The Energy Efficiency Investment Potential for the Building Environment

Two approaches

Client: DG ENER

Rotterdam, 7 November 2012

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Client: Directorate General for Energy of the European Commission

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1 Introduction

The aim of this report is to explain how the Energy Efficiency Investment Potential for the building environment can be calculated. We use two approaches. Both approaches are based on the Frauenhofer study on energy saving potentials (Eichhammer et al., 2009) [1]. The first approach uses additionally the ECF study on energy saving policies (Wesselink et al., 2010)[2]. The second approach falls back on the in October 2011 published report on the building environment in Europe from the Buildings Performance Institute Europe (BPIE)[3]. Another distinction is the definition of buildings, where in the second approach new buildings will also be taken into account.

It should be noted that the estimated figures in both approaches are characterized by high uncertainties and, hence, have to be treated with due care.

The Fraunhofer study

The most comprehensive EU-wide energy savings potential study to date has been carried out by Fraunhofer Institute & Partners (2009).[4] This study took a detailed bottom-up approach to assess the energy savings potential for end-use sectors in the EU Member States. The Fraunhofer study is based on the economic drivers such as defined by the 2007 EU Baseline Scenario (Capros et al., 2008)[5].

The Frauenhofer study analyses several scenarios on energy saving potentials, including the so-called 'Low Policy Intensity' (LPI) scenario and the 'High Policy Intensity' (HPI) scenario. The LPI scenario includes the effects of energy savings measures that are cost-effective for consumers under normal market conditions. The HPI scenario includes all measures that are cost-effective for an entire country (i.e. also measures that are not cost-effective from a consumer point-of-view). The LPI and HPI scenarios have been selected to provide a lower and upper bound for the estimate of the EE market size in the buildings sector.

The energy savings potential identified by the Fraunhofer study is the savings potential that can be realized beyond the 2007 EU Baseline Scenario. This definition of the Fraunhofer potential should be borne in mind when moving to the definition of the Energy Efficiency Investment Potential. The Investment Potential includes all investments in energy efficiency options between today and target year 2020. This means that the Energy Efficiency Investment Potential also includes those options that are assumed to be implemented in the baseline scenario.

Figure 1.1 shows the HPI energy savings potential such as identified by Fraunhofer & Partners. The Mtoe figures should be carefully interpreted for three reasons:

1. The Fraunhofer study used 2005 as base year and assumed uptake of additional policy measures to realize the savings potential as from 2005. As actual policies have been delayed or implemented in weaker form than needed to realize the potential, the figures most likely overestimate the savings that can be realized in the period up to 2020.

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[1] Eichhammer, W., T. Fleiter, B. Schlomann, S. Faberi, M. Fioretto, N. Piccioni, S. Lechtenböhmer, A. Schüring, G. Resch (2009): Study on the Energy Savings Potentials in EU Member States, Candidate Countries and EEA Countries.

[2] TREN/D1/239-2006/S07.66640, Karlsruhe, 2009.Wesselink, B., R. Harmsen and W. Eichhammer (2010): Energy Savings 2020 – How to triple the impact of energy saving policies in Europe. Report to the European Climate Foundation (ECF).

[3] http://www.bpie.eu/eu_buildings_under_microscope.html

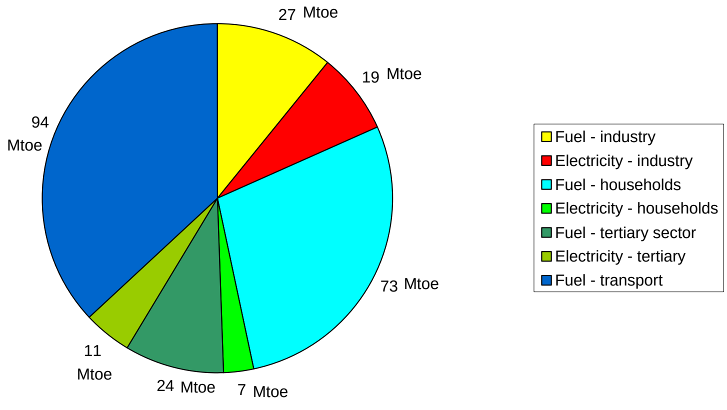
[4] http://ec.europa.eu/energy/efficiency/studies/doc/2009_03_15_esd_efficiency_potentials_final_report.pdf.

[5] http://ec.europa.eu/energy/observatory/trends_2030/doc/trends_to_2030_update_2007.pdf.

2. The Fraunhofer study does not take into account the impact of the economic recession of 2008/2009. The lower level of energy consumption being the result of the recession means that the energy savings potentials are also lower (example: lower transport activity means that energy efficiency improvement in transport results in reduced savings).
3. The Climate & Energy Package of the European Commission and accompanying policies have been implemented in the mean time. Examples are a set of Implementation Measures under the Eco-design Directive (minimum energy performance standards) and CO_2 regulation for new cars and vans. As a result, part of the identified savings by the Fraunhofer study is assumed to be already realized.
4. In the updated 2009 EU Reference Scenario (Capros et al. 2010)[6] the effects under point 2 and 3 are taken into account and result in a lower energy consumption in 2020 compared to the 2007 scenarios. However, the savings potential on top of the 2009 scenario is also lower.

The LPI and HPI saving potentials are claimed to be cost-effective from the viewpoint of energy consumers and society at large respectively. This implies a cost-benefit analysis for all saving options that compares investments, transferred into yearly costs, with yearly energy savings times energy prices. Fraunhofer & partners do not report the investments for the saving potentials, but in a separate report for ECF, they provide estimates of total investments per sector up to 2020.

Figure 1.1 Energy savings potential end-use sectors in 2020



Source: HPI scenario Fraunhofer study

The ECF report

In the ECF report (Wesselink et al., 2010) it is argued and shown that the so called High Policy Intensity (HPI) Scenario of the Fraunhofer study fits best with the 20% energy savings ambition of the European Union. The HPI scenario assumes a major policy effort to overcome energy efficiency barriers, including policies that de-facto make energy efficiency measures cost-effective from an end-user perspective. Cost-effective is considered under “ideal” conditions, i.e. not using discount rates that reflect current rates at which end-users have access to capital, but using discount rates between 6 and 8% reflecting long-term societal and political priorities.[7]

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6 Note that this effect does not have an impact on the Energy Efficiency Investment Potential. See discussion on the definition of energy savings potential used by Fraunhofer and the definition of the Energy Efficiency Investment Potential before.

7 See Wesselink et al. (2010, p. 14 and 47), http://www.roadmap2050.eu/contributing_studies.

The ECF report provides Marginal Abatement Cost Curves (MACC) per sector for saving measures, starting with the cheapest measures. These curves were used to calculate the annual net costs of realizing a given saving potential. Account was taken of the potential already used up in the baseline. The saved annual energy costs, calculated with the energy prices in the ECF report, together with the net costs, result in gross annual costs, mainly constituting annualized investment costs. These were transferred into total incremental investment costs using the discount rates mentioned in the ECF report.

Europe's Buildings under the Microscope (BPIE)

This report analysed Europe's building stock (EU 27 + Switzerland and Norway) including building characteristics, building codes and other regulatory measures. The collected data (survey) allowed to determine the energy and CO_2 saving potential of Europe's buildings and to model a variety of scenarios for the systematic renovation of the European building stock till 2050.

2 Approach 1

Approach 1 is limiting the building environment to the following sub-sectors:

- Dwellings (excluding electricity for lighting and appliances)
- Tertiary buildings (including electricity for lighting, fans and AC)
- Office buildings in industry.

The methodology for estimating the energy efficiency investment potential in the building sector according to the HPI scenario is built on the following assumptions:

- In line with the Energy Efficiency Plan-2011 approach, it is assumed that the HPI potentials should be realized. These potentials are defined in the Fraunhofer study per sector, i.e. Households 51 Mtoe, Tertiary 26 Mtoe, and Industry 46 Mtoe (see first column of Table 2.1).

- These potentials were corrected for non-buildings energy use and for the energy savings already realized according to the lower energy-intensity per sector for PRIMES-2009 compared to the PRIMES-2007 scenario. Finally the potentials have been expressed in primary terms (electricity with factor 2.5) in coherence with the MACC approach (see next point)[8].This results in corrected HPI-building potentials of 41 Mtoe for Households and 22 Mtoe for Tertiary (see second column of Table 2.1). For industry, the Fraunhofer study does not provide separate data on savings in office buildings. From other sources it is estimated that industrial office buildings constitute about 10% of all Tertiary buildings. This fraction has been used for all data for industrial buildings.

- For the corrected HPI potentials, the total annual costs/benefits have been roughly estimated, based on the corresponding Marginal Abatement Cost Curves (MACC) for each sector from the ECF study (Wesselink et al., 2010). These total annual costs/benefits are assumed to consist of the annual energy saving benefits on the one hand and the annualized investments on the other.

- The MACCs of the ECF study do not specify separately the costs (investments) and the benefits (lower energy costs). The annual energy savings benefits have been estimated by multiplying the amount of energy savings (in Mtoe) by the corresponding energy prices, as specified in the ECF study (see Table 2.1, column ‘Energy saving benefits’).

- The annualized investment costs follow from subtracting the annual energy saving benefits from the total annual costs/benefits.

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8 Sometimes it is argued that the Marginal Abatement Cost Curves approach doesn’t take into account real discount rates, transaction costs and the price of carbon and as such would affect the cost estimates.
The discount rates used here – as explained in the Fraunhofer and ECF study – reflect a situation in which the major barriers for refurbishment are solved. In case these are not solved, it could indeed lead to an underestimation of real costs. Net transaction costs (the sum of hidden costs and benefits) are particularly significant in case all refurbishment options are taken one-by-one instead of a package approach. In the latter case, these costs fall within the uncertainty range of investment costs used by Fraunhofer. One should also note that perceived costs might differ from household to household based on several factors (motivation, familiarity with the technology etc.). We refer to a study from Ecofys on ‘the hidden costs and benefits of domestic energy efficiency and carbon saving measures (DECC, 2009)’.
Concerning the price of carbon, prices in the Fraunhofer study are end-use prices based on the PRIMES scenario. These include carbon prices.

- Finally, the amount of total investment needs up to 2020 has been estimated by multiplying the annualized investment costs by an annuity factor, based on ECF discount rates and assumed lifetimes of the investment concerned (see last column of the Table 2.1).

Table 2.1 Energy saving potentials and total investment needs up to 2020 in buildings

	Energy saving potentials in 2020		Annual costs/benefits			Total investment needs up to 2020 (B€)
	Original HPI potential per sector[a] (Mtoe)	Corrected HPI potential for buildings only[b] (Mtoe)	Total costs/benefits (B€)[c]	Energy saving benefits (B€)[d]	Annualised investment costs (B€)	
Households	51	41	-7.1	-74.8	67.7	428
Tertiary	26	22	0.4	-16.4	16.8	145
Industry	46	2	-16.6	-12.8	-3.8	15
Total	**123**	**65**	**-23.3**	**-104.0**	**80.7**	**587**

a) Original estimates by Eichhammer et al. (2009).
b) Corrected for non-buildings energy use and for the energy savings already realized according to the PRIMES 2009 scenario.
c) Negative figures imply benefits ('negative costs').
d) Energy savings * energy prices

Summarizing the above, we can read that, given the definition of the building environment, the corrected HPI potential by 2020 is 65 Mtoe, which leads to an investment of 587 billion euros by 2020.

3 Approach 2

In approach 2, the building environment is defined as:

- Refurbishment of public buildings;
- Refurbishment of the residential sector;
- New buildings with an energy performance beyond standards.

As such, we will not take into account the energy efficiency investment potential of electricity savings from (household) appliances and lighting as most of this potential is regulated by means of minimum performance standards under the Eco-design Directive. Compared to approach 1, a clear distinction is made between the refurbishment of public versus residential buildings and new buildings will be taken into account.

Before discussing the Energy Efficiency Investment Potential, an overview of the current status of the built environment sector is given. This will be used as building blocks for determining the Investment Potential.

3.1 Current status

Floor space

In October 2011, the Buildings Performance Institute Europe (BPIE) published an extensive report on the built environment in Europe.[9] According to the figures in this report, the EU27 has 24 billion square meters of floor space in the built environment, of which 75% in the residential sector and 25% in the non-residential sector. Data for the residential sector is further split in an EU average 64% share for single family houses and 36% for apartment blocks. The non-residential floor space is split in an EU average 28% wholesale & retail, 23% offices, 17% education, 11% hotels & restaurants, 7% hospitals, 4% sport facilities and 11% other.

Building ownership

For discussing the energy efficiency investment potential of the (proposed) binding refurbishment rate for public owned buildings, insight is needed in ownership structures in the different Member States. Used figures are coming from the BPIE study survey. The differences between the members states are huge. Private ownership of non-residential buildings is less than 15% in Estonia and Bulgaria but more than 80% in Denmark, France, Lithuania, Latvia and Greece. For residential buildings, more than 80% is occupied by the owners in Spain, Hungary and Romania; in countries like the Netherlands and Austria it is only 60%.

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9 http://www.bpie.eu/eu_buildings_under_microscope.html

3.2 Energy Efficiency Potentials

Energy Efficiency Potentials in existing buildings

This section is basically based on two studies, i.e. the Fraunhofer 2009 study and the BPIE 2011 study.

As indicated in Figure 1.1, the 2020 cost-effective potential for energy savings in the built environment is 115 Mtoe at the EU27 level. The majority of the potential (97 Mtoe) is related to space heating, whereas the remaining 18 Mtoe is related to electricity savings from (household) appliances and lighting. The savings potential in the residential sector is 2/3 of the total potential in the built environment. The cost-effective fuels savings potential are also given in the Fraunhofer HPI scenario (Fraunhofer ISI & Partners, March 2009)[10].

The potentials are based on a pre-recession view. Because of reduced activity in the building sector, it is most likely that the savings potential for new buildings identified in Table 3.1 and Table 3.2 overestimate the actual potential. The capitals between brackets in the table read as follows:

- A = B + D;
- Potential for EE heating equipment in existing stock = B – C[11];
- E = F +G = H+I.

Table 3.1 The EU energy saving potential for heating in the residential sector in 2015 and 2020 relative to the PRIMES 2007 baseline projection[12][13]

	Unit	2015	2020
Cost effective saving potential for heating in the residential sector (A)			
EU27	ktoe	45429	72486
EU15	ktoe	39217	61704
EU12	ktoe	6212	10783
Cost effective saving potential for heating in existing stock (B)			
EU27	ktoe	28877	49786
EU15	ktoe	24298	41135
EU12	ktoe	4579	8651
Cost effective saving potential for heating from refurbishment of existing stock (C)			
EU27	ktoe	20180	34838
EU15	ktoe	17612	29784
EU12	ktoe	2570	5055
Cost effective saving potential for heating in new dwellings (D)			
EU27	ktoe	17635	22348
EU15	ktoe	15824	20012
EU12	ktoe	1811	2335

Source: Fraunhofer ISI, 2009

10 To be derived from: http://ec.europa.eu/energy/efficiency/studies/efficiency_en.htm

11 The energy savings potential related to heating in the built environment is composed of two main categories: insulation/better windows and more efficient conversion equipment. It makes sense to provide the potentials for both. Note that the potentials for more efficient conversion technology would be much larger in case of no refurbishment of the building shell, i.e. the potentials are not double counted.

12 These figures have been updated, compared to the original Fraunhofer 2009 study (most figures are slightly higher).

Table 3.2 The EU energy saving potential for heating in the non-residential sector in 2015 and 2020 relative to the PRIMES 2007 baseline

	Unit	2015	2020
Cost effective saving potential for heating in the non-residential sector (E)			
EU27	ktoe	16188	23660
EU15	ktoe	12800	18733
EU12	ktoe	3386	4924
Cost effective saving potential of existing stock (F)			
EU27	ktoe	15208	22390
EU15	ktoe	12146	17884
EU12	ktoe	3060	4505
Cost effective saving potential of new stock (G)			
EU27	ktoe	980	1269
EU15	ktoe	654	849
EU12	ktoe	326	419
Cost effective saving potential in small buildings (H)			
EU27	ktoe	10992	16005
EU15	ktoe	8459	12336
EU12	ktoe	2533	3666
Cost effective saving potential in large buildings (I)			
EU27	ktoe	5196	7654
EU15	ktoe	4341	6397
EU12	ktoe	853	1258

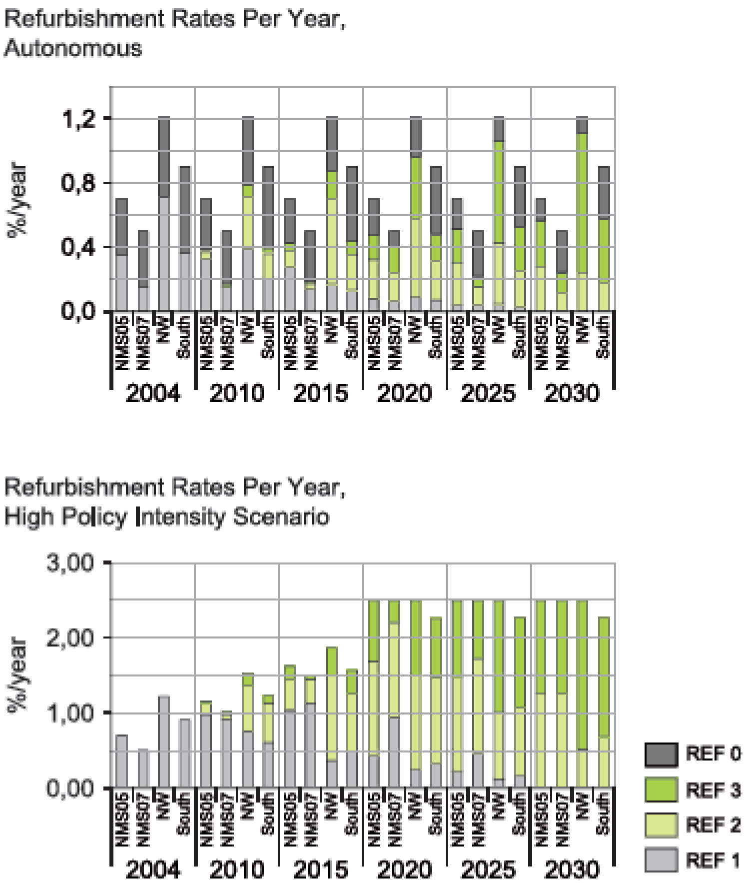
Source: Fraunhofer ISI

From the above tables, we learn that the energy savings potential of the residential sector is more than three times bigger than the potential in the tertiary sector (public and commercial services). In the residential sector, total fuel demand for heating would decrease by 22% in 2020 in case the full potential identified by Fraunhofer would be realized.[14] For the non-residential sector, the relative savings are 18% in 2020. The potential for energy savings from improved insulation are based on the refurbishment rates as given in the below figure (HPI scenario), where REF1 corresponds with current building code standards, REF2 with more advanced standards and REF3 for low energy houses. From figure 3.1, it becomes clear that annual refurbishment rates in the HPI scenario are considerably more ambitious than the autonomous refurbishment rates. For North West Europe, rates are doubled, whereas for new Member States they increased with a factor 4-5.

Total investment costs related to the potentials cannot directly be derived from the Fraunhofer study.

[14] Note that the savings for an individual building are even larger since in 2020 only part of the stock is refurbished whereas the savings are calculated as an average for the full stock.

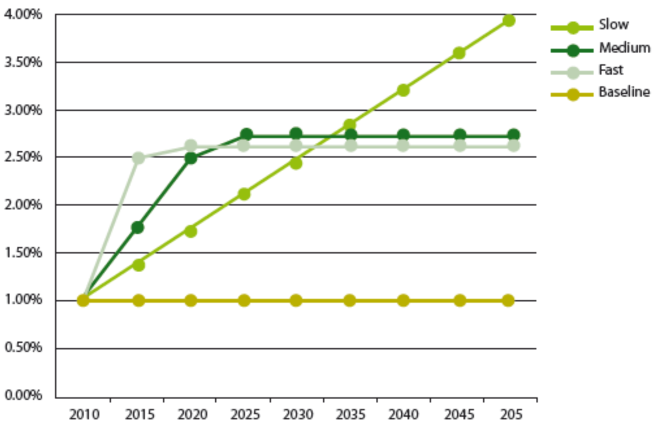
Figure 3.1 Refurbishment rates per year in autonomous and high policy intensity scenario



Source: Fraunhofer & Partners, 2009

In the 2011 BPIE report, energy savings potentials for the building stock are calculated. Starting point of the BPIE analysis is the ambition to have renovated all buildings in the EU in 2050. To achieve this average, annual refurbishment rates should go up from around 1% today to 2.5% for the period up to 2050. Depending on the rate of uptake of higher refurbishment rates BPIE distinguishes between three different scenarios (see Figure 3.2).

Figure 3.2 Baseline and three accelerated refurbishment rates scenarios in order to achieve full refurbishment of the EU building stock in 2050



Source: BPIE, 2011

BPIE distinguishes four types of renovation each with own costs estimates:

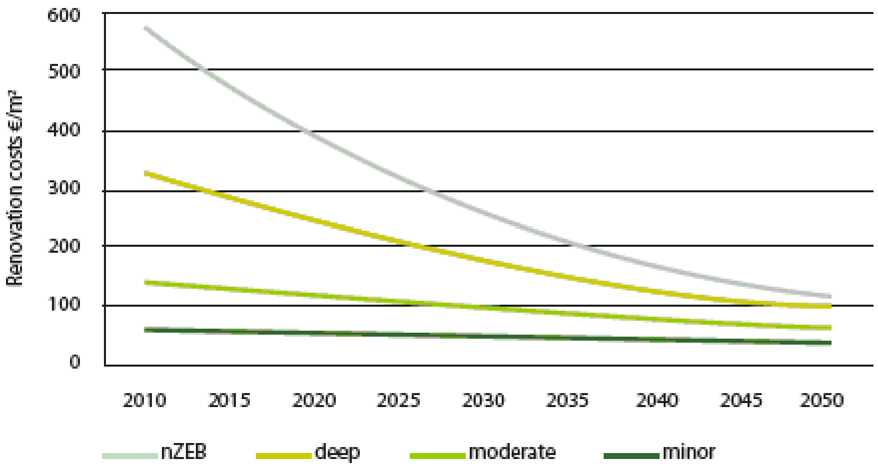
Table 3.3 Renovation types and costs estimates

Description (renovation type)	Final energy saving (% reduction)	Indicative saving (for modelling purposes)	Average total project cost (€ /m²)
Minor	0-30%	15%	60
Moderate	30-60%	45%	140
Deep	60-90%	75%	330
nZEB	90%	95%	580

* nZEB stands for nearly zero energy buildings
Source: BPIE, 2011

A building with minor energy-related renovation (BPIE assumes that 85% of today's refurbishments are like that) is considered to save 0-30% of the energy needed for heating. In the model of BPIE, an average savings percentage of 15% is taken for the minor renovation type. The costs reflect the total installed costs of measures, i.e. materials, labour and professional fees, but do not include any costs not directly related to improving the energy performance of buildings. The assumed decrease in renovation costs in given in the below figure.

Figure 3.3 Reduction of renovation costs over time



Source: BPIE, 2011

Next step in the BPIE analysis is to identify those parts of the building stock in which the majority of the energy savings potential can be realized. Table 3.4 shows that in general, pre 1960 buildings and particularly those in North & West Europe (including the big German, French and UK stock) make up more than 40% of the total potential. In the BPIE modelling, most of the energy savings efforts up to 2030 are assumed to take place in pre 1960 buildings

Table 3.4 Prioritising part of the (residential) building stock holding most of the energy savings potential

		North & West	South	Central & East
Old	pre 1960	41,7%	8,0%	6,4%
Modern	1961-1990	17,7%	6,9%	9,3%
Recent	1991-2010	4,8%	1,5%	1,8%
New	2011-2020	1,0%	0,4%	0,4%

Source: Derived from BPIE, 2011

The 2020 results of the BPIE analysis are given in Table 3.5. The scenarios 1-4 differ regarding the uptake of higher refurbishment rates (Figure 3.2) and (development in) the share of minor, moderate, deep and nZEB type of renovations. That means that in the baseline scenario 1% refurbishment rate is kept constant over time with 85% of the refurbishments being minor (Table 3.3). For the deep scenario, a medium rate of refurbishment (Figure 3.2) is assumed and a progressive move towards deep type of renovations (Table 3.3) instead of minor type. Scenario 4 is a two-stage scenario meaning minor to moderate refurbishment up to 2030 and then upgrading to deep or nZEB type of renovations. Up to 2030, this scenario is equal to scenario 2.

Table 3.5 Results BPIE analysis for 2020 – residential sector (source BPIE, 2011)

Scenario		0	1A	1B	2	3	4
Description		Baseline	Slow & Shallow	Fast & shallow	Medium	Deep	Two-stage
Annual energy saving in 2020	TWh/a	94	169	271	283	527	283
2020 saving as % of today	%	2%	4%	7%	7%	13%	7%
Investment costs (present value)	(€ billion)	107	161	255	252	477	252

Source: BPIE, 2011

Summary energy efficiency potentials existing building stock

The Fraunhofer study identifies almost 50 Mtoe (or 580 TWh) of energy savings potential in 2020 for refurbishment of existing buildings in addition to the business as usual development. The BPIE study comes up with a range of 169 to 527 TWh potential energy savings in 2020, including 94 TWh of energy savings to be realized business as usual. It seems therefore that the Fraunhofer study is best compared with the (ambitious) deep scenario of the BPIE study. The bigger additional potential identified by Fraunhofer (580 TWh) compared to the BPIE study (527 TWh – 94 TWh) is well explained by the time period considered in each of the two studies. The Fraunhofer results are based on the period 2004/5-2020, whereas the BPIE results shown are based on the period 2010-2020.

Energy efficiency potential new buildings

For new buildings, the energy efficiency potential to be identified relates to the energy savings that can be achieved when building beyond the energy performance standard. From Table 3.2, we learn that the Fraunhofer study identified 22 Mtoe additional energy savings for new residential buildings (20 Mtoe in EU15 and 2 Mtoe in the New Member States). The additional savings potential for the non-residential sector is much lower with 1.3 Mtoe (0.8 Mtoe in EU15 and 0.4 Mtoe in NMS, see Table 3.3). The figures for the residential sector are based on the projection of new buildings in the 2007 EU baseline scenario (Capros et al., 2008). For the EU15 a net increase of 18.3 million households is projected for the period 2005-2020, for the new MS it is estimated to be 1.7 million.

3.3 Energy Efficiency Investment Potential

In this section, the Energy Efficiency Investment Potential is calculated for:

- Refurbishment existing stock public building;
- Refurbishment existing residential building stock;
- New residential buildings.

Refurbishment existing stock public buildings

The previous section showed that significant energy savings potential for heating is available for the built environment and particularly for existing buildings. To realize this potential, an intensification of energy efficiency policies is needed. Energy performance certificates are currently among the few energy efficiency instruments for existing buildings but the instrument is too weak to make a strong difference and move refurbishment rates and ambition levels towards the ones considered in the Fraunhofer and BPIE study. The political compromise on the Energy Efficiency Directive reached on 14 June 2012 could push the refurbishment of existing stock of public buildings.[15]
In the Impact Assessment of the Energy Efficiency Directive (SEC(2011) 779 final) two options regarding the proposed 3% renovation rate have been explored:

- Realizing the target at cost-optimal levels;
- Realizing the target at nearly zero energy levels.

Setting an obligation on refurbishment of public buildings, representing 12% of the total building stock according to the Impact Assessment, would have a high visibility in public life (e.g. schools) and could serve as an example for change in the private sector as well. Social housing (0-30% of the residential building stock in different Member States) is not included in the target scope because of the different ownership structures of social housing between Member States.

The 3% level is determined as follows (SEC(2011) 779 final):

- The pre-recession renovation rate is 3% per year of which 50% energy-related (1.5% per year);
- In the period 2010-2020 1.7% annual renovation is expected under business as usual schemes (being the impact of the recast EPBD and national support schemes);
- In case energy efficiency improvement is combined with ongoing maintenance and refurbishment, it is cost effective in most cases. Therefore the 1.5% could be levelled up to 3%;
- Going beyond 3% would put too much pressure on the cost effectiveness and put difficulties on the construction sector to meet increased demand.[16] Going below 3% would lack ambition.

Although the Impact Assessment provides arguments for the 3%, it might be (and is currently) discussed whether such high figure can be achieved. The figure of 3% is not backed up by the country survey data as well as some earlier studies provided in the BPIE study. On the other hand: as the share of public building in the total building stock is modest, such high renovation rate might be achievable, but might be at the expense of the renovation rates in other parts of the built environment.

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15 It was initially the aim, as from 1 January 2014, that 3% of the total floor area owned by public bodies should be renovated each year. However, the scope is reduced to heated and/or cooled buildings owned and occupied by **central** government. Behavioural changes can be counted towards the annual renovation rate, as well as building sold, demolished or taken out of use. The European Commission estimated that due to the reduced scope the impact decreased from 4.2 to 0.4 Mtoe energy savings in 2020.

16 This argument might be questioned since the public buildings comprise only 12% (and perhaps smaller in case the social housing stock is excluded) of the total building stock.

Table 3.6 Table Renovation rates from BPIE country survey and other sources (source BPIE)

Country	Residential	Non-residential	Unspecified	Comment
AT			1.20%	
CY			0.9%	Average rate 1980-2009
CZ	2.4% (single family); 3.6% (Multi-family)			Estimated by SEVEn
FI			1-1.5%	
DE			0.7%	
HU	1.30%			
IT			1.20%	
LT	0.36%	2.75%		Average rate for 2005-10
NL	3.5%	1.6% (offices)		
NO	1.5%	1.5%		
PL	2.5% (multi-family buildings)			
PO			1.5%	
SL			2%	
CH			0.8-1%	
Other sources*				
Novikova (2008)			1%	
Janssen (2010)			1.2-1.4%	
Petersdorrf (2004)			1.80%	EU15
Lechtenböhmer (2009)			1%	EU27

*as quoted in "Employment Impact of a Large-Scale Deep Building Energy Renovate Programme in Hungary" - Urge-Vorsatz et al, Central European University

In the Impact Assessment of the Energy Efficiency Directive (SEC(2011) 779 final), the following investment needs have been reported:

Table 3.7 Investment needs (in billion euros) for binding 3% refurbishment rate public buildings (SEC(2011) 779 final)

	Investment needs in 2020	Average annual investment needs 2010-2020	Investment needs in 2020	Average annual investment needs 2010-2020
	Cost optimal target achievement		Nearly zero energy target achievement	
Additional energy related investment	1.2	1.56	5.28	5.04
Total energy related investment	2.64	3.48	10.56	10.2
Total Investment	4.08	5.16	13.68	13.2

The above table shows the additional energy related investment costs to increase the energy-related renovation rate from 1.5 to 3%. Consequently, total energy related investment needs are about 2 times bigger than in the business as usual scenario (compare row "additional energy related investment" and "total energy related investment"). The table also shows that the energy related investment needs are between 65% (cost optimal level) and almost 80% (nearly zero

energy level) of the total investment needs for a renovation (compare row "total energy related investment" and "total investment").
The Impact Assessment does not discuss the ambition level of the renovation but sticks to the distinction between cost-optimal target achievement and nearly zero energy target achievement. Still, it is interesting to know how the figures in Table 3.7 compare to the input values of the BPIE study. To make this comparison, we assume that 10% of the 24 billion square meter floor space in the EU belongs to the public sector[17]. With an annual refurbishment rate of 3%, 30% of the public building stock (25% in case of a 2.5% refurbishment rate) can be renovated in the period 2010-2020. Using the costs estimates from Table 3.3, we can calculate an average annual investment need of 4 to 42 billion euros for a 3% renovation rate (4 billion relates to minor type of renovation, 42 billion to nearly zero energy type of renovation). From this, we conclude that the investment needs for cost optimal target achievement has a minor type of ambition level following the definition of "minor" of the BPIE study (compare the 4 billion with the 3.48 billion in Table 3.7) and that the investment needs for nearly zero energy target achievement strongly differ between the Impact Assessment and the BPIE study (compare 42 billion with the 10.2 billion in Table 3.7).

For the Energy Efficiency Investment Potential for existing public buildings, we should focus on the cost-optimal target achievement variant (cf. Article 4 in the recast EPBD). This leads to a total Energy Efficiency Investment Potential in the period 2012-2020 of around 40 billion euro, of which about 65% is energy-related.[18] In line with the BPIE study, we assume that about 40% of the non-residential floor space is publicly owned. This means that the majority of the potential will be found in Germany, France, UK and Spain.

Refurbishment of existing residential building stock

The following method is applied for determining the Energy Efficiency Investment Potential for the existing residential building stock:

- 75% of the floor area in the built environment (24 billion m2) belongs to the residential sector;
- A retrofit rate of 2.5% per year is assumed (in line with data from the HPI scenario as given in Figure 3.1) [19];
- A moderate refurbishment is assumed with 140 euro/m2 investment costs (Table 3.3).

Between 2012 and 2020 a floor area of 450 million m2 can be refurbished annually.[20] Total investments costs are 63 billion euro per year (140€ *450M) or 504 million euro for the period 2012-2020. Member State specific Investment Potentials are based on the amount of households per country.

New buildings

The energy savings potentials for new buildings identified by Fraunhofer need to be corrected for two reasons:

- New insights in population growth and structural change (number of people per household) as reflected in the more recent 2009 EU Reference Scenario (Capros et al. 2010);
- The fact that the large majority of new residential buildings built between 2005 and 2012 has been built according to current energy performance standards and not beyond.

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17 25% of the total floor space belongs to the non-residential sector. It is assumed that 40% of the non-residential floor space belongs to the public sector, which makes 10%.

18 ≈ 5.16 billion x 8 years.

19 Note that for Southern Europe a slightly lower (2.25%) retrofit rate has been assumed in the HPI scenario.

20 75% x 24 billion m2 x 2.5%.

When combining these two elements, we derive from Capros et al. (2010) that the net growth of households in EU15 is 13.4 million between 2010 and 2020 (2012 is not available), and in the new MS 1.1 million. This means that roughly 2/3 of the energy savings potential identified by Fraunhofer can be realized.

The construction cost per square meter for a new building is on average 1500€ in the EU15 and 1000€ in the new MS.[21] The additional cost to go from a classic building to a near zero energy building is approximately 15%[22] (thus compulsory from 2020 onwards). Assuming 100-150 m2 living area per average household and 225 euro or 150 euro investment costs per m2 for nearly zero energy buildings, the Energy Efficiency Investment Potential (thus the additional cost) can be derived.

For EU15:
- (13.4 million new households x 100/150 m2 x 225 euro/m2) x 0.8 [23] ≈ 240– 360 billion euro.

For New MS:
- (1.1 million new households x 100/150 m2 x 150 euro/m2) x 0.8 ≈ 13 – 20 billion euro.

For the non-residential sector we estimate an Energy Efficiency Investment potential of 30 -45 billion, i.e. roughly 5% of the total investment potential of residential buildings.[24]

Summary building environment Energy Efficiency Investment Potential

The analysis of the Energy Efficiency Investment Potential is summarized in Table 3.8.

Table 3.8 Summary Energy Efficiency Investment Potential analysis building environment

	Refurbishment public buildings	Refurbishment residential buildings	New buildings
Energy Efficiency Investment Potential 2012 – 2020 EU27 overall [billion euro]	40	500	250 -380 (residential) 30-45 (non-residential)
Main assumption for determining the Investment Potential	3% annual retrofit rate, cost optimal target achievement.[25]	2.5% annual; retrofit rate, moderate renovation.[26]	Nearly zero energy buildings
Where can the majority of the potential be found?	Mainly in Germany, France, UK and Spain	Linked to number of households per MS	Primarily in EU15
Typical project size	For very large buildings investments could above € 25 million. In most cases, investments will	Bundling of investments is needed to make up financeable projects (bigger than € 30-50	For large public/commercial buildings, investments could be above € 25

21 Source : construction websites.
22 It can be less costly for bigger dwellings and when starting with an nZEB design where some costs (like on a heating installation) can be saved on, compared to classic buildings.
23 0.8 correct for the 10 year time period considered in the data and the actual 8 year left to 2020. The calculation outcome has not been corrected for building projects that are already in the pipeline and will be built according to current standards.
24 Based on the ratio of energy savings potential residential sector and non-residential sector.
25 Based on the new Energy Efficiency Directive reached on 14 June 2012, the 3% will only be applied for buildings owned by central governments.
26 A moderate ambition level in terms of energy efficiency gains means that the average building saves 45% of its energy use. Deep savings (75% savings) or nearly zero energy renovations (95% savings) are also possible and would provide a much higher Investment Potential (factor 2.5 for deep renovation and factor 4 for nearly zero energy renovation).

	Refurbishment public buildings	Refurbishment residential buildings	New buildings
	be below € 25 million.	million)	million. For new residential buildings bundling of investments might be needed to make up financeable projects.
Type of actors involved	Public authorities	Public and commercial housing associations and individual homeowners	Project developers
Compliance with EE eligibility criteria	Ambition level is unclear. However, 30% is possible. See also text	Possibly. See also text	Yes (in case of nearly zero energy buildings)

Discussion refurbishment public buildings
It is unclear from the Impact Assessment of the European Commission what ambition level is aimed for regarding the refurbishment of public buildings. The choice of the cost-optimal level (similar to the "minor" type of refurbishment as identified in the BPIE study, yielding between 0 and 30% energy savings, 15% average) might lead to projects which do not meet 20% energy savings. This should however not be used as an argument to lower the 20% energy efficiency criterion for building refurbishment. For IFIs (International Financial Institutions), to add value in this area, a more stringent efficiency criterion (30-40%) might even be considered, as in reality, the potential is higher than 20%.

Discussion refurbishment residential buildings
The Investment Potential for refurbishment of the residential building stock is large. However, almost 70% of the buildings are owner-occupied, which makes bundling of projects more difficult. Regarding refurbishment of the residential building stock, the most natural focus area for IFIs would be the public rental sector (housing associations) and (big) private renters. How about private housing associations (of flat owners)? In many countries, especially in the new MS, these are holding the major share of the market.
The energy efficiency improvement realized after refurbishment depends on the ambition level. As for refurbishment of public buildings, IFIs might consider to adopt a more stringent (30-40%) energy efficiency criterion in order to add value in this market.

Discussion New buildings
The Investment Potential for new buildings is substantial. One of the issues is that bundling of small projects is probably not the first focus area for IFIs. As such, regional and national authorities could/should play a substantial role in the bundling of projects so they reach a size interesting for IFIs (50 million euro and bigger). To add value in large-scale projects in the tertiary sector and residential sector, the 20% energy efficiency criterion should be adjusted for new buildings. As the market moves to nearly zero energy buildings, demonstration of nearly zero energy would offer an area of high value loans. Setting 'nearly zero energy' as energy efficiency criterion rather than a percentage improvement that goes beyond the (moving) energy performance standard would be most transparent. However, this should be applied progressively due to costs issues and economic efficiency.

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