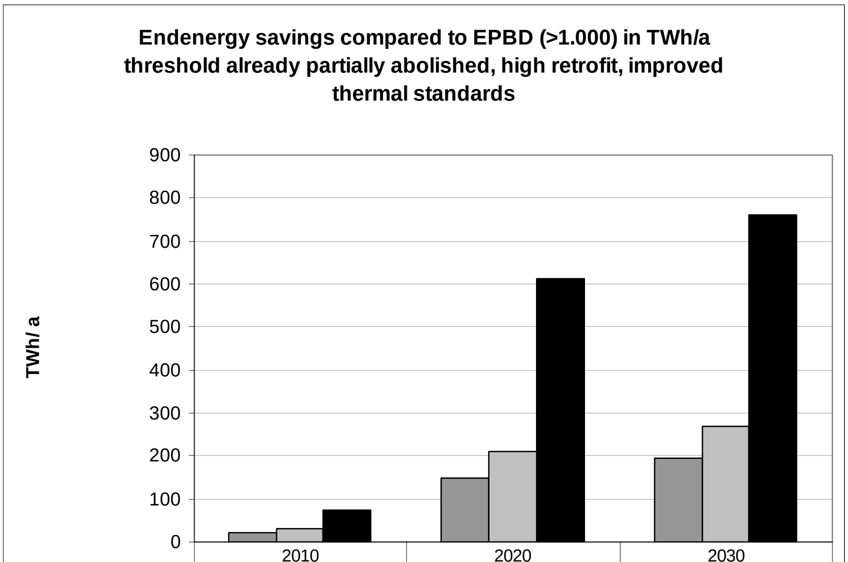


	2010	2020	2030
EPBD >500 m²	3	25	27
EPBD >200 m²	5	36	39
EPBD >50 m²	13	108	112

2.4.3 Effect of improved thermal standards due to cost optimal requirements

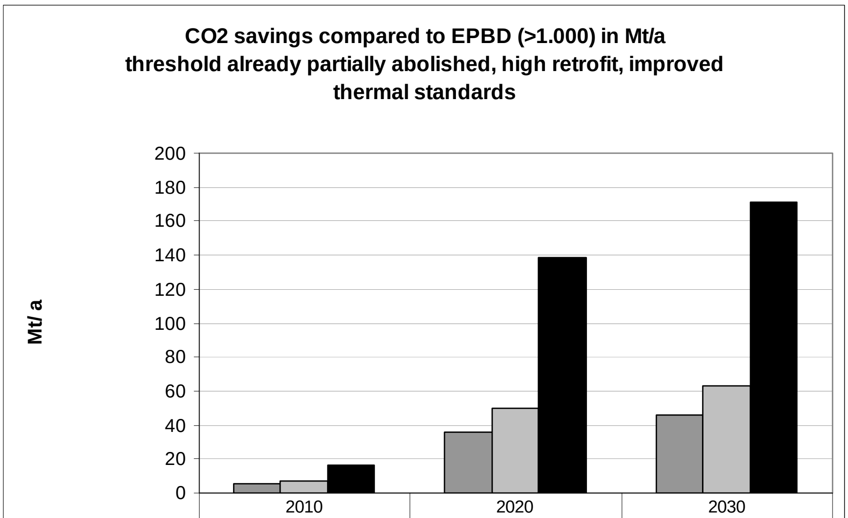
The effect of cost optimal U-values is described in the following graphs.

Figure 2.11 End energy savings compared to current EPBD from higher retrofit rates and improved thermal standards, threshold already partially abolished



	2010	2020	2030
EPBD >500 m²	22	148	194
EPBD >200 m²	30	211	270
EPBD >50 m²	73	612	759

Figure 2.12 CO_2 savings compared to current EPBD from higher retrofit rates and improved thermal standards, threshold already partially abolished



	2010	2020	2030
EPBD >500 m²	5	35	46
EPBD >200 m²	7	50	63
EPBD >50 m²	17	139	171

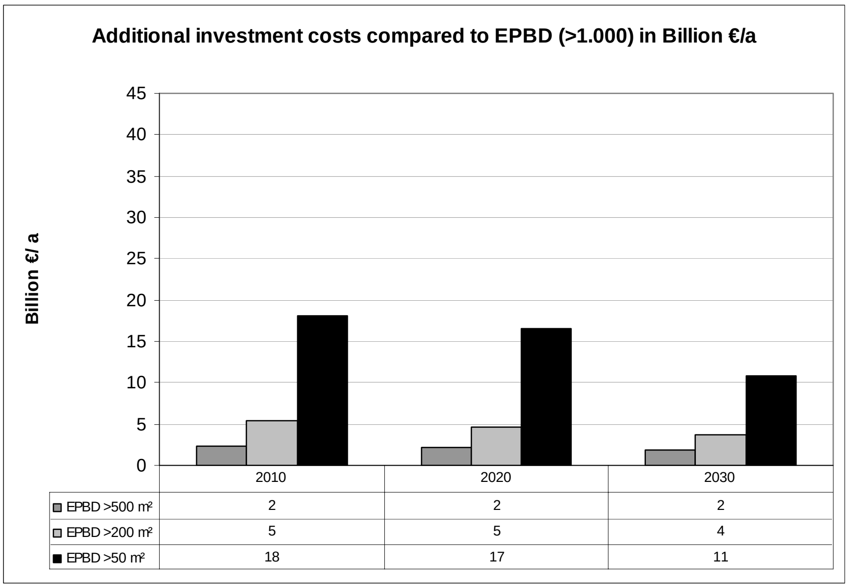
2.5 Economic effects

The effects in the EU27 on additional investments (additional energy related costs of refurbishment measures that exceed the costs of non-energy related maintenance[2]), according annual additional investment costs (annual costs for interest and amortization of these investments) energy costs savings compared to the business as usual scenario are described in the following tables and graphs.

[2] The additional energy related investments can be taken into account if retrofit measures can be coupled to anyway due renovation measures. Given the assumed retrofit rates, this is realistic and highly recommended. If energy efficiency measures cannot be coupled to maintenance measures, the total costs of the measure would need to be taken into account.

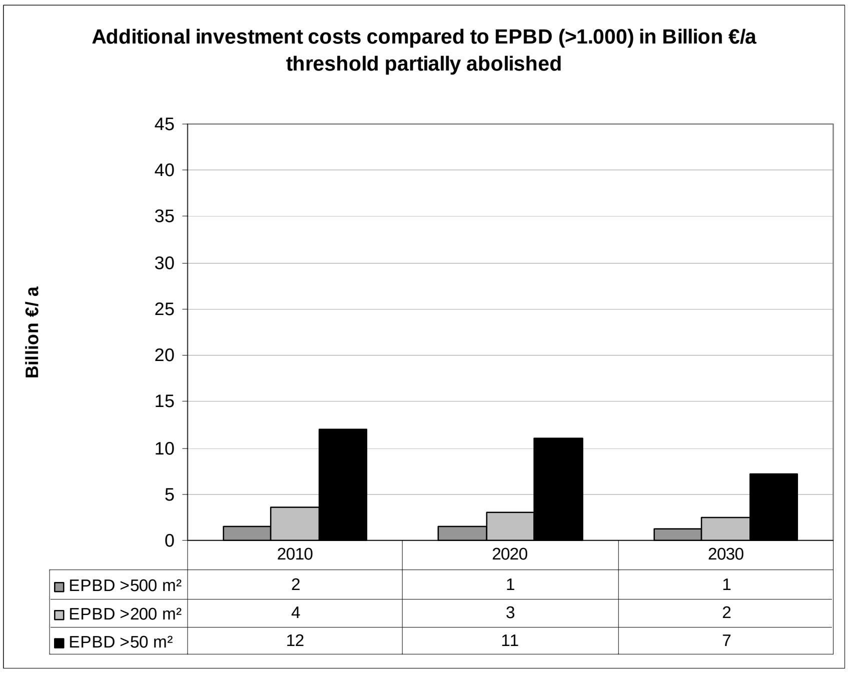
2.5.1 Effect of different threshold options

Figure 2.13 Additional investment costs compared to current EPBD from different threshold options



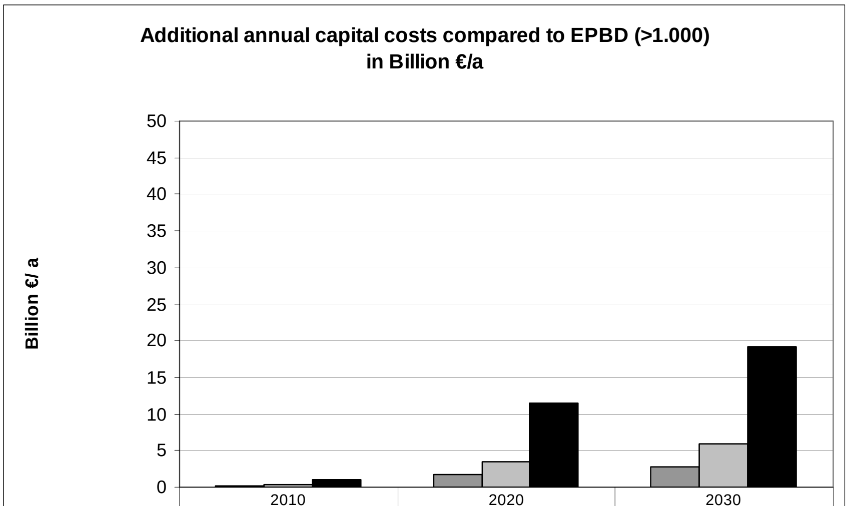
	2010	2020	2030
EPBD >500 m²	2	2	2
EPBD >200 m²	5	5	4
EPBD >50 m²	18	17	11

Figure 2.14 Additional investment costs compared to current EPBD from different threshold options, threshold already partially abolished



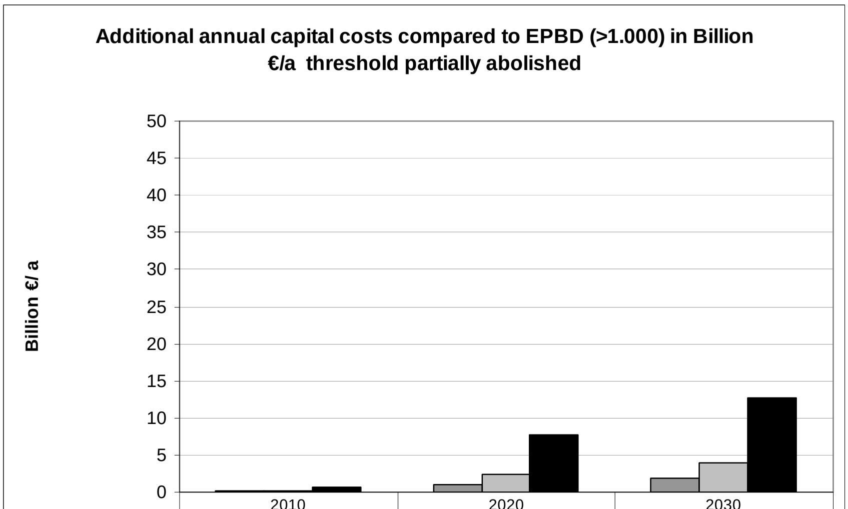
	2010	2020	2030
EPBD >500 m²	2	1	1
EPBD >200 m²	4	3	2
EPBD >50 m²	12	11	7

Figure 2.15 Additional annual capital costs compared to current EPBD from different threshold options



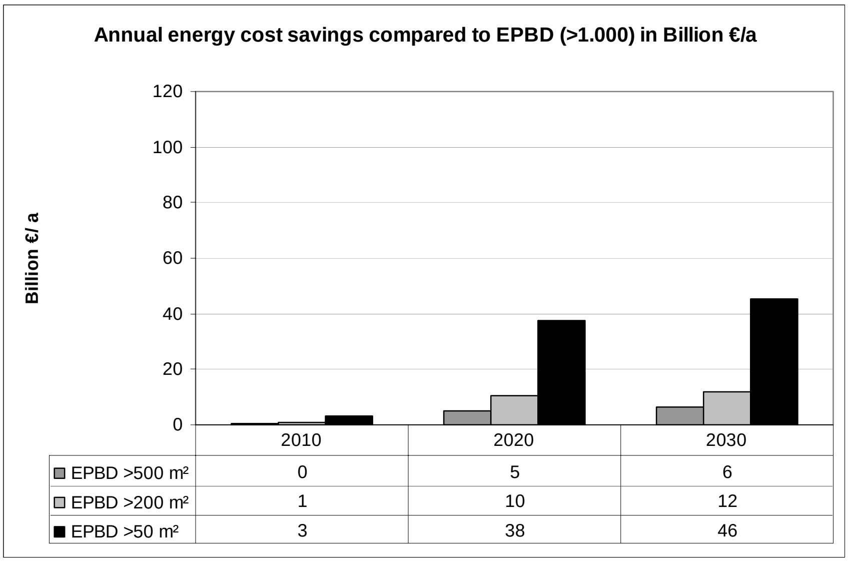
	2010	2020	2030
EPBD >500 m²	0	2	3
EPBD >200 m²	0	4	6
EPBD >50 m²	1	12	19

Figure 2.16 Additional annual capital costs compared to current EPBD from different threshold options, threshold already partially abolished



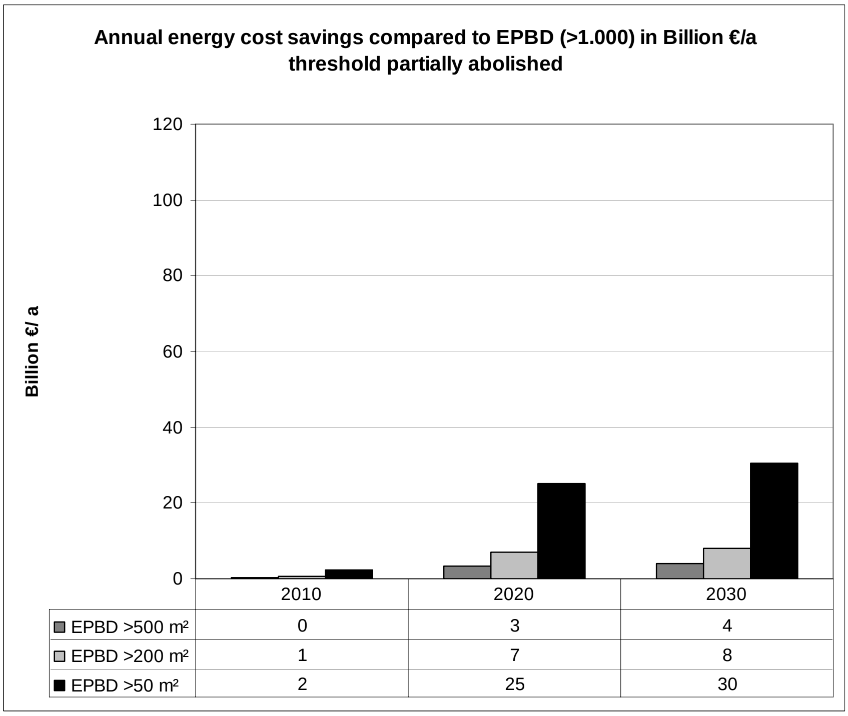
	2010	2020	2030
EPBD >500 m²	0	1	2
EPBD >200 m²	0	2	4
EPBD >50 m²	1	8	13

Figure 2.17 Annual energy cost savings compared to current EPBD from different threshold options



	2010	2020	2030
EPBD >500 m²	0	5	6
EPBD >200 m²	1	10	12
EPBD >50 m²	3	38	46

Figure 2.18 Annual energy cost savings compared to current EPBD from different threshold options, threshold already partially abolished



	2010	2020	2030
EPBD >500 m²	0	3	4
EPBD >200 m²	1	7	8
EPBD >50 m²	2	25	30

By subtracting annual additional investment costs from energy cost savings, the annual profit can be calculated. A positive value means that energy costs savings exceed annual investment costs in the framework of the assumed investments, interest rates and energy price development.

Figure 2.19 Total annual profit compared to current EPBD from different threshold options

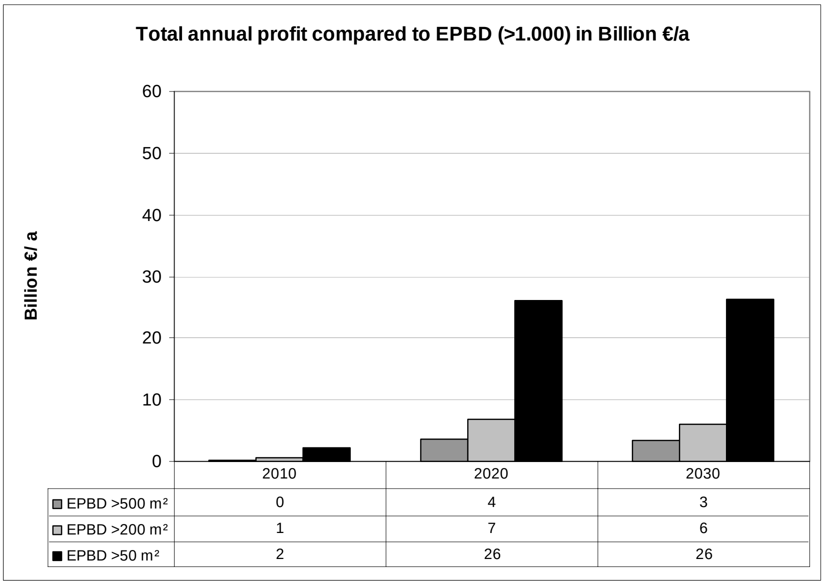
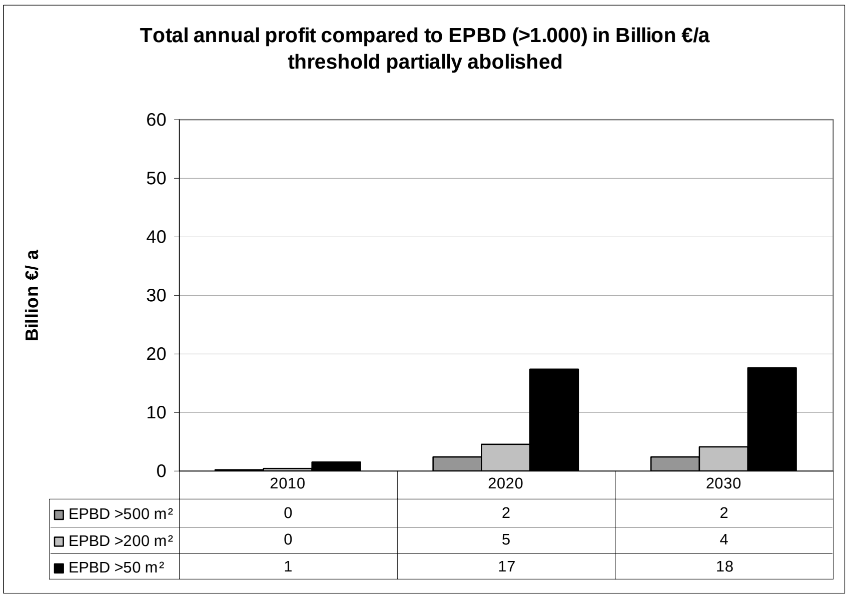


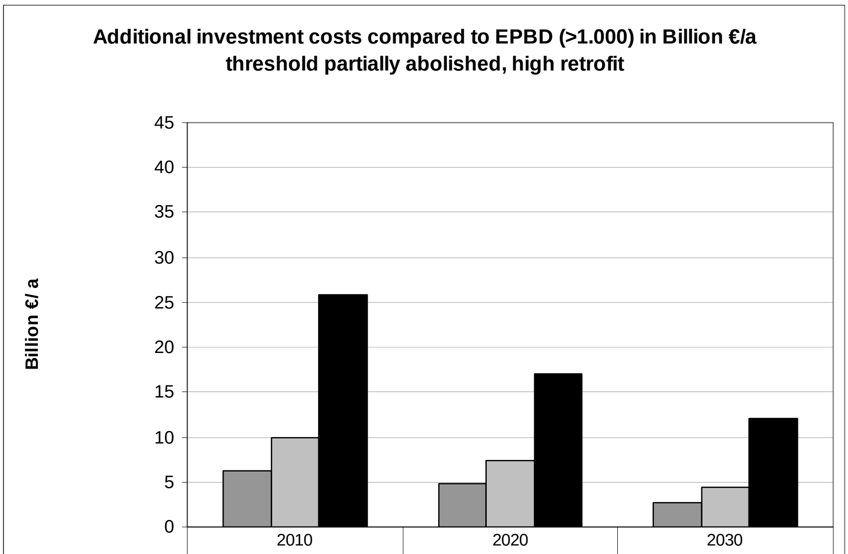
Figure 2.20 Total annual profit compared to current EPBD from different threshold options, threshold already partially abolished



2.5.2 Effect of high retrofit rates due to improved certification and compliance

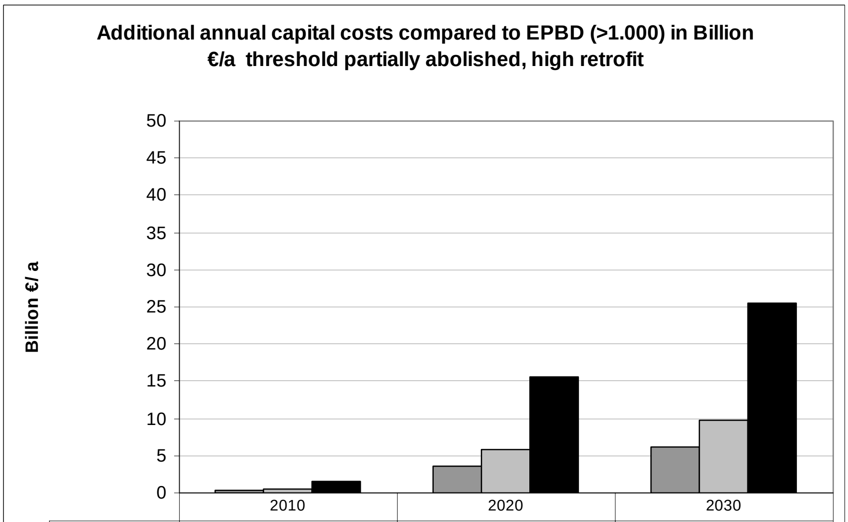
The effect of higher retrofit rates is described in the following graphs.

Figure 2.21 Additional investment costs compared to current EPBD from higher retrofit rates, threshold already partially abolished



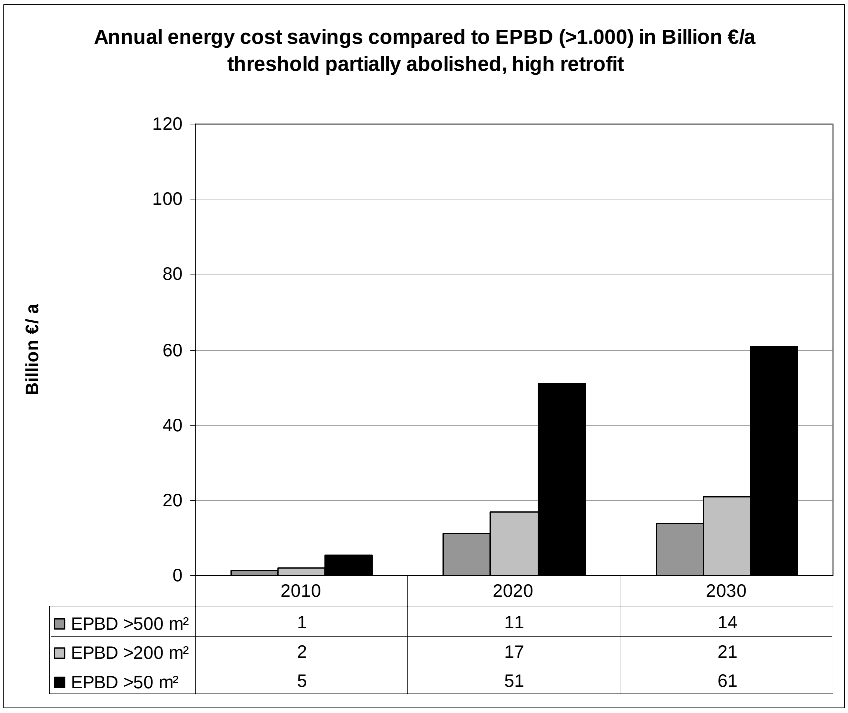
	2010	2020	2030
EPBD >500 m²	6	5	3
EPBD >200 m²	10	7	4
EPBD >50 m²	26	17	12

Figure 2.22 Additional annual capital costs compared to current EPBD from higher retrofit rates, threshold already partially abolished



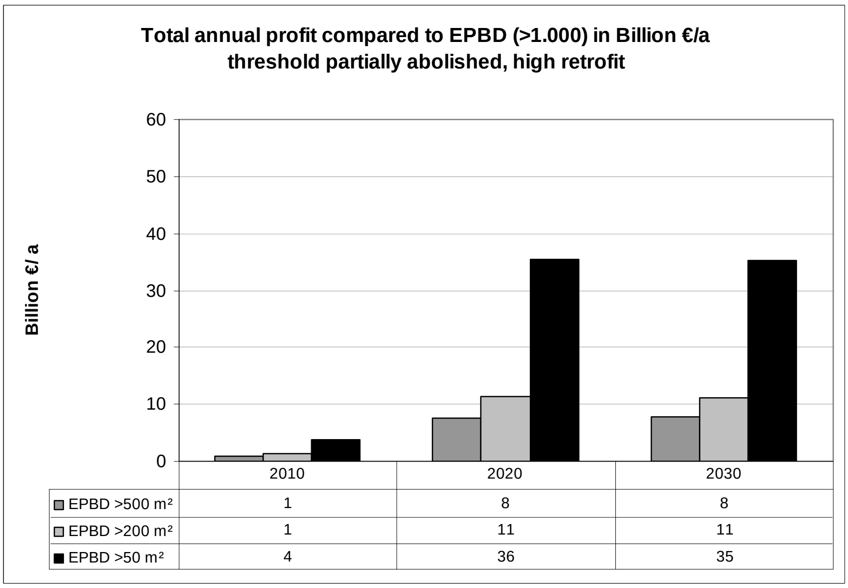
	2010	2020	2030
EPBD >500 m²	0	4	6
EPBD >200 m²	1	6	10
EPBD >50 m²	2	16	26

Figure 2.23 Annual energy cost savings compared to current EPBD from higher retrofit rates, threshold already partially abolished



	2010	2020	2030
EPBD >500 m²	1	11	14
EPBD >200 m²	2	17	21
EPBD >50 m²	5	51	61

Figure 2.24 Total annual profit compared to current EPBD from higher retrofit rates, threshold already partially abolished

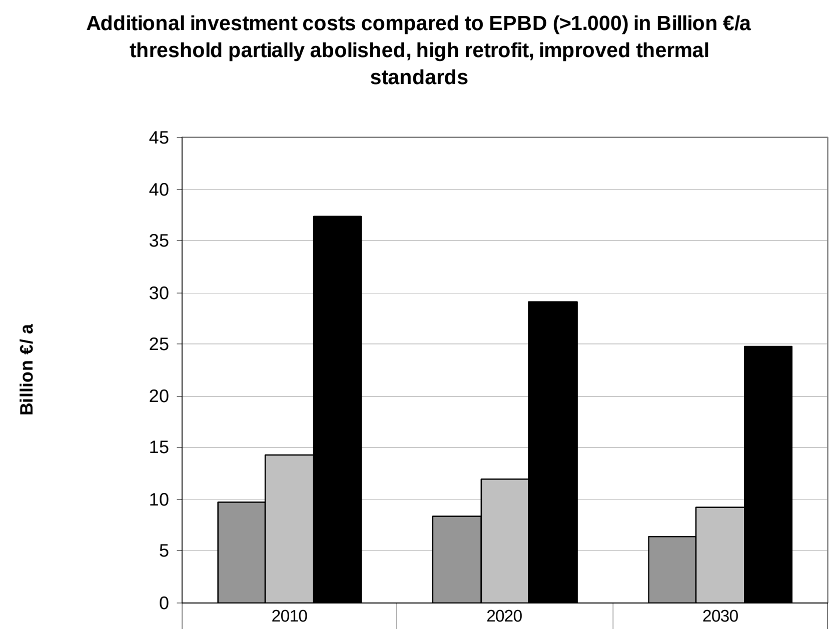


	2010	2020	2030
EPBD >500 m²	1	8	8
EPBD >200 m²	1	11	11
EPBD >50 m²	4	36	35

2.5.3 Effect of improved thermal standards due to cost optimal requirements

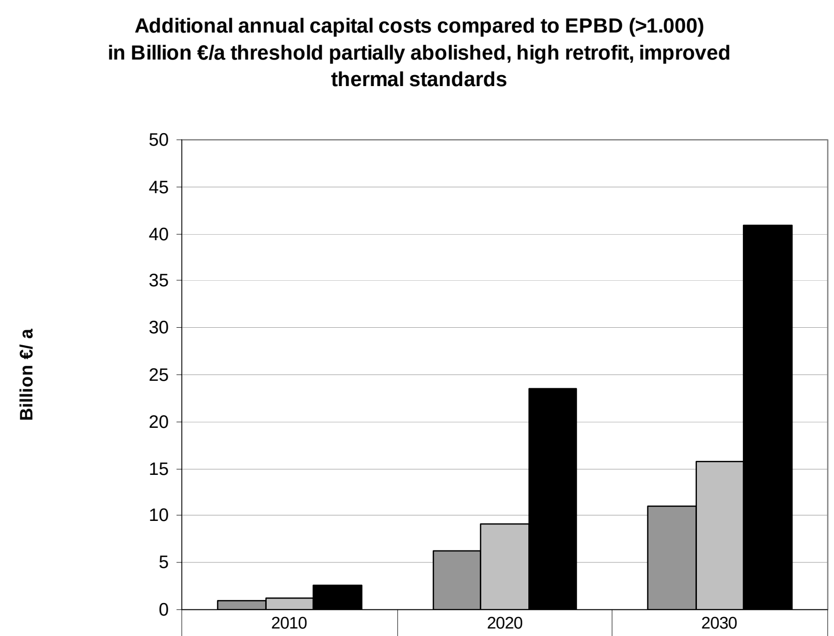
The effect of higher retrofit rates combined with improved thermal standards is described in the following graphs.

Figure 2.25 Additional investment costs compared to current EPBD from higher retrofit rates and improved thermal standards, threshold already partially abolished



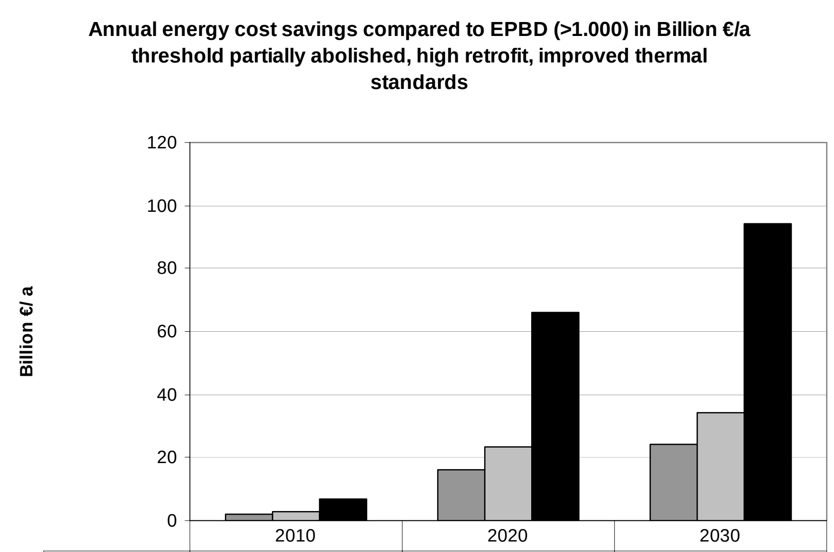
	2010	2020	2030
EPBD >500 m²	10	8	6
EPBD >200 m²	14	12	9
EPBD >50 m²	37	29	25

Figure 2.26 Additional annual capital costs compared to current EPBD from higher retrofit rates and improved thermal standards, threshold already partially abolished



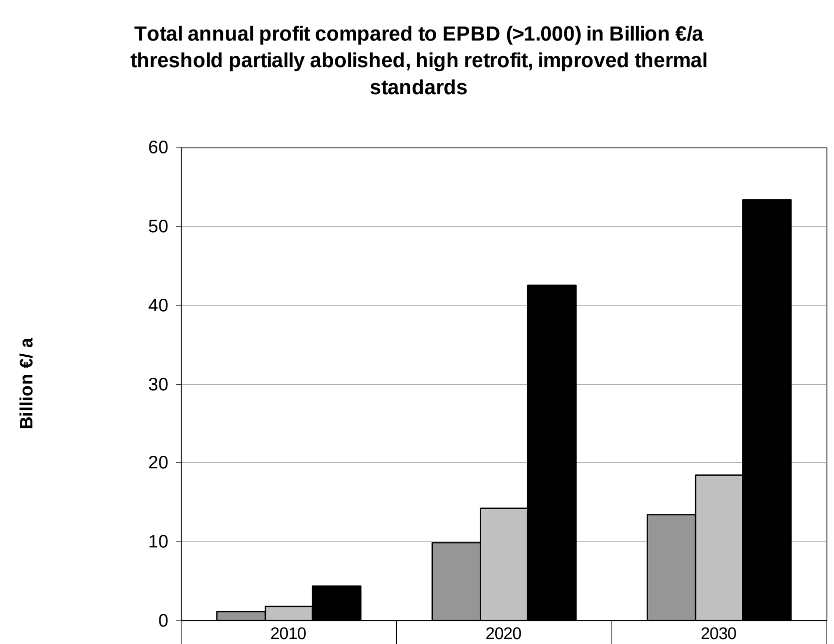
	2010	2020	2030
EPBD >500 m²	1	6	11
EPBD >200 m²	1	9	16
EPBD >50 m²	3	24	41

Figure 2.27 Annual energy cost savings compared to current EPBD from higher retrofit rates and improved thermal standards, threshold already partially abolished



	2010	2020	2030
EPBD >500 m²	2	16	24
EPBD >200 m²	3	23	34
EPBD >50 m²	7	66	94

Figure 2.28 Total annual profit compared to current EPBD from higher retrofit rates and improved thermal standards, threshold already partially abolished



	2010	2020	2030
EPBD >500 m²	1	10	13
EPBD >200 m²	2	14	19
EPBD >50 m²	4	43	53

It is visible, that the total annual profit can be further improved by the introduction of cost optimal U-values.

2.6 Societal effects - job creation

The impact of energy efficiency measures on job creation is influenced by various dependencies and specific market situations, tax systems etc. per country. A detailed analysis would demand quite complex models including input – output analyses of all sectors, a task which would be out of the scope of the current assessment.

However a simplified method can be chosen that neglects smaller effects but still offers a good indication of possible employment related impacts of energy efficiency measures. Thereby the assumed additional turnover from energy efficiency projects is divided by the average turnover per employee in the construction sector and multiplied by a specific factor, a methodology which has been used e.g. in [Ecofys 2004], [Ecofys 2005] and [Wuppertal Institut 2006]

$$job\_creation = \frac{additional\_turnover}{turnover\_per\_employee} * factor$$

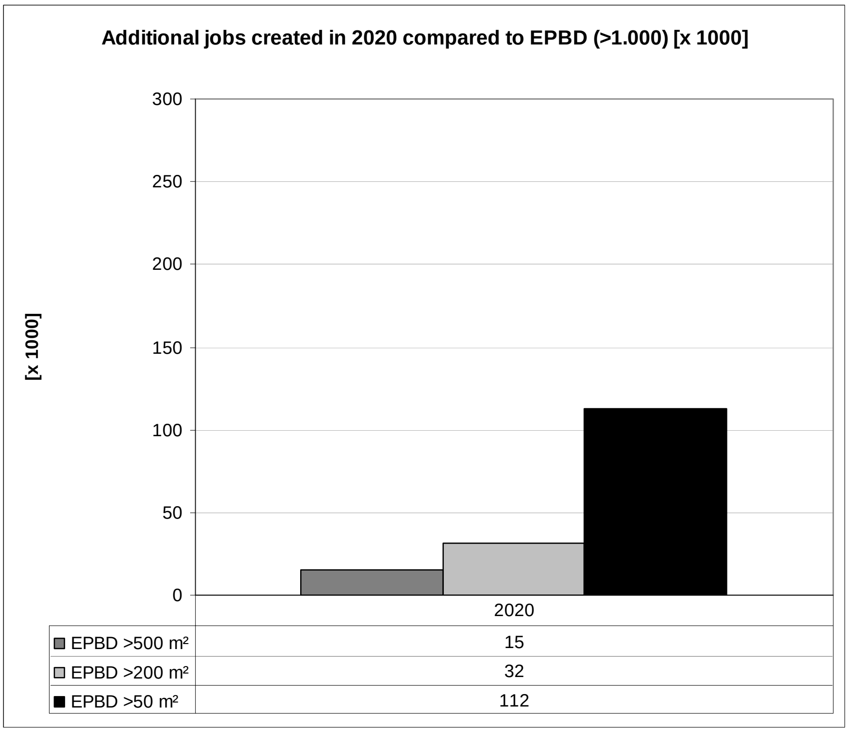
This factor depends on the specific labour intensity of the measures carried out. Depending on exact kind of activities, this factor may vary between 0,5 (share of material costs of energy efficiency measures twice as high as the usual mix of material and labour costs as presently observed in the building industry of the EU27) and 1,0 (share of material costs according to usual mix). In the present study, the factor was therefore assumed to be 0,7.

According to EUROSTAT, the average turnover per employee in the construction sector of the EU27 in 2005 was 103 thousand EURO per employee and year.

New jobs are created with the additional investments triggered as from 2009 and can be maintained for several years. However, as the investments are decreasing over time (due to the fact that parts of the building stock will be renovated after a certain time) it is reasonable to calculate the average employment effect on basis of the additional investments in 2020. Applying the turnover per employee and the additional investments in 2020 according Figure 2.13, Figure 2.14, Figure 2.21 and Figure 2.25, the following job effects in the EU27 can be estimated.

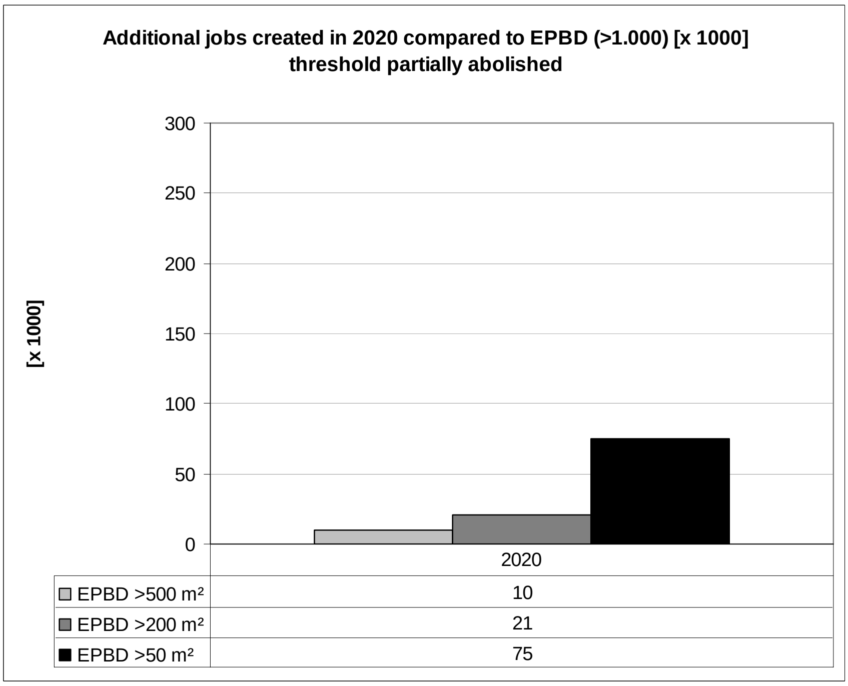
2.6.1 Effect of different threshold options

Figure 2.29 Job effects compared to current EPBD from different threshold options



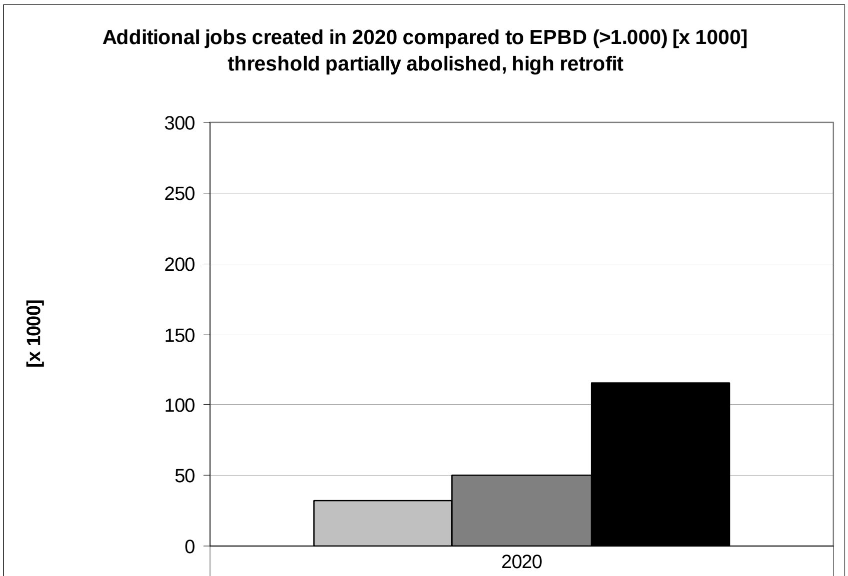
This means e.g. that after lowering the threshold to 50 m², ca. 112.000 additional new jobs can be created and maintained (by the investments in the following years) compared to the current EPBD.

Figure 2.30 Job effects compared to current EPBD from different threshold options, threshold already partially abolished



2.6.2 Effect of high retrofit rates due to improved certification and compliance

Figure 2.31 Job effects compared to current EPBD from higher retrofit rates, threshold already partially abolished

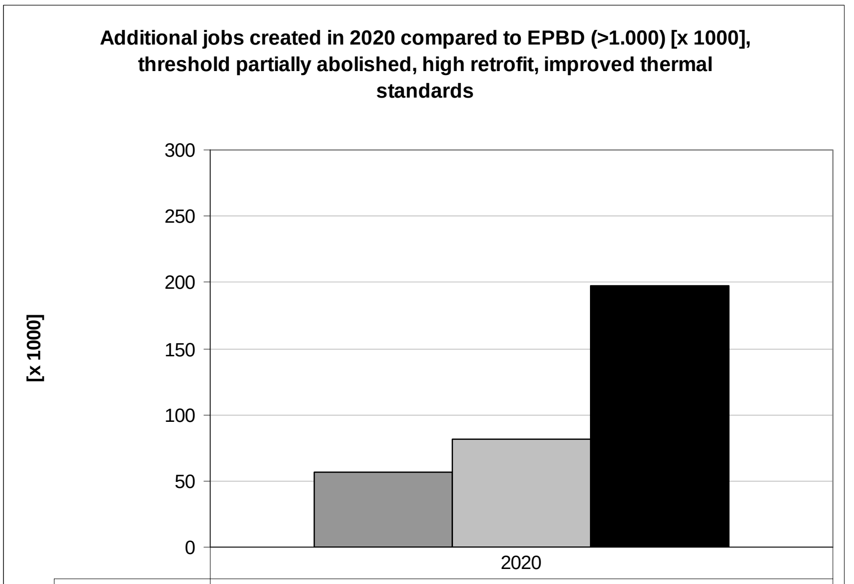


	2020
EPBD >500 m²	32
EPBD >200 m²	50
EPBD >50 m²	115

2.6.3 Effect of improved thermal standards due to cost optimal requirements

The effect of higher retrofit rates combined with improved thermal standards is described in the following graph.

Figure 2.32 Job effects compared to current EPBD from higher retrofit rates and improved thermal standards, threshold already partially abolished



	2020
EPBD >500 m²	57
EPBD >200 m²	81
EPBD >50 m²	197

3 Focus strengthening of Energy performance Certificates

3.1 Introduction

This document reflects the input provided by Ecofys Nederland to the Commission regarding the Commission staff working document, accompanying the Proposal for a recasting of the energy performance of buildings directive (2002/91/EC) – impact assessment.

In the following chapters methods, assumptions and results are presented for the options that have been reviewed. Inputs by Ecofys Netherlands, either new or adoptions of earlier input, are several times marked by italics.

3.2 Assessment of policy options for EPBD

3.2.1 Extrapolation Mc Kinsey study

A study on costs and potentials for CO_2 abatements in Germany concludes that63 Mt CO_2 savings can be achieved annually by *low or even negative abatement* in the buildings sector. At the level of EU-27 this could mean 500 Mt CO_2 emission reduction by 2020.

Method and main underlying assumptions
The calculations are based on information of the Mc Kinsey report (especially page 38 and 39) [Mc Kinsey, 2007]. A distinction is made between measures which mainly have an impact on fuel demand and measures which mainly have an impact on electricity demand. As such, the CO_2 saving German percentage for 2020 is divided over CO_2 emission reduction by fuel saving and by electricity saving. These percentages are used to extrapolate the figures for Germany to the CO_2 emission reductions of all the EU-27 MS (source PRIMES data).

This means 500 Mt CO_2 emission reduction includes CO_2 emission reductions by business as usual and cost effective fuel and electricity saving measures by 2020.

Comment: the 63 Mt can be achieved by measures costing less 20 euro/save ton CO_2, so suggestion to change text in low or even negative abatement costs.

3.3 Quality and compliance requirements

Current landscape: Although the implementation is still in its early stage a notable amount of complaints were already submitted to the Commission in 2007 and 2008 with regards to unsatisfactory quality of energy performance certificates from Member State which already started. Such a view is also reflected in the public consultation on the EPBD recasting, where the request for improvement and/or strengthening of the EPBD article on certificates is the top ranked issue. The number of complaints on low-quality certificates will most likely increase considerably in near future, when more national certification regimes are fully operational.

With regards to the procedure on issuing certificates, some of the national certification regimes require an on site check of the building by the expert to gather information on its technical shape, followed by a calculation of the energy rating of the building based on this information. This procedure usually leads to high quality certificates, assuming that the quality of the expert is sufficient. Others alternatives also allow for the building owner to give technical information (which could be of apocryphal quality due to non-expertise) on the building to the expert, who prepares a certificate only based on this information and using many simplified and standardised assumptions depending on the building type without visiting the site. This does not always reflect the actual shape of a building and therefore can lead to incorrect rating results and inappropriate recommendations in the certificate, but leads to low costs for certification. Furthermore, it allows for incorrect and false input to sugar-coat the rating result, which is not always easy to detect on an ad-hoc basis by a third party (e.g. a future prospective buyer or tenant of a building).

The certification of a building could also be linked to compliance criteria on building regulations: Aspired energy savings in the buildings sector presuppose compliance with relevant building regulations/codes. In fact, the non-compliance rate on building codes (with regard to energy aspects) varies between 26 to 33 % for new buildings and even 40 to 50 % for refurbishment of existing buildings in EU-27 when no proper control is in place[3]. **The impact of these non-compliance rates can be quantified *to 2.3 to 4.2 Mtoe wasted and 2.5 to 4.7 billion € avoidable energy costs between 2009 and 2020*[4] *in the EU-27.***

Several stakeholders[5], experts and energy agencies[6] require having **effective control regimes** in place in order to increase compliance with building regulations. The important impact of compliance control was also expressed by stakeholders and their contributions to the public consultation on the EPBD recasting. Furthermore, the Commission also

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[3] S. Lechtenböhmer, A. Schüring, T. Hanke (Wuppertal Institute): Scenarios on the Demand for Space Heating in Residential and Tertiary Sector Buildings in the EU27 and EEA Countries, Germany, 2008

[4] Relative to 100% compliance. Based on extrapolation of savings in the UK estimated by DCLG, 2007. "Regulatory Impact Assessment Energy Performance of Buildings Directive Articles 7-10". Based on averaged energy price in 2015 for gas, oil, district heating and wood.

[5] In position papers and studies, such as European Construction Industry Federation FIEC: FIEC Memorandum - The impact of buildings on climate change, 2007 (amended version 2008); European Energy Network EnR: Implementation of the EU Energy Performance of Buildings Directive - a snapshot report, 2008

[6] As e.g. presented at the 2nd Sustainable Energy Week event 'Energy Performance of Buildings Directive - Next Steps' in January 2008 and as demonstrated in a Swedish case study of 2007 (European Energy Network EnR: Implementation of the EU Energy Performance of Buildings Directive - a snapshot report, 2008),

receives a considerable number of citizens and experts complaints on lack of compliance in practice coming from Member States where no control regime exists.

So ideally, sufficient quality of energy performance certificates and high compliance rates of construction and refurbishment works with building regulations are guaranteed at the same time with a single instrument.

Suggested policy option to explore:
The check of EPBD building certificates by a compliance control scheme could be such a smart instrument. A similar control regime is i.e. currently developed in the Flemish Region of Belgium. Denmark introduced a regime for systematic quality control of certificates already in 2006.

Such a control scheme should be as effective and as least administratively cumbersome as possible. In doing so, a justified balance between control costs and benefits (in terms of improved quality and saved energy and emissions) can be achieved. **Random sampling checks of certificates of 3 different levels of detail and frequency** could therefore be introduced as a new requirement by the EPBD recasting as the adequate approach. **Such** random sampling regime could range from validity checks of input and/or result data for certificates to on-site checks of buildings certified.
Moreover, this type of (compliance) control regime could also guarantee a sufficient quality of experts issuing the certificates: Member States have introduced varied requirements with regard to qualification (educational requirements and training) of independent experts which are entitled to certify buildings. The independence, required by the existing EPBD and quality of these experts therefore broadly varies within the EU. As such, the quality of currently issued certificates varies broadly as well. However, the EPBD's objective is not to fix national job requirements for certification issuers.

Provisions that would be desirable but difficult to implement are:

- control of all energy performance certificates;
- controlling all construction works for compliance with building regulations and;
- prescribing the qualification needs for experts issuing the certificate at EU level.

In order to achieve the full impact of these provisions, a random control of the real outcomes (validity and quality of certificates and construction/refurbishment works) at national level could be made mandatory by random sampling checks for certificates in the EPBD recasting[7]. This approach would also reflect the subsidiarity principle with regard

[7] For similar objectives, Denmark already revised its certification procedure in 2006, firstly introduced in 1997, to 'quality level' 5 and 6 respectively in its 2nd generation certification scheme:
In a range from 1 to 6, 1 being lowest quality which only consists of "Meter reading reported by the building owner and the utility companies", whilst 5 and 6 mean "Computation by energy consultants based on building envelope inspection" and " Computation by energy consultants combined with meter reading".
The revision of the Danish provisions was based on several years of experience since 1997, which also underlined the importance of quality control within the certification scheme (subsequently also named as 'label'/'labelling scheme'). The analysis of Jensen et al conclude that "Confidence in the energy label is the most important factor in achieving the main aim of the labelling scheme - energy savings. The user must at all times have confidence in the registrations made, the calculations, the label itself, and especially that the suggested energy saving measures are viable and will result in improved economy. Thus, it is essential to maintain a high level of quality in the energy labelling scheme. If quality is poor,

to laid down training requirements and educational preconditions for certification issuers, which are in the competence of the Member States.

Member States could be requested by an EPBD recasting to establish random sampling checks for 0.5 % of annually issued certificates[8] of 3 levels of detail: A certain share of these 0.5 % checks could requested to be done by a validity check of input data and rating outcome of energy performance certificates only. Another (lower) share could requested be checked (stricter) for input data and be recalculated by a controller. And another (very low) share of random sampling checks could consist of the aforementioned proposal plus control of the building on site for compliance with building regulations and correspondence with the certificate. *The overall cost of random sample checks in the EU-27 according to this proposal are estimated at between 75 and 78 M€ from 2009 through to 2020[9].*

The estimated impact in terms of energy savings is derived from an existing national assessment on EPCs in the UK[10]. The estimated impact of properly made energy performance certificates is that 8 to 12% of cost effective energy efficiency measures are realized[11]. These savings equal 0.9% of the United Kingdom's existing residential building stock's emissions[12]. No information is available on the effect of certification on the renovation rate of buildings.

When the UK impact estimate is extrapolated to the EU27 as a whole[13], the following impacts are estimated. When no proper control mechanism is in place, the impact of EPCs is projected to range from 16.3 to 25.3 Mtoe in 2020 and from 31.3 to 48.5 Mtoe in 2030. In terms of emission reductions, this equals 45.7 to 70.9 Mton in 2020 and 87.6 to 135.7 Mton in 2030.

When compliance is increased through moderately strengthened regulations[14], an additional impact ranging from 0.9 to 1.3 Mtoe in 2020 and from 1.5 to 2.3 Mtoe in 2030 is generated. This equals an additional emission reduction of 2.3 to 3.5 Mton in 2020 and 2.4 to 6.6 Mton in 2030.

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the users will lose confidence in the labels. […] Credibility may be lost very fast as a few poor labels can do a lot of damage. The quality control of the Danish energy labelling scheme takes place at all levels of the scheme.", taken out of: Ole Michael Jensen, Morten Tony Hansen, Kirsten Engelund Thomsen, Kim Wittchen: Development of a 2nd generation energy certificate scheme – Danish experience, 2007

8 Underlying that an accredited expert, specialised on issuing energy performance certificates for buildings, compiles one certificate per working day, so about 200 certificates a year. A random sampling check of 0.5 % of certificates would therefore mean that accredited experts face with one control per year on average.

9 Quality checks costs equal to 0.5% of EPC issuing costs (as discussed with ms. Miladinova, 23.6.2008).

10 Calculated from data originating from DCLG [2007]. Carbon saved claimed for EPCs in first year of implementation, electricity use excluded in PRIMES reference emissions.

11 Calculated from data originating from DCLG [2007]. Savings claimed exclusively for EPCs, i.e. additional to EEC savings. Applies to first year of implementation, only when EPC is available. This range may differ from figures mentioned below because of non-additionality and different time frames.

12 For comparison: in Germany, the certificates are projected to help avoid 0.35% of the existing residential building stock's emission (calculated from: ForschungsZentrum Jülich, 2005. "Evaluierung der CO_2-Minderungsmaßnahmen im Gebäudebereich", p. 20. Carbon saved claimed for EPCs after three years of implementation, electricity use excluded in PRIMES reference emissions).

13 Of course, conditions in other Member States might differ from those in the UK in terms of savings potential (size, profitability) and complementary policies.

14 Based on compliance rates mentioned by Lechtenböhmer, Schüring & Hanke, 2008. "Scenarios on the Demand for Space Heating in Residential and Tertiary Sector Buildings in the EU27 and EEA Countries", Germany, 2008.

Consequently, properly carried out energy performance certificates may bring *along 7 to 16 thousands of new jobs. Although the type of job created is expected to differ among member states, the majority of the jobs will consist of architects, engineers, and/or specialised energy advisors.*

The costs for a thorough quality control system appear manageable. *The total one-time costs of the development of an administrative system are estimated at around 6.4 M€. For comparison, costs in the United Kingdom have been estimated at 1.9 M€ (or 1.5 M£). In case separate administrative systems are developed in every individual member state, total costs could run up to around 50 M€.*
The recurring costs of performing administrative activities are usually covered in the price of an EPC. For example, the total yearly costs of the Danish administration of the scheme paid by the consumers amount to about €0.8 million. *These costs cover the quality assessment control, the registration of data and the development of facilities to help improve and minimise the work for the consultants as well as some training activities for the consultants*[15].

Costs of performing random quality checks for the EU27 would range between 75 and 78 M€ from 2009 through to 2020, and between 144 and 149 M€ from 2009 through to 2030.
Note however that quality control, when it is separated from compliance control, only applies to EPCs that have been issued. In Denmark, in 30% of sales an EPC was, although required, not made available (non-compliance)[16]. In these cases, there is no EPC to perform a random quality check on.

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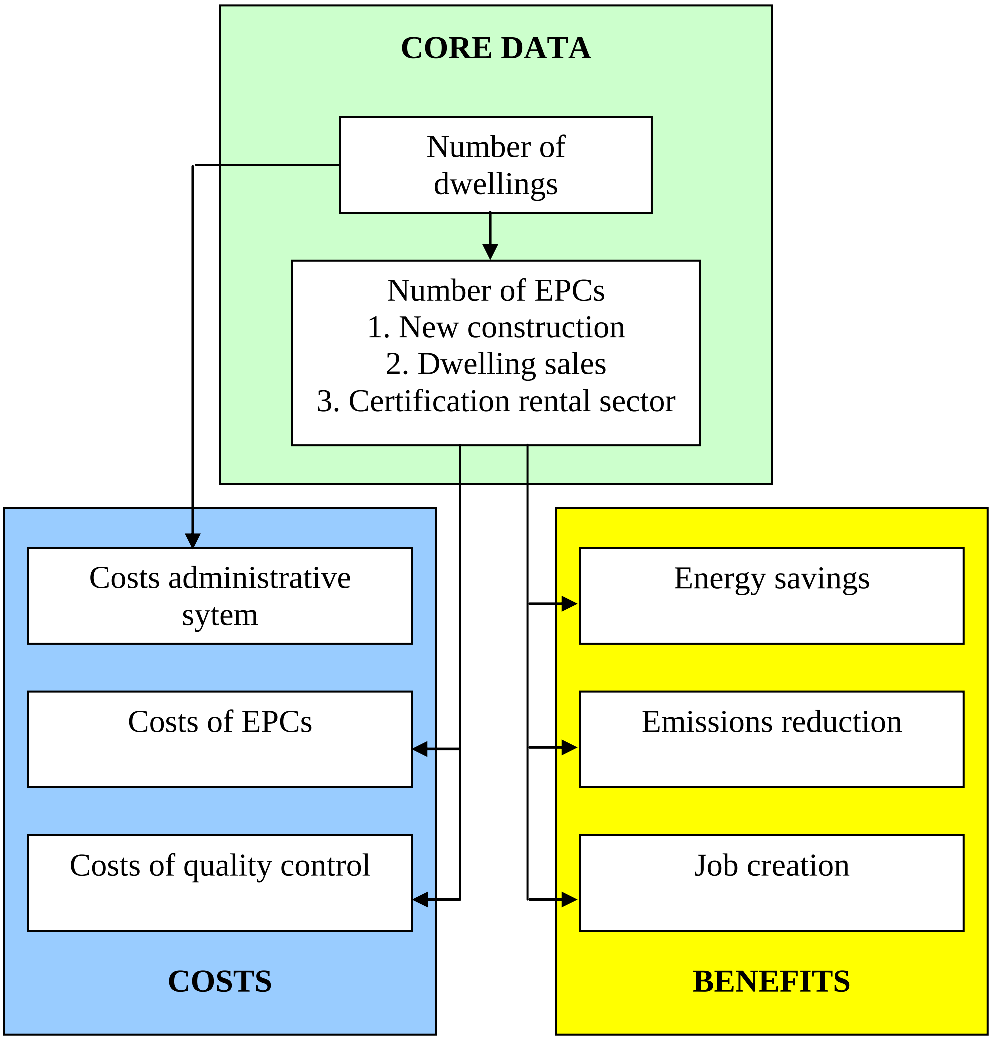
15 Jens Laustsen (Danish Energy Authority) & Kirstine Lorenzen (COWI), 2003. "Danish Experience in Energy Labelling in Buildings", p. 20.

16 Compliance rate of 70% in single family dwellings. "Danish Experience in Energy Labelling in Buildings", p. 24.

Methodology, main underlying assumptions and results
In this section, the methodology that has been used to perform the assessment for quality and compliance requirements is presented. A schematic overview of this methodology is depicted below. Moreover, results are listed in addition to those presented in the text on the previous pages.

Figure 3.33 Methodology for the impact assessment of option B1.

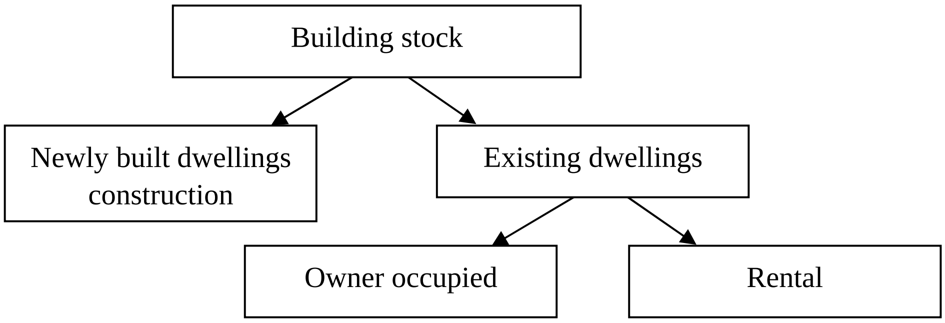


<u>Number of dwellings</u>

Method
The size of the building stock in all EU25 countries was assessed based on recent statistical data [Federcasa, 2006]. Additional statistics for Bulgaria and Romania were added in order to reach a complete basis for the EU27 stock.
Based on statistics concerning the number of demolished and newly constructed dwellings [Federcasa, 2006], an annual demolition rate (0.11%) and an annual construction rate (1.2%) were established for the EU27. Projection of these rates resulted in an update of the building stock size to the starting year 2009. Further extrapolation into the future resulted in an outlook on the size of the EU27 building stock until the year 2030.

The shares of owner-occupied and rental dwellings in the total EU27 building stock were estimated based on an average of statistics available for 15 European countries[17] [Eurostat, 2008].

Figure 3.34 Breakdown of the EU building stock used in the analysis



Main underlying assumptions:

- Building stock dynamics (construction and demolition rates) will remain stable until the year 2030;
- Building stock composition (share owner-occupied, share rental) will remain unchanged until he year 2030;
- The evolution of the building stock in the countries mentioned above reflects current and future dynamics in the EU27 as a whole.

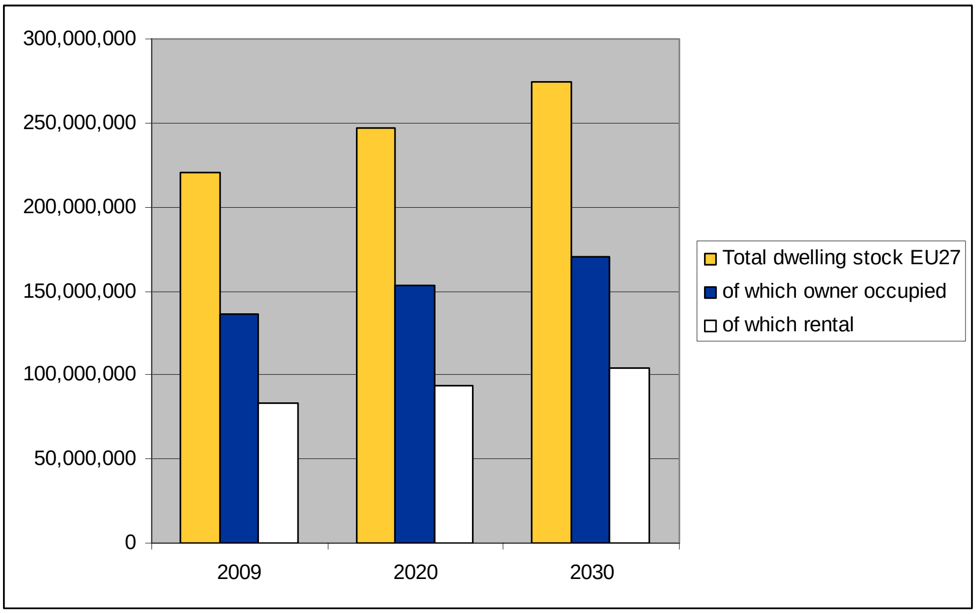
Results

In the year 2009, the EU27 building stock will consist of around 220 million dwellings. The majority of 137 million dwellings are owner-occupied.

The remaining 84 million are rental dwellings. The development of the building stock over the years is shown below.

[17] More specifically: Belgium, Denmark, Germany, Greece, Spain, France, Ireland, Italy, Luxembourg, Netherlands, Austria, Portugal, Finland, Sweden and the United Kingdom.

Figure 3.35 Number of dwellings in the EU27 building stock.



<u>Number of energy performance certificates</u>

Method

In order to calculate the number of EPCs issued annually, three categories were distinguished:

1. Newly constructed dwellings

Since an EPC is required for all newly constructed dwellings, the aforementioned construction rate was used to calculate the number of constructed buildings in the EU27.

Compliance: for newly constructed dwellings, ranges of non-compliance rates were used: 26 to 33 % when no proper control is in place, and 17 to 23 % with moderately strengthened regulations [Wuppertal Institute, 2008].

2. Sold existing dwellings

Based on the number of sales of existing dwellings in the UK, Germany, France, Italy, Spain, The Netherlands and Denmark [RICS, 2007; VROM, 2007; INE, 2008; and various country reports of the Impact project], a weighted average sale rate of 2.2% (relative to the entire stock, i.e. including rental dwellings) was obtained.

In order to avoid double counting of dwellings that are re-sold within the 10 year EPC validity period, a profile of sales over time was established [similar to the profile used for DCLG, 2007; see Annex I].
Compliance: for sold existing dwellings, ranges of non-compliance rates were used: 40 to 50 % when no proper control is in place, and 25 to 35 % with moderately strengthened regulations [Wuppertal Institute, 2008].

3. Transferred rental dwellings

A profile of certification activities over time was assumed for lessors. Again, the profile is similar to that used for the rental sector in DCLG [2007]. This approach is based on the assumption that lessors will implement the certification of their property on a building portfolio level, rather than on the level of transfers of individual tenants. As a result, the method used is not in line with the number of EPCs that are legally required over time in the rental sector. Instead, the possibility that rental dwellings have a certificate, even when this is not (yet) legally required, is taken into account.

Compliance: for transferred rental dwellings, no compliance rates were included in the calculations. The underlying assumption is that the number of certificates obtained by lessors on a building portfolio level will equal or exceed the number of required certificates. As a result, lessors will dispose of fully certified portfolios within ten years from the starting year. This would enable lessors to reach a compliance rate of 100%.

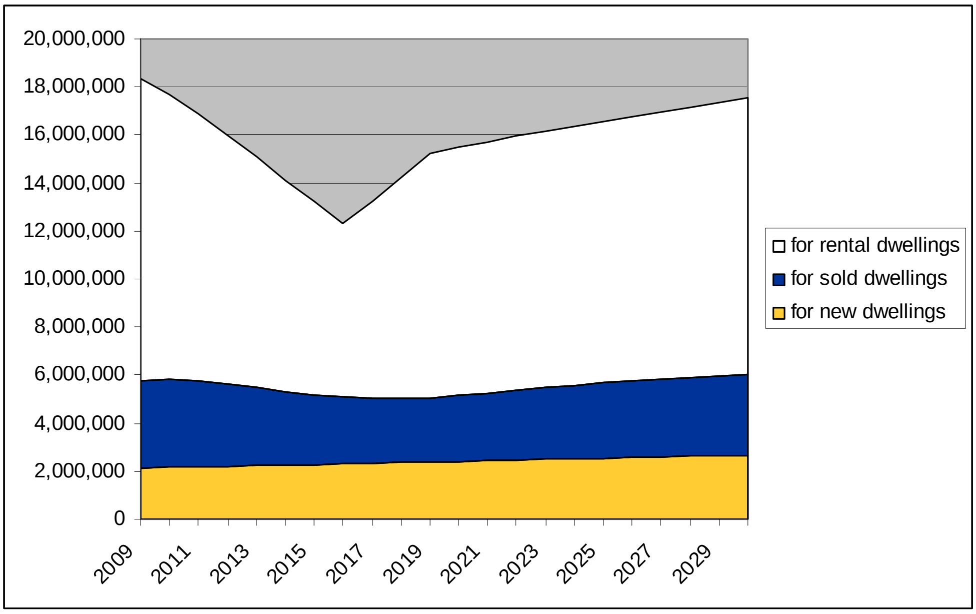
Main underlying assumptions:

- EPCs are valid for a period of 10 years
- It is assumed that a certificate is available for all owner-occupied buildings that are re-sold within ten years of an earlier sale. In other words, the non-compliance rate is neglected when correcting for double-counting;
- Lessors will implement the certification of their property on a building portfolio level, rather than on the level of transfers of individual tenants (see Annex I);
- The profile over certification activities by lessors is such that the number of certificates obtained by lessors on a building portfolio level will equal or exceed the number of required EPCs. As a result, lessors will dispose of fully certified portfolios within ten years from the starting year;
- The behaviour of private lessors could be expected to differ from that of institutional lessors (housing associations, municipal bodies, etc). Also, in the private subsector some non-compliance is likely to occur. These deviations are not taken into account. Instead, portfolio-based certification by institutional lessors is assumed to represent proceedings in the rental sector as a whole.

Results

Based on the assumptions mentioned above, the number of EPCs issued is as indicated in the Figure below. From 2009 through to 2020, the cumulative number of EPCs is found to range from 164 million (no proper control, low end compliance) to 182 million (proper control, high end compliance). When projected from 2009 trough to 2030, the cumulative number of EPCs ranges from 315 to 348 million, respectively.

Figure 3.36 Number of EPC issued in the EU27, assuming proper control in place and high end compliance estimates.



Energy savings and emission reduction

Method

In the EPBD impact assessment for the UK [DCLG, 2007], assumptions were made regarding the additional penetration of energy saving measures due to energy performance certification. These assumptions imply that the impact of an individual EPC is that, on average, around 10% of the cost effective annual savings potential in a dwelling is realized. Similarly, average carbon savings per energy performance certificate were assessed.

The impacts, as assumed for the UK, were assumed to apply to all sold existing dwellings and rental dwellings with an energy performance certificate. Subsequently, both impacts were projected on the EU27 building stock. A range is assumed (20% bandwidth on either side) in order to evaluate the sensitivity of the results.

Main underlying assumptions:

- An impact of certification is assumed only for sold existing dwellings and for rental dwellings. The energy performance of newly built dwellings is assumed to be influenced by dedicated normative legislation, rather than by certification;
- The assumed impact of EPCs in the United Kingdom (in terms of savings and emission reduction) is similar to the impact of EPCs in other EU27 countries. A 20% bandwidth on both sides is assumed to cover differences, if any, in e.g. cost-effective savings potentials, fuel use and complementary energy policies;
- No electricity savings are assumed to result from energy performance certification;
- As a result of the lifetime of the applied energy saving measures, the assumed impact of the EPCs persists until the years 2020 and 2030;
- The average amount of savings induced per EPC is assumed to remain constant between 2009 and 2030.

Because the impact assumed in the United Kingdom is vital to the results of the current analysis, it was compared to findings for the German context. In Germany in 2010, the annual emission reduction due to energy performance certification is projected to range from 0.42 (no double counting) to 1.04 $MtCO_2$/a (including the effect of additional monetary incentives) [ForschungsZentrum Jülich, 2005]. These German projections correspond to 0.2 to 0.5 tCO_2/EPC, respectively. The assessed impact for the United Kingdom, 0.4 tCO_2/EPC, lies within that range.

Results

When no proper control mechanism is in place, the impact of EPCs is projected to range from 16.3 to 25.3 Mtoe in 2020 and from 31.3 to 48.5 Mtoe in 2030. In terms of emission reductions, this equals 45.7 to 70.9 Mton in 2020 and 87.6 to 135.7 Mton in 2030.

When compliance is increased through moderately strengthened regulations, an additional impact ranging from 0.9 to 1.3 Mtoe in 2020 and from 1.5 to 2.3 Mtoe in 2030 is generated. This equals an additional emission reduction of 2.3 to 3.5 Mton in 2020 and 2.4 to 6.6 Mton in 2030.

Costs of energy performance certification

Method

The costs of an EPC were assessed based on data available for seven European countries[18] [Impact, 2006; COWI, 2003; DCLG, 2007 and VROM, 2008c]. On average, costs are found to lie within a range of 241 to 448 €/EPC. Based on these costs, a range was calculated for the EU27 as a whole.

Total costs were calculated by multiplying the average price with the number of EPCs issued. However, an additional correction was made in order to take into account economies of scale. Such economies of scale occur when a single energy performance evaluation is valid for multiple buildings. For instance, a large number of identical dwellings can be certified at lower costs on the basis of reference dwellings.

Main underlying assumptions:

- The average cost of an EPC in the countries for which data was available is assumed to represent the cost of an EPC in EU15 countries. For the EU10 plus Bulgaria and Romania, costs are assumed to be 20% lower than in the EU15. Still for the EU10 this might be a bit too high. Lets discuss it next week.
- The same price is assumed for certification of newly built dwellings, sold existing dwellings and dwellings is the rental sector.
- Economies of scale are quantified by the assumption that one single building evaluation accounts for:
    - 2 EPCs issued for new dwellings
    - 2 EPCs issued for sold existing dwellings
    - 10 EPCs issued for rental dwellings

[18] More specifically: the United Kingdom, Germany, France, Spain, The Netherlands, Denmark and Belgium.

Results
In absence of proper control mechanism, the total cost of EPCs issued between 2009 and 2020 would range from 7.7 to 15.8 billion €. For those issued between 2009 and 2030 a cost of 14.7 to 30.0 billion € would be incurred.

When compliance is increased through moderately strengthened regulations, ad-ditional costs of EPCs issued between 2009 and 2020 would range from 1.2 to 2.1 billion €. For those issued between 2009 and 2030 a cost of 2.2 to 4.0 billion € would be incurred.

Administrative costs

Method
With regard to administrative costs, the distinction is made between three categories:

1. Costs of the development of an administrative system

The cost of setting up an administrative system is estimated based on data that is available from the impact assessment in the UK [DCLG, 2007]. Based on assumptions on the cost structure and on the relative sizes of the dwelling stocks in the UK and the EU27, a cost estimation is performed.

2. Costs of using the administrative system

The administrative system is mainly used for the registration of data. Data in the database are e.g. used to evaluate compliance rates, the number of proposals, the investments and the possible savings and other information from the scheme [COWI, 2003]. Costs that are incurred for the registration of data in an administrative system are covered in the cost of an EPC [COWI, 2003]. Therefore, in order to avoid double counting, no specific costs are calculated for registration.

3. Costs of the performance of quality control (random checks)

The random quality checks of EPCs are assumed to be carried out as proposed in the text of the impact assessment. In total, that is, 0.5 % of the issued certificates are checked. More precisely, 0.3% is assumed to undergo a validity check of input data and rating outcome of energy performance certificates only. A lower share of 0.15% checked (stricter) for input data and is recalculated by a controller. Finally, 0.05% is assumed to be checked (stricter) for input data, recalculated and controlled for compliance with building regulations on site.
The quality control checks are linked with compliance control. Once the required EPC is found to be available in a certain situation, the EPC might be subjected to a random check. Therefore, no additional costs for compliance control (i.e. on top of the costs for quality control) are included in the costs presented in the results.
Finally, the existence of random quality control checks implies that a proper control mechanism is in place. Therefore, costs were calculated based on the compliance rates mentioned for these circumstances by {Wuppertal Institute, 2008].

Main underlying assumptions:

- Two thirds of the costs of an administrative system are assumed fixed, regardless of the number of dwellings involved. The remaining third is assumed to be linearly proportional to the number of dwellings involved;

- Costs for administrative systems for EU10 countries plus Bulgaria and Romania are assumed to be 20% below those in EU15 countries;
- The random quality checks of EPCs are assumed to be carried out as proposed in the text of the impact assessment;
- The costs of compliance control are assumed to be included in the quality control mechanism based on random checking;
- The average time needed is assumed to be: 0.5 hours for a quick random check, 1.5 hours for a random check plus recalculation, and 6 hours for full data control, recalculation and on site inspection;
- The hourly rates of employees involved in quality control are assumed to be 70 €/hr for EU15 countries. The rates for EU10, Bulgaria and Romania are assumed to be 20% lower compared to those in the EU15;
- Costs for the registration of data in an administrative system are assumed to be accounted for in the price of energy performance certificates [as noted in COWI, 2003].

Results

Based on the aforementioned assumptions, the total one-time costs of the development of an administrative system are estimated at around 6.4 M€. For comparison, costs in the United Kingdom have been estimated at 1.9 M€ (or 1.5 M£). In case separate administrative systems are developed in every member state, total costs could run up to around 50 M€.

Costs of performing random quality checks would range between 75 and 78 M€ from 2009 through to 2020, and between 144 and 149 M€ from 2009 through to 2030.

Job creation

Method

In order to determine the number of jobs that are created by the energy performance certification, a simplified method is chosen, similar to the one used in the assesment of job creation as a result of the threshold options:

$$job\_creation = \frac{additional\_turnover}{turnover\_per\_employee} * factor$$

The additional turnover is represented by the total costs of issued EPCs. The average turnover per employee in the sector ‘architectural and engineering activities and related technical consultancy; technical testing and analysis’ (NACE code K742_K743) of 22 European countries in 2006 was 101 k€ per employed person[19] and year [Eurostat, 2008]. Although the type of professional that issues EPCs differs strongly among countries[20] [Impact, 2006], this NACE category is believed to adequately represent the involved workers in the EU27 and is therefore used in the analysis.The factor depends on the labour intensity of the work that is carried out. In the present study it was assumed that the additional turnover is generated through energy performance certification, which has

19 Note that, statistically, the concept ‘employed person’ could differ from ‘employee’.

20 Whereas in some Member States, for instance, only architects and engineers are eligible to issue certificates, in others a broader arry of professionals are active in this field

a labour intensity that is similar what is usually observed in the NACE category at hand. Therefore, a factor of 1 is used in the calculations.

Results

In terms of employment, the certification generates around 6.9 to 14.2 thousands of jobs. Moderately strengthening the control mechanism would generate an additional number of 1.1 to 1.9 thousands of jobs. In either case, the type of job generated will differ somewhat from one member state to another. At present, the Intelligent Energy Europe project 'Impact' has shown that mainly architects, engineers, and/or specialised energy advisors are eligible for energy performance certification. In some member states, however, work will be carried out by advisors not primarily educated in the building field) or by craftsmen [Impact, 2006].

The income used in the calculations represents "architectural and engineering activities and related technical consultancy; technical testing and analysis". This NACE category most closely represents the certifiers in most member states. However, as mentioned, in some member states will be carried out by advisors not primarily educated in the building field or by craftsmen.

The figures presented relate to the number of steady jobs in the year 2020. Depending on the variability of the number of EPCs issued annually - when, for instance, the profile in the rental sector differs from the one assumed in Annex I - some variations might exist over time.

The results on additional job creation due to the strengthened control mechanism are based on the compliance rates from Wuppertal Institute [2008]. If the certification scheme works ideally in all member states, i.e. with a 100% compliance rate, the result would range between 10 and 20 thousands of jobs.
The apparently limited number of jobs is explained to a large extent by the fact that economies of scale in the process of certification have been taken into account. This means that a considerable share of EPCs can be based on reference dwellings, and therefore do not require the full capacity of a certifier.

3.4 Requiring that the recommended cost-effective measures of the certificate are realized within a certain time period

Unfortunately, the evaluation of the impact of requiring that the cost-efficient recommendations of the Certificate are realized within a certain time cannot be based on the countries that have adopted certain requirements in this aspect, i.e. Denmark and Portugal, as there are no impact assessments available. Still, experts evaluate that if requirements are included this may lead to the following indicative impact for EU-27:

- Final energy demand saving of approximately 12 Mtoe, i.e.3% reduction by 2020 in the EU-27 building sector
- CO_2 emission reduction of about 50 Mt, i.e. 1% reduction by 2020 in overall EU-27 MS CO_2 emissions. *[based on literature sources mentioned in paragraph method and main underlying assumptions].*

However, *although from the data available it is not possible to make estimations on the investments requirements*, it can be expected that meeting the costs can be a significant challenges for some property-owners, especially those with restrained budgets, or housing associations that own a large number of properties.

The estimated investments requirements for services buildings are estimated in the range of 2000 and 30000 Meuro. These investments correspond to saving figures mentioned above.

Method and main underlying assumptions
The information is based on provided information in telephone calls with representatives of Denmark and Portugal [SBi, 2008; University of Porto, 2008]. Other sources are: [IPPC, 2007; Ecofys, 2001; McKinsey, 2007; Ecofys, 2008a]

Main assumptions are that: 1) potential is available in 40% to 50% of the services buildings; 2) in these buildings, 20% to 25% of the final energy demand can be saved by cost-effective measures and 3) by 2020 the majority of the potential can be realized.

The calculations of the investment costs are based on available information of cost per saved ton CO_2 for typical cost-effective measures such as insulation and high efficient boilers [Ecofys, 2008a; SenterNovem, 2007].

3.5 Making certificates a mandatory part of property advertisement and/or property transaction documents

Comparison with similar approach used for fuel consumption and CO2 emissions in advertisements of new cars.

Making certificates a mandatory part of property advertisement and or property transaction documents has similarities with the labelling Directive 1999/94/EC which requires the display of a label on fuel consumption and CO_2 emissions on all new cars, the publication of national guides on the fuel efficiency of new cars, the display of posters at the dealerships and the inclusion of fuel efficiency information in printed promotional literature. From a study in 2005 on the effectiveness of this directive it appears that is considered a useful tool in raising awareness but its impact has not been visible, with labels of strongly varying quality in different Member States [COM2007, 19 final; ADAC, 2005].

The recent performed evaluation of the tax incentive based on fuel consumption label system in the Netherlands confirms these outcomes. Since 1 january 2006 private cars with a green A and B label are eligible for a discount on the purchase tax (BPM) of respectively 1000 euro and 500 euro, while relative high energy consuming cars with a label D, E, F or G are surcharged by respectively 135, 270, 405 and 540 euro[21]. The aimed targets are achieved, a shift towards purchase of low energy cars is observed. The

[21] Since 1 February 2008 the bonus and malus amounts are intensified.

CO_2 emission reduction of the implemented bonus/malus incentive on energy labels is estimated to reduce 0,1 Mton CO_2 in 2011. However, the causal correlation between the incentive and this impact can not be demonstrated [ANWB et al , 2008].

Certificates in property advertisements
There are initiatives by real estate agencies, real estate branch organisations and housing associations to provide insight in the energy performance of buildings based on the certificate system in property advertisements [Chancellors, 2008; Funda, 2008; SenterNovem, 2008]. We contacted several agencies for more detailed information, till now the response is very low.

The energy label of a house is included as a separate item on the website of the Dutch branch organisation of real estate agencies (www.funda.nl). Their policy is to inform their customers as completely and transparently as possible. According to their estimation the energy label information is currently available for 2 a 3 % of the buildings on their website. The estimated cost for ICT related activities (programming software etc.) for the current display are around 10000 euro. These are costs for simple adjustments (i.e. purely display of energy label, no further explanation) of the software only, other cost are administrative (data collection and supply, see text below), estimation of these costs can only be made roughly, for instance approximately 5 to 15 minutes labour cost per certificate. Furthermore, there are costs for the data collection. At the moment, the data collection is decentralized: included in the housing information of individual real estate agencies (820 in total). There is an initiative for using the central energy label database of the Dutch energy agency in the future. The advantages of this approach are that the information is more reliable and that it offers the opportunity to visualise the energy costs as well. On the other hand, the branch organisation has to pay for this information [Funda, 2008]

Currently, most Dutch housing associations are busy with energy labeling their housing stock. Several of them consider to inform tenants besides rent, and energy performance/label also on energy costs. In this way tenants can take housing conditions, rent and energy cost into account in their choice for renting a particular building [SenterNovem, 2008; Ecofys, 2008b].

Is it legally possible to make the certificates a mandatory part of the property advertisement?
According to the Dutch Ministry of Housing, Spatial Planning and the Environmental this is possible. They refer to requirements for warnings/information in place for tobacco, loans, investments products etc. However, the question presents itself if legislation is really necessary. What are the odds that market will uptake this option on voluntary basis? In the Netherlands, Funda an several other housing sites have in principal already included the energy label in their information provision. The experiences learn that in general the market takes over this type of initiatives. For properly functioning of this option, the accessibility of reliable energy performance data on time is a cause of concern. [VROM, 2008a]

Is possible to require energy performance improvements at transaction moments?
These type of requirements conflict with legislation on free transaction of goods and the right of ownership as established by the European Convention on Human Rights. [VROM, 2008a]

Additional contacts are currently outstanding [e.g. Chancellors, 2008] in order to provide additional information regarding the issue of property advertisement.

Concluding
Making certificates a mandatory part of the property advertisement and/or property transaction documents certainly is useful with respect to raising awareness, so that environmental issues can be taken into account during decision making. However, as stand-alone measure it will not generate much impact, it has to be regarded as an essential condition to enforce the overall impact of energy performance certificates. Prerequisites for proper functioning of this option are that the energy performance data are reliable and accessible on time.

3.6 Requiring the linking of the certificates with other support or discouragement mechanisms

Linkages of the certificates with other support or discouragement mechanisms have already been adopted in several EU Member States. For example, in the Netherlands there is a green mortgage which house owners can use to implement energy saving measures during renovation. The size of the loan is coupled to the improvement of the energy performance label. This means that in case more energy saving measures are implemented the energy performance of the house is further approved and more money can be borrowed against favourable conditions (see table 3.1). In general the interest is 1% lower than the market interest. The scheme is in force since May 2008, so there is no assessment available yet of its possible impacts [VROM, 2008b].

Table 3.6 Improvements to the energy performance (in terms of energy rating) and amount provided for green mortgage in the Netherlands

From label	To label	Number of steps	Maximal green mortgage (EUR)
F	D	2	25 000
F	B	4	50 000
F	A	5	100 000

In Portugal, energy conservation measures will be financially supported by tax benefits, this scheme will in the nearby future be coupled to energy performance certificates [University of Porto, 2008].

An example of a fiscal mechanism linked to energy labelling in the mobility sector
Interesting examples of linking energy certificates to complementary financial or fiscal mechanisms are to be found outside the built environment. For example, in 2006, a bonus-malus (or 'feebate') mechanism was introduced for new automobiles in the Netherlands. The objective of the scheme is to shift market shares from inefficient vehicles towards more efficient ones. The scheme entails a fiscal

bonus (reward) or malus (penalty) for buyers of vehicles. The size of the bonuses or penalties is proportionate to the energy label of the car, which is considered an indicator of its CO_2-emissions.
An evaluation of the scheme showed that a considerable shift in market shares had in fact taken place. Meanwhile, the costs of execution of the scheme are characterized as 'relatively modest'. After all, an existing tax scheme for motorized vehicles was used as a platform for additional incentives for efficiency.
Early 2008, the bonuses and maluses were increased to higher amounts, in order to shift market shares further against virtually no additional cost. [VROM, 2007]

In the summary report of the Active Implementation of the European Directive on Energy Efficiency"(AID-EE) project is concluded that sometimes it is difficult to determine the isolated impact of a single instrument in a policy package. Informative instruments, which are generally implemented to support other instruments, constitute a good example. Their isolated impact is generally small or even zero. However, both regulatory and financial instruments as well as voluntary agreements would not be so effective without informing target groups on their obligations, financial benefits etc. An example is presented in the box below.

An example of the impact of the policy package versus the impact of an individual instrument
The case of energy labelling of appliances in the Netherlands constitutes an interesting example. It can be questioned whether labelling as a single instrument would have had a substantial impact in the Netherlands. High efficient appliances are more expensive and are probably not attractive for consumers without additional policies (subsidies and/or eco-tax). What happened after the introduction of the energy label -and a subsidy scheme linked to it- was that the market share of energy efficient appliances increased rapidly and inefficient appliances were removed from the market. This happened at higher pace in the Netherlands than elsewhere in Europe. In this case the policy package counts up to success. In Sweden no subsidy scheme was linked to the labelling. Current penetration of high efficient appliances is comparable with penetration in the Netherlands. Market transformation, however, came at a later stage and might have benefitted from policies introduced in other countries [Kahn et al, 2007]

In the Residential and commercial buildings chapter of the fourth Assessment Report of the Intergovernmental Panel on Climate Change, it is stated that there is no single policy instrument that can capture the entire potential for GHG mitigation. Due to the especially strong and diverse barriers in the residential and commercial sectors, overcoming these is only possible through a diverse portfolio of policy instruments for effective and far-reaching GHG abatement and for taking advantage of synergistic effects. Since climate change literacy, awareness of technological, cultural and behavioural choices and their impacts on emissions are important preconditions to fully operating policies, these policy approaches need to go hand in hand with programmes that increase consumer access to information, awareness and knowledge (*high agreement, medium evidence*) [IPCC, 2007]

Annex I Assumed profiles for certification in rental sector and housing sales.

Assumed profile for certification in rental sector													
Year	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2030
% certified in year x	15%	14%	13%	12%	11%	10%	9%	8%	9%	10%	11%	11%	11%
Assumed profile for house sales													
Year	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2030
% sold after x years	0.21	3.48	5.89	6.07	6.36	5.55	5.18	4.53	3.68	3.48	3.13	2.96	1.50

4 Inspection of boilers and air-conditioning systems

4.1 Background assumptions for job creations

4.1.1 Estimation of job creation by 2020 for heating systems: between 125 000 and 195 000 jobs

Methodology:
To calculate the impacts on jobs creation for heating systems, we calculate first the stock of boilers in 2020 (Source: VHK Ecodesign of boilers and combi-boilers study, 2007). Then we assess the number of each type of boiler: the category between >15 years and >20kW requires one inspection every two years, whereas the others require one inspection every four years. Finally, we made an extrapolation for EU 27.
Comment:
Result depending on the hypothesis of the people in charge of inspection: 200 inspections per year for “inspectors” (without engineering expertise) / 100 inspections per year for “energy experts, consultants”. The figure 195 000 corresponds to the hypothesis that >15 years and >20kW inspections are made by consultants because of the high complexity of the boiler type.

4.1.2 Estimation of job creation by 2020 for air-conditioning systems: between 25 000 and 35 000 jobs

Methodology:
To calculate the impacts on jobs creation for air-conditioning systems, we calculate first the number of inspections for the five majors’ countries in 2020 (Source: Roger Hitchin, Jerome Adnot, Maxime Dupont: 'Issues of the implementation of the EPBD article 9', 2005). Then we extrapolate for EU-27.

Comment:
Result depending on the hypothesis of the people in charge of inspection: 200 inspections per year for “inspectors” (without engineering expertise) / 100 inspections per year for “energy experts, consultants”. The figure 35 000 corresponds to half inspectors and half experts.

4.2 Inspection of boilers and air-conditioning systems

EPBD requires undergoing regular inspections of heating and air-conditioning systems. These systems have very important energy saving potential, up to 40-60% of their total energy use. The current EPBD is estimated to result in 10 % energy savings. There is thus substantial margin for further savings. The need for further action is all the more important because of the enormous increase of air-conditioning systems throughout Europe.

4.2.1 Requiring an 'inspection report' for heating and air-conditioning systems

Current situation:

The existing EPBD inspection requirements broadly aim at energy and CO_2 savings, but they do not specify the inspections' content and deliverables. Therefore, some of the Member States' inspection schemes are inaccurate and give limited energy savings. In many Member States inspections are not sufficiently prescribed or only based on safety checks (i.e. in France), so they do not directly lead to energy savings. Further, few Member States have organised systematic information, promotion, and advice campaigns to date, as requested by article 8(b) of the EPBD.

Consumers and house should have access to better information. Better operation and control of systems and retrofit of old systems and components by more efficient ones, generates substantial savings. Proper and regular inspection and maintenance of the heating and cooling systems accompanied by adequate information/advice to building owners for retrofitting can significantly stimulate and accelerate these savings.

Suggested policy option to explore:

An inspection report should be given to building owner after the inspection. This should include an energy efficiency rating of the heating/cooling systems, e.g. compared to up-to-date and/or best technology available, and recommendations for cost-effective improvement measures.

An additional requirement could be introduced to provide an estimate of the cost of replacing the existing boiler, water heater, or cooling system with that required under Ecodesign minimum requirements, or 'A' class under Energy Labelling.

An inspection report including recommendations for system improvement would not need to be made in the same frequency as the inspection of the systems itself, as its rating and recommendation results remain valid for a longer period of time.

The relevant CEN standards for inspections could be further developed. These would allow an efficiency rating of the installations. They could represent an overarching guideline which supports Member States' implementation of an inspection report. The EPBD recasting could therefore directly refer to these CEN standards and minimum energy efficiency installation requirements could be set by Member States based on these standards.

As a further step, the recommended saving measures in the inspection report could be requested to be realized. Measures with short payback periods could be required to be implemented faster than the ones with a longer payback period. Therefore, the inspection report should have clear information on economic information to building owners.

Impact:
In average, the inspection report could bring about 30% of building owners inspected to follow the advice, e.g. in France, the impact of individual energy advice has been estimated at 30%, and in Sweden incentives on individual oil boilers substitution resulted in 30% renovation. The inspection report could lead to about 3-4% additional replacements of the stock of boilers and combi-water heaters by 2020. The annual savings by 2020 would be around 90 TWh (324 000 millions of MJ) primary energy, 20 Mt CO_2, or €2 billion (net of extra cost of replacement).

Inspections of heating and cooling systems can furthermore - apart from energy savings - achieve co-benefits, such as decrease of discomfort hours caused by non-properly operating heating/cooling systems, as examined by Bory et al. In addition, the new system could help manufacturers to produce heating and air-conditioning systems for the EU market which are easier to inspect, what could therefore improve the companies' competitiveness. Furthermore, inspection of heating systems is linked to creation of jobs, which can be estimated at 195,000 jobs (inspectors and energy consultants) in EU-27 in 2020. For air-conditioning systems, it can be estimated at around 35,000 jobs (inspectors and energy consultants) in EU-27 in 2020.

Additional cost to the Member States and their consumers of the inspection report should be low, as the information on the existing boiler, and system etc. should already be available from the building certificate and boiler/cooling inspection. Extra cost will be selecting the right size and technical specification of replacement and cost of installation system. Given a well designed system, the add-on cost to the inspector should be low (less than 10% of inspection cost e.g. every 4 to 6 years).
Finally, as is the case for recommendations from the buildings certificate, national subsidy schemes could and should support the investments that originate from the inspection report.

4.2.2 Introducing quality check and compliance requirements

Current situation:
The technical saving potential of the compliance requirements is estimated very high, to 30%, which correspond to around 840 TWh primary energy savings (3 024 000 millions of MJ), reduction of €55 billion of costs and 252 Mt CO_2e emissions savings for heating systems per year by 2020. Similarly regarding the air-conditioning systems, technical energy savings potential can reach a maximum of 50%. The energy savings of the compliance requirements can thus be estimated at around 20%, which correspond to around 16 TWh (57 600 millions of MJ) primary energy savings, reduction of €1.1 billion of costs and 5.7 Mt CO_2e emissions savings per year by 2020.
Without control, the inspection outcomes of heating and air-conditioning systems, the national inspection schemes unlikely achieve sufficient energy efficiency improvements. Analysis of stakeholders and experienced Member States (e.g. Sweden, Germany, France, Italy) recommend to ensure that effective enforcement systems are in place for compliance and to assess regularly and independently whether the control regimes are effective.

Member States have introduced substantially different requirements with regard to educational preconditions and training of the independent experts who are allowed to execute inspections. Their actual independence, required by the existing EPBD, and quality therefore broadly varies within the EU.
The importance of compliance controls is also underlined by numerous contributions to the public consultation on the EPBD recasting: About one third of all contributors asked explicitly for compliance control requirements for inspection in an EPBD revision, whereof about 90 % of them are representing big European associations.Any compliance control scheme for inspections should be well balanced with regard to control costs and achievable benefits in terms of energy and emission savings and their gross economic costs. Such a control scheme has to be as effective possible at low administrative efforts. In doing so, a positive balance between benefits and control costs (in terms of improved quality and saved energy and emissions) can be achieved.

Suggested policy option to explore:
Random sampling checks of inspection reports (presented in option “Requiring an 'inspection report' for heating and air-conditioning systems”) of different levels of detail and frequency could therefore be introduced as a new requirement. These levels of random sampling regime could range from validity checks of input and/or result data for inspection reports to on-site checks of heating and air-conditioning systems inspected. The compliance control regime could also guarantee a sufficient quality of experts carrying out the inspections leaving for the Member States to lay down training requirements and educational preconditions for inspectors. However, by a control of the inspection report a sufficient quality of inspectors would be checked automatically at the same time.
Member States could be requested to establish random sampling checks for e.g. 0.1 % of annually inspections carried out of 3 levels of detail: A certain share of these checks could requested to be done by a validity check of input data and given recommendations of inspection reports only. Another (lower) share could requested be checked (stricter) for input data and the recommendations could be recalculated by a controller. And another (very low) share of random sampling checks could consist of the aforementioned proposal plus control of the heating/air-conditioning system on site for correspondence with the certificate.

Results:
So similar to what has been described under the option regarding Quality and compliance requirements of certifcates a random sampling control of inspection results/reports is an option to improve the quality of inspections; guarantee a sufficient quality of information on energy efficiency improvement measures provided to the owner of a building by the inspection report and therefore increase the retrofitting rate of heating and air-conditioning systems and; ensure a sufficient quality of inspectors at the same time for reasonably low administrative efforts and costs.
A random sampling check of the inspection outcomes for heating and air-conditioning systems does have positive effect on creation of jobs: I.e. in Portugal, the quality of the certificates is checked every five years on 10% of the total. For inspections, random sampling rate can be assumed as similar, what could result in 23,000 jobs (inspectors and energy consultants) for EU-27 in 2020.

4.2.3 Minimum energy performance requirements

The present energy performance requirements and their levels of ambition broadly vary across the Member States, even within similar climatic zones. Cross-border comparisons of requirements fixed are difficult due to very different basic approaches regarding how energy performance requirements are calculated and expressed. In addition, a multitude of different parameters are used for calculation purposes. Furthermore, with regard these parameters, very different definitions exist in Member States. Moreover, some Member States focus on fixing the transmission losses of a building by setting minimum requirements for individual components, such as windows, others have established holistic energy performance rating methodologies, fixing e.g. the maximum allowed primary energy demand and/or CO_2 emission for a building. These may inter alia incorporate energy consumption for lighting, ventilation and domestic hot water.

This fragmented situation is the result of many years of development of building regulations in the Member States, each having different starting points, dates (some started decades ago, some recently) and executive bodies. The existing performance requirements and methodologies also regularly undergo revision. Furthermore, the performance requirements have to be in line with other, non-energy national building regulations, which are outside the scope of the EPBD. An all-embracing research project was launched in autumn 2007 in order to assess these differences and to analyse how cross-border comparisons can be made in principle. The project consists of 16 international partners from cross the EU and is scheduled to run for 2.5 years.

The overarching aim of an EU legal activity on energy performance requirements in the buildings sector is to achieve optimum performance requirements, which are feasible, cost effective and in balance with provoked energy savings, technical and environmental feasibility and subsidiarity. It is also important for regulation to encourage and not hamper innovation in the buildings sector. The existing EPBD respects this by setting the frame with a holistic methodology (instead of fixing very specific details of each component of a building) and any change in legislation must recognise the importance of this approach.

5 Minimum energy performance requirements

This section provides analysis possible benchmarking schemes throughout the EU as an input for the European Commission's impact assessment for the recasting of the EPBD. Options explored in this option are also covered in chapter 2 (see section 2.3).

5.1 Establish EU energy performance requirements

This option proposes to specify EU-wide energy performance requirements for buildings in the EPBD taking into consideration central factors such as different climate zones and buildings types (residential and non-residential buildings). This option is essentially a top down approach stemming from the supranational level and extending to national and sub-national remits. This option explicitly addresses the uneven and often sub-optimal energy efficiency legislation in buildings throughout the EU, by imposing binding, harmonized and cost-optimal requirements to be applied throughout the EU.

Such an approach to improving energy efficiency in buildings is promising in terms of rendering cross national comparisons easier, easing compliance through standardization, and in the long term removing administrative and regulatory barriers to the European single market. On the whole, a set, binding directive on energy efficiency performance requirements in buildings could provide the Commission with a clear "level playing field" to assess, monitor, and enforce the EPBD.

However, such binding and uniform requirements run a twofold risk. Firstly, given the multifarious configuration of the building stock throughout the EU, as well as the different variables affecting energy consumption (climate zone, related regulations, new vs old buildings etc.), elaborating a cost-optimum standard set of requirement to fit the specific particularities of all EU-27 member states would prove quite trying indeed. Furthermore, it would anchor such requirements in a rigid way in the recasted EPBD directive, by leaving little or no room for future manoeuvre with regards to the evolution of energy efficiency practices in national building stock policies.

Finally, lessons learnt from past European regulation in issues not directly pertaining to the single market (e.g the broad agenda set out in the Lisbon agenda of 2000) points to providing more flexible compliance standards in forums such as the Open Method. Envisaging having national action plans laying out the configuration of the building stock, the energy efficiency goals to be reached and a coherent and realistic method for achieving these goals in a giving timeframe seems to be a more suitable approach to this particular directive in light of the items mentioned above.

5.2 Introducing a benchmarking mechanism

National energy performance requirement comparison

It is notoriously hard to draw definite conclusions from comparing national energy performance (EP) practices. Such is the case even among member states in similar climate zones. In particular, there is substantial uncertainty with regards to the extent to which one or several building references and system configurations are representative of the average of all new and old building stocks. Indeed, a great number of minor and sometimes random variables may have a determining impact on calculation outcomes and overall conclusions. For instance, even if energy consumption is expressed in kWh/m^2, national conventions on the definition of the reference floor area are a variable to account for. Other examples making it impossible to accurately, although not meaningfully compare various national practices include differences in variables included in calculations such as the energy use of electrical appliances, different calculation methodologies for occupancy, hot water use, internal heat gains, treatment of thermal bridging etc. Focusing on establishing comparable benchmarks should thus be a priority and a locus of attention of the current recasting of the EPBD. Although Member States are already following principles laid out in the applicable European standards (CEN specifically), a guiding benchmarking system established in this present recasting has the potential to improve progress in achieving energy efficiency at the corresponding cost-optimum levels.

Although it is not possible to obtain clear results in comparing various national benchmarking systems among one another, drawing comparisons among national energy performance in building practices can provide useful lessons, not least in the current context of the recasting of the EPBD. Indeed such cross national comparisons may bring to light differences in calculation methods and thus inform the European Commission on what applicable and transferable “best practices” may be of use in the context of establishing benchmarking mechanisms throughout the EU. Furthermore, setbacks and undesired effects in examining national practices can also inform future policy approaches in energy performance requirements in buildings at the supranational level. An assessment of the level of compliance in national legislation of energy performance requirements can inform the ongoing discussion with regards to tightening the requirements, together with considerations related to the economically optimal energy performance, the degree of compliance with the requirements, the maturity of the market, etc. Below is an overview of existing benchmarking systems in some of the best performing European Member States.

5.2.1 Suggestions for establishing an EU wide benchmarking system

Based on consultation with national experts, comparison among countries often demands a specific methodology for each case and cross national evaluation, with emphasis put on accounting for the most important differences among countries (methodologies, climate etc.). However, using a “common denominator” to adjust and adapt existing calculation methodologies can bring one closer to comparing, and ultimately evaluating varying national practices in the energy performance of buildings.

Comparing two or more countries among each other may rely on establishing or referring to Standard Assessment Procedure (SAP 2005), a calculation methodology that complies with the EPBD and is based on standardised assumptions about occupancy and heating patterns. Given that a number of EU countries are already relying on the SAP calculations, it is useful to think of a possible benchmarking mechanism that identifies EU wide common practices as founding pillar for building an adaptable and transferable benchmarking system for the whole of the EU-27.

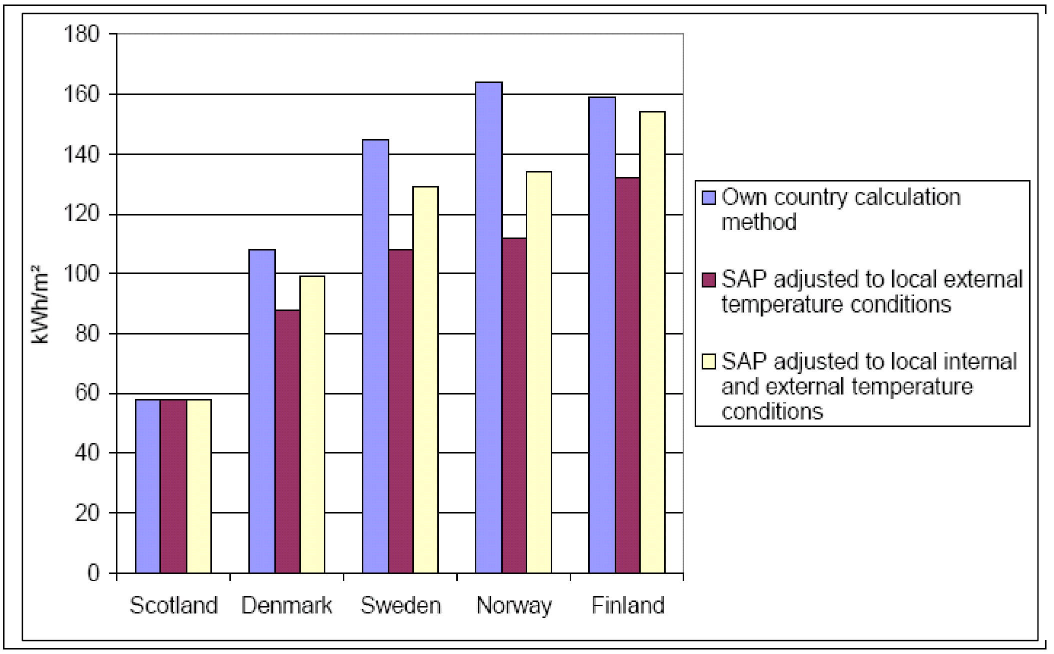
Denmark

Calculation standards in Denmark use a common EU denomination of calculated energy use, which is expressed in kWh/m². The methodology accounts for the efficiency of the heating installations, heat losses from heat distribution systems, energy for water heating and overall energy for household electricity multiplied by a factor of 2.5. In order to compare Danish performances to other EU countries, relying on the SAP calculations and the items included in it (space heating, water heating, mechanical ventilation and in some cases, lighting) is an important step to lay the base for comparison. Such a process can be anchored in a standardized EU wide benchmarking mechanism. For instance, although "internal" Danish calculations (i.e. not aiming at an cross national comparison scheme) initially express energy/ m² on the basis of external dimensions for the floor area, they may be adjusted to internal dimensions in order to provide meaningful comparison with other countries which use an adjusted methodology.

Based on the above mentioned cross national harmonization tools, namely building on the SAP calculation, the SBSA 2007 report provides an adjusted benchmarking tool to compare several countries among each other based on their national calculations – provided adequate disclaimers on the ultimate accuracy of the results is taken into account (see Figure 5.1).

In order for a meaningful comparison to take place in countries located in different climate zones, the benchmarking developed in the SBSA report used a reference dwelling and the SAP methodology, as well as degree-day data (the difference between the mean internal and external temperature obtained on a daily basis and summer over the heating season). In other words, in an EU wide benchmarking system, *space heating requirements are adjusted and directly proportional to degree-days.* Figure 5.1 shows the process of "raw" national calculations that evolve into a benchmarking system to compare various national performances and methodologies.

Figure 5.1Comparison of energy required (kWh/m2) for space heating of benchmark building using a) country calculation methods, b) SAP 2005 adjusted for external temperature and c) SAP 2005 adjusted for both external and internal temperature assumptions of each country



Adapted from SBSA 2007: International comparison of energy standards in building regulations: Denmark, Finland, Norway, Scotland and Sweden

It is important to bear in mind that although mitigating climate differences in calculation may be feasible, one should always proceed with caution by directly comparing energy performances of buildings among different countries, given the assumptions of national methods, even when SAP standards are applied. Indeed, although fixed values are set for building features in EU countries, such values may appear deceptively comparable. In an illustrative example, the BBR 2008 study notes that “the diameter of the pipes to the bath and shower in the semi-detached dwelling in this study [Flanders] is 18 mm, whereas in the NL such pipes are generally much smaller. So in the Dutch methodology the largest pipe diameter is the category “> 10 mm”, which implicitly calculates with a fixed value of 13 mm.”
Other obstacles in obtaining direct comparisons are factors such as energy use for electrical appliances and other energy using products (boilers and water heaters in particular), hot water use and other different inherent assumptions.

On the whole however, the closest methodology to be developed for an EU wide benchmarking mechanisms can build on the SBSA 2007 report, as well as the analysis and observations made in similar exercises in comparing cross national energy performance of buildings.

Administrative Costs

A side effect of national implementation measures of energy efficiency standards is a drive up in the administrative costs of fragmented policies and requirements. For instance, the costs of obtaining Energy Performance Certificates at the national level increases the burden of such a procedure, in terms of paperwork, time, and financial costs. For instance, although the Netherlands already meets EPBD requirements on a number of points, issues still requiring compliance are being adapted and incorporated into Dutch law (Article 7 - Energy performance certificate), or measures are brought under the attention of the end-users via another route (Article 8 - Inspections of boilers and Article 9 - Inspections of air-conditioning systems). Like the European Union, the Dutch government has an active policy to keep the administrative costs for citizens minimised. For this reason, the costs for obtaining a certificate are kept to a minimum. There is little available data on the administrative costs of national measures on building energy efficiency. However it is clear that a more uniform and harmonized approach at the EU level has the potential to significantly decrease costs.

5.2.2 Building on existing policies and incentives

Beyond the calculation methodology to be devised for establishing a benchmarking system, taking into account the practical aspect of implementation to reach goals set out in a recasted EPBD are important to consider. Namely, integrating existing and best performing practices of certain member states as standards and guidelines into an EU-wide policy should be considered. A study for the EURIMA Blueprint Project mapped an exhaustive list of common and best performing practices in renovation and energy performance improvement thrusts throughout the EU.

Table 5.1 Implementing instruments for energy efficiency in buildings policies in the EU

Regulatory instruments	Regulatory benefits for above-standard energy performance
	Above-standard requirements for government buildings
	Mandatory environmental performance evaluation with minimum requirements
	Energy upgrading requirements when renovating buildings
Economic instruments	Preferential loan for significant (above-standard) energy performance improvements
	Tax credits for installing energy saving products
Communicative instruments	Building energy performance audits
	Demonstrating projects
	Voluntary energy conservation agreements
Organizational instruments	Independent energy audits with organisational support
	Professional management for multi-family housing
	Independent verification of sustainable real estate investments
	Energy service contracts

Source: Klinckenberg & Sunikka 2006

5.3 Setting up EU wide low or zero energy or carbon buildings/passive house requirements

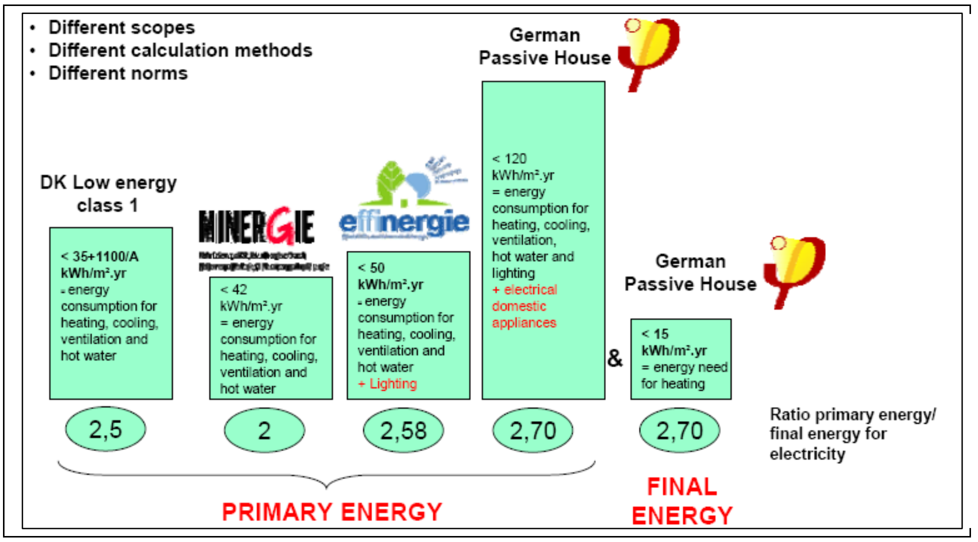
In June 2008, the town Council of Marburg in Germany took the decision of obliging all new and old buildings undergoing renovations to have solar panels installed in view of turning the town into a zero energy town. A penalty of 1.000 Euros for non-compliance was also enacted. While this example is extreme, it comes to show how central the notion of passive house requirements has become, ranging from the supranational to the local level.
The revised Energy Performance of Buildings Directive (EPBD – 2002/91/EC) could provide auspicious ground for the European Commission to introduce requirements that set targets to make the use of low energy homes a widespread and sustainable practice in the European Union.

5.3.1 Measures for passive housing requirements in a recasted EPBD

The most up do date mapping of the current situation of initiatives aiming at introducing larger scale passive housing was undertaken by the European Alliance of Companies for Energy Efficiency in Buildings (EuroACE) in the Spring of 2008. Although many European countries are taking steps towards implementing requirements for very low energy housing over a 5-12 year timeframe, few intend to strengthen the requirements for existing buildings, which is an important step towards achieving a major reduction in the overall energy used for buildings. In order to do this effectively, the recasting of the EPBD should request that Member States define very low energy housing at national level, draw up a national strategy towards this level of energy performance, and start to focus on upgrading the energy performance of the existing building stock. Such a policy option could in fact be a complimentary addition to a benchmarking mechanism, using similar Open Method type approaches combined with strict monitoring and evaluation practices.

Defining very low energy buildings
In order to establish a requirement for passive housing in the EU, a common definition may be desirable, although specify minimal requirements for passive building design such as for the thermal envelope could prove more practical. Indeed in the EU, although requirements are present in certain forms in a number of member states, definitions of what constitutes passive housing differ, sometimes significantly. Seven out of twenty seven EU countries have an official definition of passive housing: Austria, the Czech Republic, Denmark, Finland, France, Germany and the United Kingdom - England and Wales. Future planned official definitions are in the pipeline in Belgium, Luxembourg, Romania, Slovakia, Norway, Sweden, and Switzerland. EuroAce observed that countries in the EU in general have different definitions, scopes and importantly, calculation methods. Figure 1.2 provides an example of different calculation methods between Denmark, Switzerland, France and Germany.

Figure 4.2 Comparison of different performance standards



Source: Effinergie presentation, March 2007. Adapted from EUROACE SBI Survey, March 2008: European national strategies to move towards very low energy buildings

Determining the primary energy consumption of a given building is usually the goal of calculation methodologies. Yet, as mentioned above, several factors, even under this broad methodology, produce different results. Indeed, the definition and thus the calculation of primary energy consumption depends on the chosen boundary for calculations (i.e. at which point in the energy consumption cycle of building to make calculations). In most EU countries, primary energy calculations take place between the point of extraction of the energy source and the entry of energy into a given building. Therefore, conversion losses of energy vary depending on which point is chosen. The thermal envelope of a building also constitutes a boundary level for calculations.

The ongoing Assessment and Improvement of the EPBD Impact (ASIEPI) is currently elaborating a benchmarking method to compare and assess national energy performance requirements in Member States.

5.3.2 Job creation and associated costs for EU passive housing requirements

Under this option, costs associated with expanding passive housing in the EU are remarkably high. Job creation is tightly linked with inspection schemes in the EU, as well as skilled job development in remits such as heating and cooling systems. As such, figures available on inspection as well as heating and cooling are taken into account.

Costs

Investment costs for passive housing are substantial. A stated goal of rendering 210 million m^2 of newly constructed commercial and residential buildings into passive housing every year in the EU, i.e the quasi totality of newly constructed commercial and residential buildings in the EU (as an indication, this is more than ¼ of the entire residential building stock of France) would cost between €50 billion and €120 billion a year on top of regular construction costs for new buildings. The substantial costs involved in expanding passive housing, as well as the differing national definitions of passive housing, tends to point to a flexible and less constraining application and requirements from the EU level.

Jobs

Given that the above goal of rendering 210 million m^2 of newly constructed residential and commercial buildings into passive housing is only indicative (it is not realizable even in the medium term), jobs creation associated with a thrust in passive housing promotion would encompass those jobs created in certification inspections, up to 80.000 by 2020 (given that such a scheme would be a pre-requisite for a well functioning passive housing policy). In addition, specialization in passive housing construction (architects, consultants, specialized construction firms and workers) has the potential to create up to 120.000 jobs, depending on the extent to which passive housing is widespread. These numbers take into account ECOFYS' methodology, whereby turnover from energy efficiency projects is divided by the average turnover per employee in the construction sector and multiplied by a specific factor. Here, a lower factor (0.5) is used given that energy efficiency costs for passive housing are higher. As such, job creation is not projected to be as high as for less costly (in terms of additional investments) policies (e.g. option A and B). It is important to note that these numbers are purely indicative as the realization of 210m2 of passive housing a year is not currently feasible. Thus job creation, must be understood to be proportional to the extent to which passive housing expansion occurs.

Finally, the less constraining nature of passive housing requirements also give room for less stringent applications and ultimately, job creations.

We took average prices of newly constructed square meter based on ADEME figures (http://www2.ademe.fr/servlet/KBaseShow?sort=-1&cid=96&m=3&catid=15019), and calculated extra costs (7% -15%) associated with passive housing and the benchmarking goals of 210m2 per year.

See, Option B1 in DG TREN IA

Extrapolations based on skilled jobs required for option B and C in the IA as well as on EURIMA studies.

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Annex II

$ per barrel	2005	2020	2030
EC, high price scenario	54,5	100,1	119

According price scenario in cent/kWh incl. taxes		2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Gas	cent/kWh	9,8	9,9	10,1	10,2	10,4	10,5	10,7	10,9	11,0	11,2	11,4	11,5	11,7	11,9	12,1	12,2	12,4	12,6	12,8	13,0	13,2	13,4
Oil	cent/kWh	8,9	9,1	9,2	9,3	9,5	9,6	9,8	9,9	10,1	10,2	10,4	10,5	10,7	10,8	11,0	11,2	11,3	11,5	11,7	11,9	12,0	12,2
Electricity	cent/kWh	16,8	17,0	17,3	17,5	17,8	18,1	18,3	18,6	18,9	19,2	19,5	19,8	20,1	20,4	20,7	21,0	21,3	21,6	21,9	22,3	22,6	22,9
District heating	cent/kWh	10,3	10,5	10,6	10,8	10,9	11,1	11,3	11,4	11,6	11,8	12,0	12,1	12,3	12,5	12,7	12,9	13,1	13,3	13,5	13,7	13,9	14,1
Wood	cent/kWh	6,1	6,2	6,3	6,4	6,5	6,6	6,7	6,8	6,9	7,0	7,1	7,2	7,3	7,4	7,5	7,6	7,8	7,9	8,0	8,1	8,2	8,4

i. Estimations made corresponding to current Danish action plans, for new buildings.

ii. Due to boiler replacement combustion efficiency increased on average by 7 % in Italy (mainly gas boilers) and 5 % in Finland (mainly oil boilers); Fuel saving due to a more frequent regular maintenance (yearly instead of customary average) was calculated between 1.3 % and 2.5 % (Ireland); Statements by Marcello Antonucci, Krzysztof Klobut in presentation 'How to evaluate the impact of inspections and advice programmes for boilers' at 9th World Congress Clima2007, Helsinki, June 2007 (http://www.rehva.com/projects/clima2007/WSs/WS7/WS7_pSUMMARY.pdf)

iii. Directive 2006/32/EC of the European Parliament and of the Council of 6 July 2005 establishing a framework for the setting of ecodesign 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, OJ L 191, 22/07/2005 p. 29 -58

iv. 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, OJ L 297, 13/10/1992, p. 16–19

v. The outcomes of relevant projects under the SAVE programme, such as AUDITAC and HARMONAC, can be of further support.

vi. 'Summary of WS : How to evaluate the impact of inspections and advice programmes for boilers' at 9th World Congress Clima07, Helsinki, 2007, www.rehva.com/projects/clima2007/WSs/WS7/WS7_pSUMMARY.pdf

vii. VHK EcoDesign of boilers and combi-boilers study, 2007 and DG TREN model based calculations built on the VHK study.

viii. Daniela Bory, Jerome Adnot, Carmelo Greco, Dominique Marchio: Auditing the European room air-conditioning systems and potential energy savings, 2007

ix. VHK EcoDesign of boilers and combi-boilers study, 2007, task 2 and extrapolated from EU-25 to EU-27 by BIO Intelligence Service S.A.S. (using calculation methodology according to Jerome Adnot)

x. In 2017, based on extrapolation out of Roger Hitchin, Jerome Adnot, Maxime Dupont: 'Issues of the implementation of the EPBD article 9', 2005

xi. VHK EcoDesign of boilers and combi-boilers study, 2007, task 6, p. 36 (data correspond to scenario for design option 3 for XL boilers).

xii. Daniela Bory, Jerome Adnot, Carmelo Greco, Dominique Marchio: Auditing the European room air-conditioning systems and potential energy savings, 2007.

xiii. Based on extrapolation out of data originating from 'Energy Efficiency and Certification of Central Air Conditioners' (EECCAC), 2003.

xiv. As e.g. presented at the 2nd Sustainable Energy Week event 'Energy Performance of Buildings Directive - Next Steps' in January 2008 and as demonstrated in a Swedish case study of 2007 (see European Energy Network EnR: Implementation of the Energy Performance of Buildings Directive - a snapshot report, 2008),

xv. Example presented at the 2nd Sustainable Energy Week event 'Energy Performance of Buildings Directive - Next Steps' in January 2008 and as demonstrated in a Swedish case study of 2007 (see European Energy Network EnR: Implementation of the Energy Performance of Buildings Directive - a snapshot report, 2008). In Sweden, energy monitoring must be undertaken for a period of two years after the building has been completed, to demonstrate compliance on the ground. The policy was introduced in mid-2006 and results will begin to emerge soon.,Large property developers have expressed their support for the initiative.

xvi. Provided by ECORYS

xvii. For similar objectives, Denmark already revised its certification procedure in 2006, firstly introduced in 1997, to 'quality level' 5 and 6 respectively in its 2nd generation certification scheme:

xviii. In a range from 1 to 6, 1 being lowest quality which only consists of "Meter reading reported by the building owner and the utility companies", whilst 5 and 6 mean "Computation by energy consultants based on building envelope inspection" and " Computation by energy consultants combined with meter reading".

xix. The revision of the Danish provisions was based on several years of experience since 1997, which also underlined the importance of quality control within the certification scheme (subsequently also named as 'label'/'labelling scheme'). The analysis of Jensen et al conclude that "Confidence in the energy label is the most important factor in achieving the main aim of the labelling scheme - energy savings. The user must at all times have confidence in the registrations made, the calculations, the label itself, and especially that the suggested energy saving measures are viable and will result in improved economy. Thus, it is essential to maintain a high level of quality in the energy labelling scheme. If quality is poor, the users will lose confidence in the labels. […] Credibility may be lost very fast as a few poor labels can do a lot of damage. The quality control of the Danish energy labelling scheme takes place at all levels of the scheme.", taken out of: Ole Michael Jensen, Morten Tony Hansen, Kirsten Engelund Thomsen, Kim Wittchen: Development of a 2nd generation energy certificate scheme – Danish experience, 2007

xx. Underlying that an accredited expert, specialised on issuing energy performance certificates for buildings, compiles one certificate per working day, so about 200 certificates a year. A random sampling check of 0.5 % of certificates would therefore mean that accredited experts face with one control per year on average.

xxi. Provided by ECORYS/BioIntelligence

xxii. Energy performance requirements: meaning regulations which limit the energy use of buildings under standardised conditions, expressed as a fixed limit of e.g. the annual final or primary energy use in kilowatt hours per square meter useful floor area of a building [kWh/m2.a]

xxiii. Such as e.g. "useful floor area", a common value on which the energy performance of a building is based on: Energy consumption in kWh per m2 useful floor area, varying up to +/-10 - 15 % across Member States, see e.g. information paper P65 "Comparing Energy Performance Requirements over Europe" at the Commission's Buildings Platform (www.buildingsplatform.eu).

xxiv. ASIEPI project - Assessment and Improvement of the EPBD Impact, project under the Intelligent Energy Europe Programme, 10/2007 to 3/2010

xxv. Ambitious energy performance requirements for buildings (insulation and reduction of uncontrolled ventilation by improved air-tightness) sometimes have been blamed for a degradation of the indoor environment and increase in problems in connection with moisture and dampness in buildings. Several studies, such as the comprehensive Swedish survey about health, well being and energy efficient buildings (Energy efficient and healthy buildings, M. Gullberg, ÅF Process Sweden, E. Öfverholm, Swedish Energy Agency, M. Bengtsson and N. Tolstoy, National Board of Housing, Building and Planning, 2005) disproved this claim. Health aspects in buildings are rather a question of proper construction work and pattern of use, independent of the level of energy performance requirements on the construction, notably that adding envelope insulation and improving air-tightness need to be made together with correct ventilation and air-conditioning systems.

xxvi. In this regard, e.g. an overall limitation of the building's primary energy demand calculated according to the aforementioned holistic methodology by a building regulation leaves full room for best technical solutions how to comply with these requirements, so which combination of e.g. insulation levels, boiler efficiency level and use of renewable energy sources ensures to keep the overall primary energy limit of a building. A counter-example would be to define exactly in the building regulation what type/level of insulation has to be used for the building envelope or which type of boiler is allowed to be installed etc in order to limit the energy consumption of the building.