Sensitivity Analysis of Cost Effective Climate Protection in the EU Building Stock

Report established by ECOFYS for Eurima

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Executive Summary

In the reports "Cost effective climate protection in the Building Stock of the EU-8 Member States" and "Cost effective climate protection in the EU-15 Building Stock" Ecofys analysed the impact of the EPBD and possible extensions on the building stock of the EU-25 Member States. Since 2003, when the price analysis was made for the reports, the energy prices, against many forcasts, further increased. To analyse the sensitivity of the economic results of the reports, five energy price scenarios are presented and justified:

- Scenario 1: Ecofys forecast 2002 EU-15 prices (existing report)
- Scenario 2: Ecofys forecast 2005 EU-15 prices (updated)
- Scenario 3: Ecofys forecast 2005 plus current price for CO_2 certificates
- Scenario 4: High price scenario (derived from the deferred investment scenario of the World Energy Outlook 2005 of the IEA)
- Scenario 5: Peak price scenario

The effects of modified energy prices on the economic results are assessed for the technical potentials as well as for the phased implementation of the EPBD and possible extensions. Table 1 presents that the energy cost savings in scenario 5 are compared to the scenario 1 more than doubled, whereas the annual profit (see Table 2) increases by a factor larger than 3.

Table 1: Annual energy cost savings 2010 phased implementation

Energy cost savings 2010	EU-25		
In billion EURO	EPBD	Ext. EPBD > 200m²	Ext. EPBD all houses
Price scenario 1	8,6	11,0	18,5
Price scenario 2	9,3	11,8	19,8
Price scenario 3	10,3	13,1	22,0
Price scenario 4	11,4	14,5	24,3
Price scenario 5	17,8	22,6	38,0

Table 2: Total annual profit 2010 phased implementation

Total annual profit 2010	EU-25		
In billion EURO	EPBD	Ext. EPBD > 200m	Ext. EPBD all houses
Price scenario 1	4,3	5,2	8,7
Price scenario 2	4,9	6,0	10,1
Price scenario 3	5,9	7,3	12,3
Price scenario 4	7,0	8,7	14,6
Price scenario 5	13,4	16,8	28,3

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Introduction

In the reports “Cost effective climate protection in the Building Stock of the EU-8 Member States” and “Cost effective climate protection in the EU-15 Building Stock” Ecofys analysed the impact of the EPBD and possible extensions on the building stock of the EU-25 Member States. The studies demonstrate that the EPBD will have a significant impact on the CO_2 emissions of the building stock, with insulation measures of existing buildings offering the main saving potential. Coupling energy-efficiency measures with general maintenance and retrofit measures in the building sector, these measures are cost effective.

Since the energy market is highly volatile the objective of this study is the sensitivity analysis of the both reports to assess the effects of modified energy prices on the economic results.

In the first chapter, five energy price scenarios are presented and justified, building the basis for the sensitivity analyis.

Chapter 2 assesses the effect of these scenarios on the cost effectiveness of insulating a pitched roof of a residential building in a moderate climate according to an example in the brochure “Insulation in a nutshell” published by Eurima.

In Chapter 3 the impact of the modified energy prices on the economic results of the reports “Cost effective climate protection in the Building Stock of the EU-8 Member States” and “Cost effective climate protection in the EU-15 Building Stock” is analysed.

1 Energy Price Scenarios

To analyse the sensitivity of the economic results of the reports “Cost effective climate protection in the Building Stock of the EU-8 Member States” and “Cost effective climate protection in the EU-15 Building Stock”, five energy price scenarios are investigated. Since 2003, when the price analysis was made for the reports, the energy prices, against many forcasts, further increased (see Figure 1). E.g. the European Commission expected in the report “European Energy and Transport – Trends to 2030” a peak price for the year 2001, followed by a decrease of prices.

Figure 1: Oil price (Brent crude oil in USD)

Hence, in the following scenarios the prices successively increase up to a peak price scenario, starting from the energy prices of the existing EU-15 study:

- Scenario 1: Ecofys forecast 2002 EU-15 prices (existing report)
- Scenario 2: Ecofys forecast 2005 EU-15 prices
- Scenario 3: Ecofys forecast 2005 plus current price for CO_2 certificates
- Scenario 4: high price scenario
- Scenario 5: peak price scenario

1.1 Scenario 1: Ecofys Forecast 2003 EU-15 Prices (existing report)

1.1.1 Assumptions

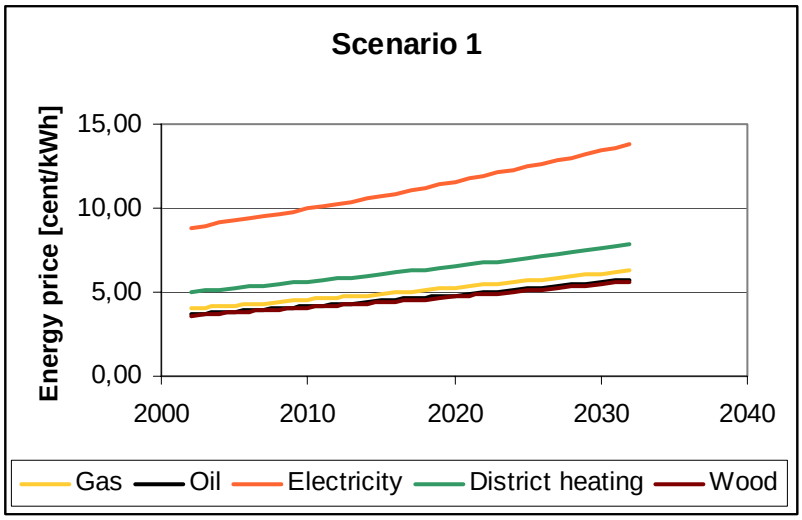
- In scenario 1 the price basis is taken from the existing study on the EU15 countries.
- These data were deduced from Eurostat statistics from 1992 until 2002 and have been projected to the future.
- This lead to an increase rate of 1,5% p.a., kept for all energy carriers.

1.1.2 Energy Prices

Table 3: Energy Prices Scenario 1

Scenario 1			
Increase rate	1,5%	Average 2002 -2032	2002
Gas	cent/kWh	5,16	4,03
Oil	cent/kWh	4,71	3,68
Electricity	cent/kWh	11,32	8,84
District heating	cent/kWh	6,40	5,00
Wood	cent/kWh	4,24	3,61

Figure 2: Energy Prices Scenario 1



1.2 Scenario 2: Ecofys Forecast 2005 EU-15 Prices

1.2.1 Assumptions

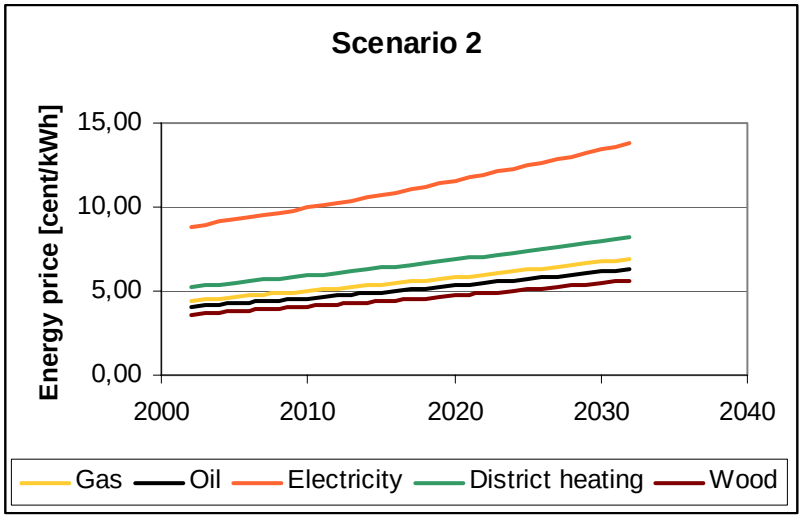
- Due to the increase of the energy prices since 2003 (see Figure 1) the price analysis made in the year 2003 by Ecofys is updated in consideration of the actual oil price developments (December 2005), leading to a new forecast for the energy prices.
- Due to the coupling of the gas price to the oil market, the prices for gas are calculated according to the ratio of costs between gas and oil prices in 2002.
- Several reliable studies assume only a moderate increase of the electricity price on long term which is in line with Scenario 1. Therefore the electricity price is kept according to Scenario 1.
- For wood the prices are also kept.
- Since district heating is partly depending on the oil and gas price a moderate increase is assumed.
- The increase rate is kept at 1,5% p.a.

1.2.2 Energy Prices

Table 4: Energy Prices Scenario 2

Scenario 2			
Increase rate	1,5%	Average 2002 -2032	2002
Gas	cent/kWh	5,69	4,44
Oil	cent/kWh	5,19	4,05
Electricity	cent/kWh	11,32	8,84
District heating	cent/kWh	6,73	5,25
Wood	cent/kWh	4,24	3,61

Figure 3: Energy Prices Scenario 2



1.3 Scenario 3: Ecofys forecast 2005 plus current price for CO_2 certificates

1.3.1 Assumptions

In this scenario the costs for CO_2 emissions should be taken into account, either as avoided damage costs or as mitigation costs. As described in the report "Cost effective climate protection in the EU-15 Building Stock" great uncertainties remain in estimating the external damage costs of the greenhouse gas effect. These include uncertainties in understanding the climate mechanisms in the earth's atmosphere as well as uncertainties in evaluating the socio-economic changes resulting from climate change. Physical impacts of climate change have been estimated, including: sea level rise, extreme weather events, human health effects, agriculture, water resources and ecosystems including potential migration processes. A sharp distinction between assessing the damages and allocating clear damage costs is often not possible since the impacts are interlinked with each other. As a reasonable and viable solution, the costs for emission allowances related to the emissions trading scheme were taken into account by adding the current price for CO_2-certificates to the prices as described in scenario 2.

The average certificate price of the the second half of 2005 amounts to 23 €/t (see Figure 4). Depending on the emission factors for the different energy carriers the prices presented in Table 5 were considered.

Figure 4: Certficate Prices emission trading

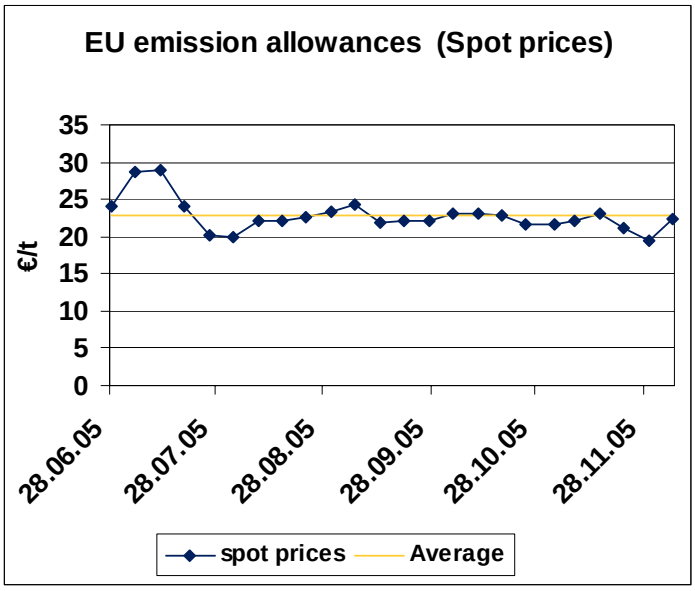


Table 5: CO_2 costs per energy carrier

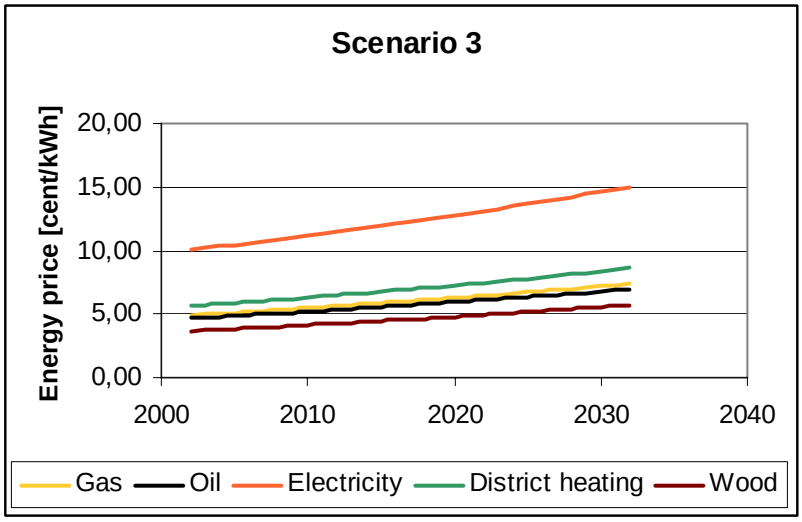
Gas	0,202	t/MWh	0,46	cent/kWh
Oil	0,266	t/MWh	0,61	cent/kWh
Electricity	0,528	t/MWh	1,21	cent/kWh
District heating	0,167	t/MWh	0,38	cent/kWh
Wood	0,02	t/MWh	0,05	cent/kWh

1.3.2 Energy Prices

Table 6: Energy Prices Scenario 3

Scenario 3			
Increase rate	1,5%	Average 2002 -2032	2002
Gas	cent/kWh	6,15	4,91
Oil	cent/kWh	5,80	4,67
Electricity	cent/kWh	12,53	10,05
District heating	cent/kWh	7,11	5,64
Wood	cent/kWh	4,29	3,66

Figure 5: Energy Prices Scenario 3



1.4 Scenario 4: high price scenario

1.4.1 Assumptions

- The high price scenario is derived from the deferred investment scenario of the World Energy Outlook 2005 of the IEA. In the Deferred Investment Scenario the international crude oil price is significantly higher over the projection period than in the Reference Scenario of IEA (which is comparable to scenario 1 presented in this sensitivity analysis)[1]. The deferred investment scenario analyses how global energy markets might evolve if investment in the upstream oil industry of MENA countries were to be substantially lower than projected in the Reference Scenario. That might occur because of domestic production policies or difficulties in securing capital in some countries, leading to higher prices.
- Analogous to scenario 3, the external demand costs were taken into account according to the emissions trading scheme
- As in scenario 2, the prices for gas and district heating are linked again to the development of the oil price.
- The prices for wood and electricity are kept the same as in scenario 3.

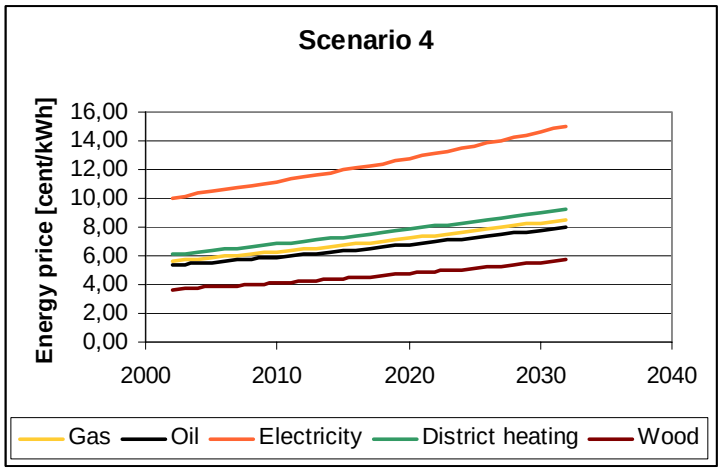
1.4.2 Energy Prices

Table 7: Energy Prices Scenario 4

Scenario 4			
Increase rate	1,5%	Average 2002 -2032	2002
Gas	cent/kWh	7,08	5,63
Oil	cent/kWh	6,66	5,33
Electricity	cent/kWh	12,53	10,05
District heating	cent/kWh	7,69	6,09
Wood	cent/kWh	4,29	3,66

[1] In the reference Scenario, the average IEA import price is assumed to fall back from recent highs to around $35 (in year-2004 dollars) in 2010, and then to rise slowly to $39 in 2030. In the Deferred Investment Scenario, the price increases gradually over time, relative to the Reference Scenario. It is about $13 higher in 2030, or $21 in nominal terms – an increase of almost one-third. Natural gas prices rise broadly in line with oil prices.

Figure 6: Energy Prices Scenario 4



1.5 Scenario 5: Peak Price Scenario

1.5.1 Assumptions

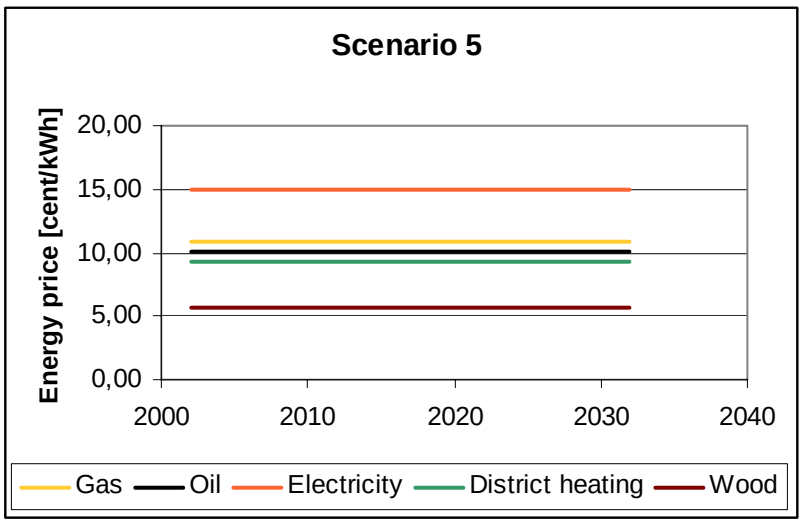
- In this scenario, it is assumed the the peak price from the last decade for brent cude oil at the stock exchange (70 USD/barrel) becomes average in the future. This price was paid at a short period in August 2005 and already decreased to below 60 USD/barrel in December 2005 (see Figure 1). Please note that the price of 70 USD/barrel correspond in the year 2032 to 117 USD in nominal terms.
- Thereby the usual price difference from stock exchange to final customer was taken into account.
- The other energy carriers were set at the value calculated in Scenario 4 for the year 2032 (end of lifetime of investigated packages).

1.5.2 Energy Prices

Table 8: Energy Prices Scenario 5

Scenario 5			
Increase rate	1,5%	Average 2002 -2032	2002
Gas	cent/kWh	10,82	10,82
Oil	cent/kWh	10,07	10,07
Electricity	cent/kWh	15,03	15,03
District heating	cent/kWh	9,31	9,31
Wood	cent/kWh	5,69	5,69

Figure 7: Energy Prices Scenario 5



2 Insulation in a nutshell

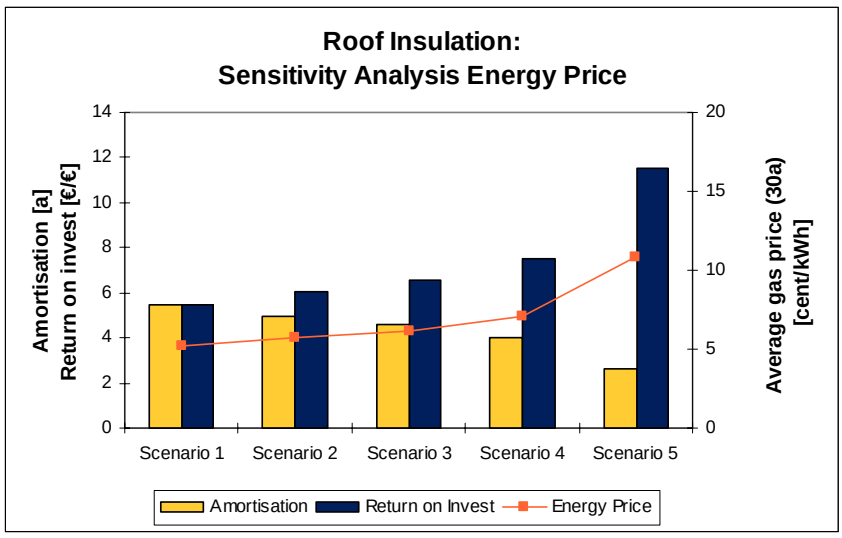
In the brochure “Insulation in a nutshell” Eurima published an example of insulating a pitched roof of a residential building in a moderate climate. This would need an investment of 30 Euro per m^2 roof leading to annual energy savings of 5.45 Euro per m^2 roof per year, which demonstrates a pay-back period of less than 6 years. Over a period of 30 years, more than a five-fold return on the investment equal to 165 Euro per m^2 roof per year would be achieved. This is a return of 5.5 Euro per Euro invested.

Table 9 and Figure 8 gives an overview of the effects of modified energy prices on the economic results. The return on investments increase from 5.5 Euro per Euro invested to 11.50 in scenario 5. Respectively the pay-back period decreases from 5.5 year to less than 3 years.

Table 9: Sensitivity analysis roof insulation in the moderate climate

		Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5
u-value before	W/m²a	1,50	1,50	1,50	1,50	1,50
u-value after	W/m²a	0,17	0,17	0,17	0,17	0,17
reduction energy demand	kWh/m²a	96	96	96	96	96
reduction gas consumption	kWh/m²a	106	106	106	106	106
gas price 2002	cent/kWh	4,03	4,44	4,91	5,63	10,82
increase rate		1,5%	1,5%	1,5%	1,5%	0,0%
included price for CO_2 certificates	€/t_{CO2}	0,00	0,00	23,00	23,00	23,00
average gas price (30 years)	cent/kWh	5,16	5,69	6,15	7,08	10,82
annual saved energy costs	Euro/m²a	5,48	6,04	6,54	7,53	11,50
saved energy costs 30 years	Euro/m²	164,5	181,3	196,1	225,9	345,1
Investment costs	Euro/m²	30,00	30,00	30,00	30,00	30,00
Return per Euro invest	Euro/Euro	5,48	6,04	6,54	7,53	11,50
Amortisation	a	5,47	4,96	4,59	3,98	2,61

Figure 8: Sensitivity analysis roof insulation in the moderate climate



3 Sensitivity analysis New-8

The report “Cost effective climate protection in the Building Stock of the EU-8 Member States” analysed the impact of insulation and energy efficiency measures for the New-8 building stock on the CO_2 saving potential, the investments required and their cost effectiveness. The analysis was done for the technical potentials as well as for the influences of phased implementation of the EPBD and possible extensions.

This section analyses the impact of the energy price scenarios on the economic results of the report mentioned above. The figures below show the resulting energy cost savings as well as the total annual cost savings for the New-8 related to the technical potential and the phased implementation. The modified energy prices do neither influence the CO_2 saving potentials nor the required investements and respective annual capital costs, which all remain the same for all scenarios.

First the results of the exisitng New-8 report are presented, secondly the impact of each price scenario on the economic results for the New-8 is presented separately. The last paragraph of this section gives an overview of the economic results for all price scenarios.

3.1 Original Price scenario

Figure 9: Original price scenario cost analysis technical potential

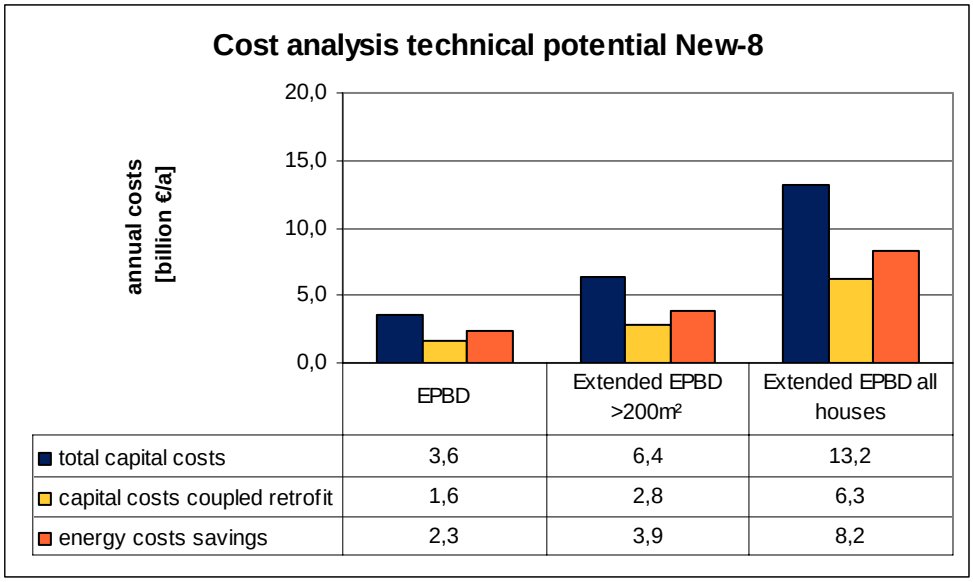


Figure 10: Original price scenario phased implementation energy cost-savings

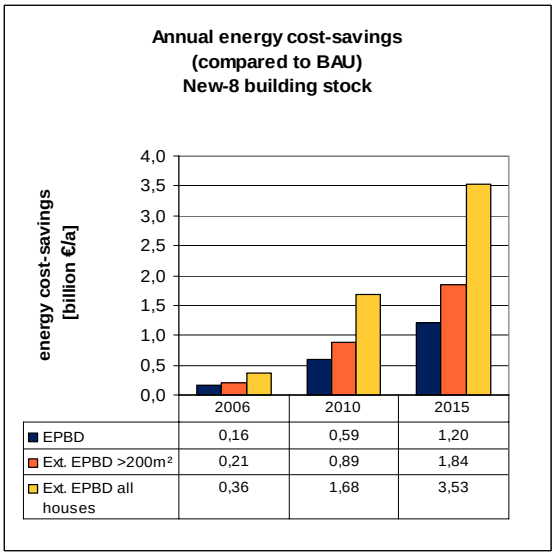
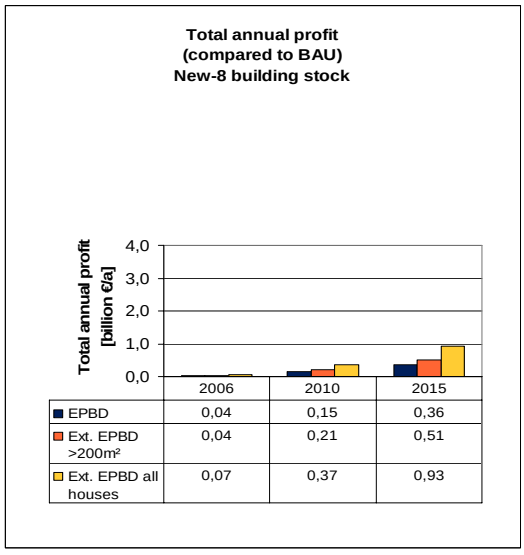


Figure 11: Original price scenario phased implementation annual profit



3.2 New-8 Price scenario 1

Figure 12: New-8 price scenario 1 cost analysis technical potential

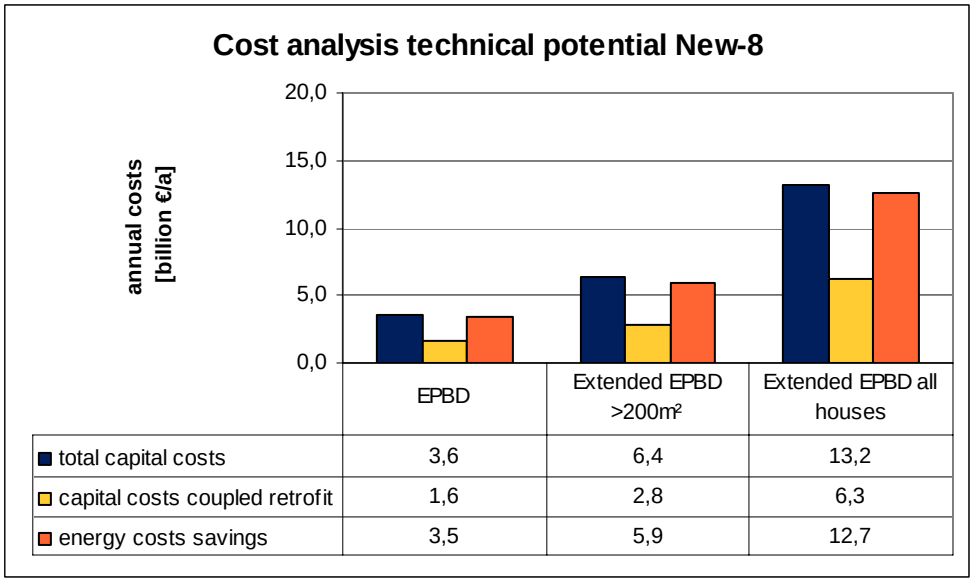


Figure 13: NEW-8 price scenario 1 phased implementation energy cost-savings

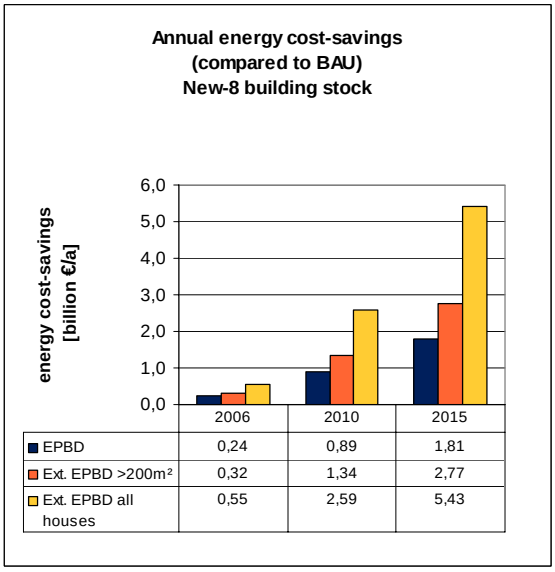
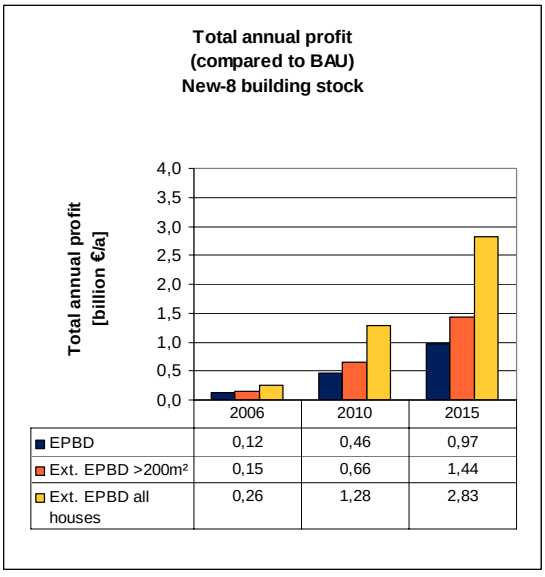


Figure 14: NEW-8 price scenario 1 phased implementation annual profit



3.3 New-8 Price scenario 2

Figure 15: New-8 price scenario 2 cost analysis technical potential

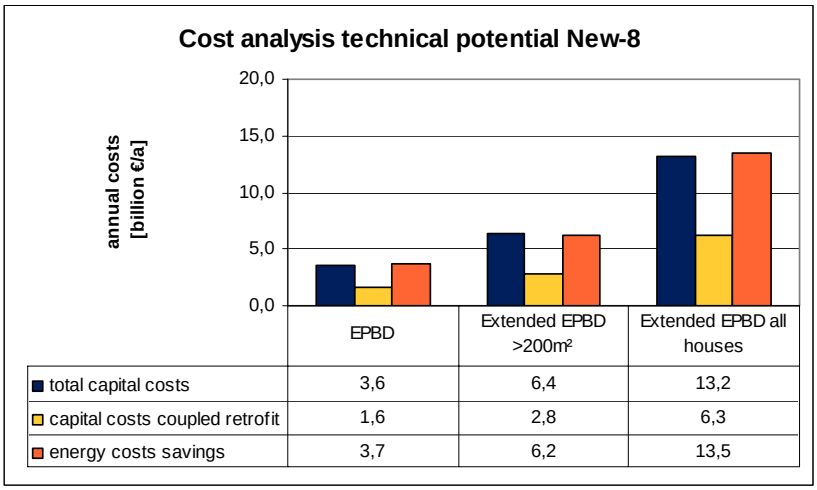


Figure 16: NEW-8 price scenario 2 phased implementation energy cost-savings

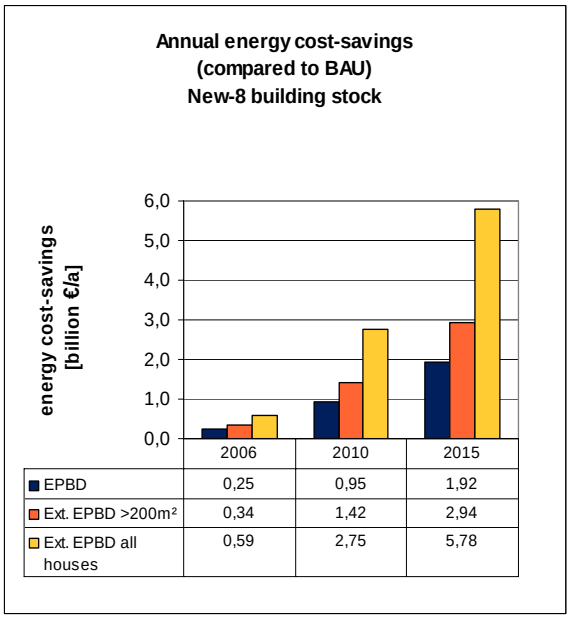
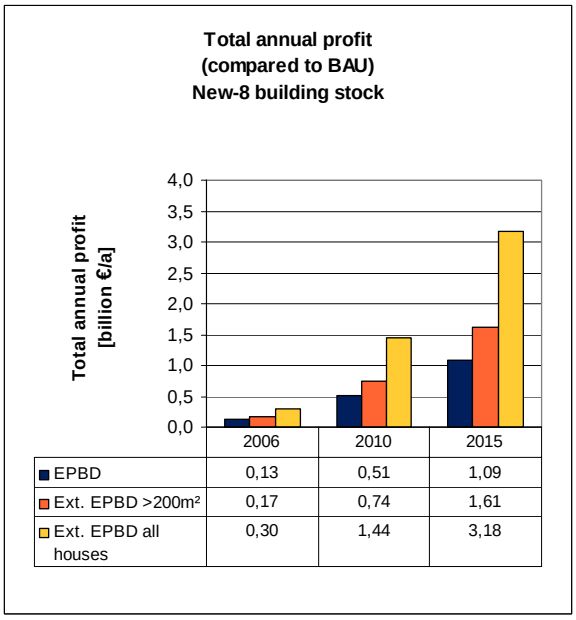


Figure 17: NEW-8 price scenario 2 phased implementation annual profit



3.4 New-8 Price scenario 3

Figure 18: New-8 price scenario 3 cost analysis technical potential

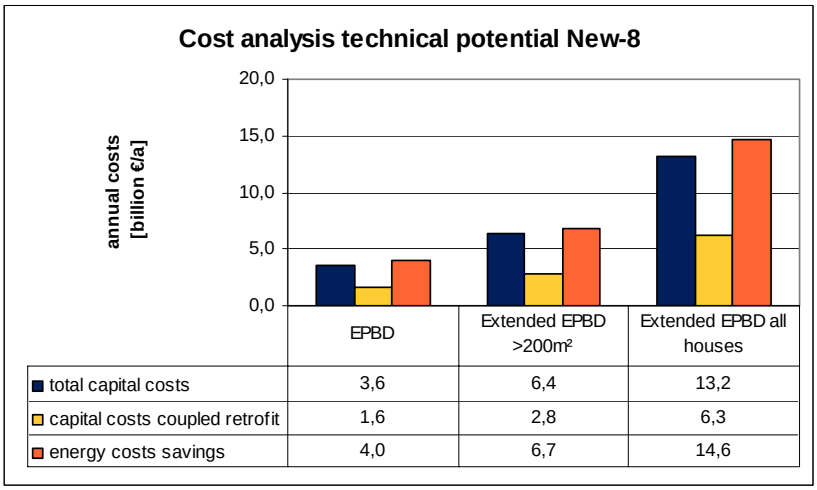


Figure 19: NEW-8 price scenario 3 phased implementation energy cost-savings

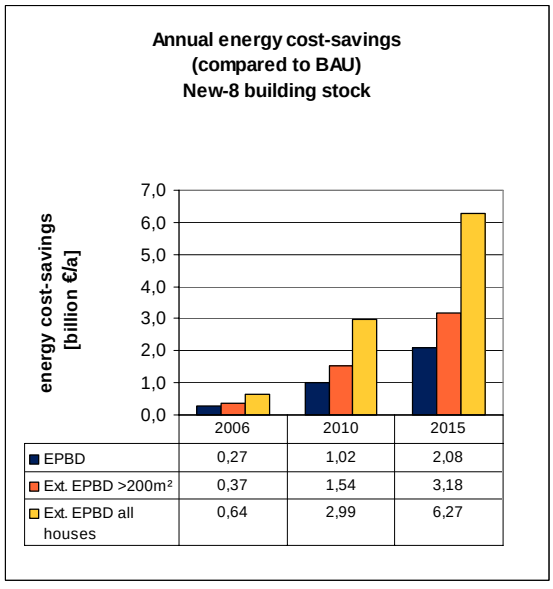
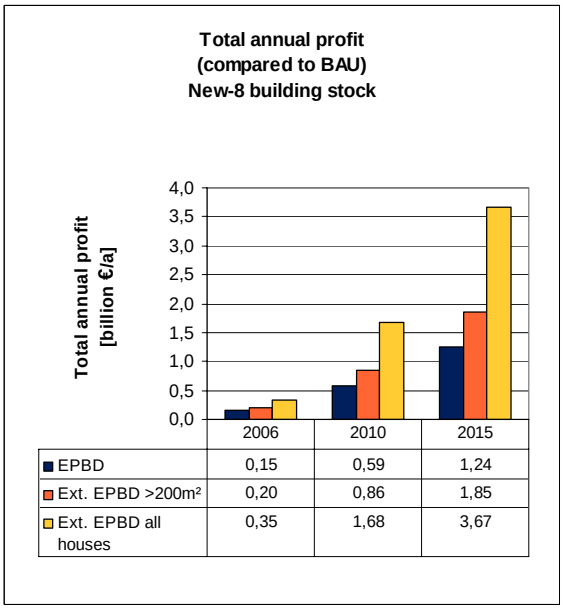


Figure 20: NEW-8 price scenario 3 phased implementation annual profit



3.5 New-8 Price scenario 4

Figure 21: New-8 price scenario 4 cost analysis technical potential

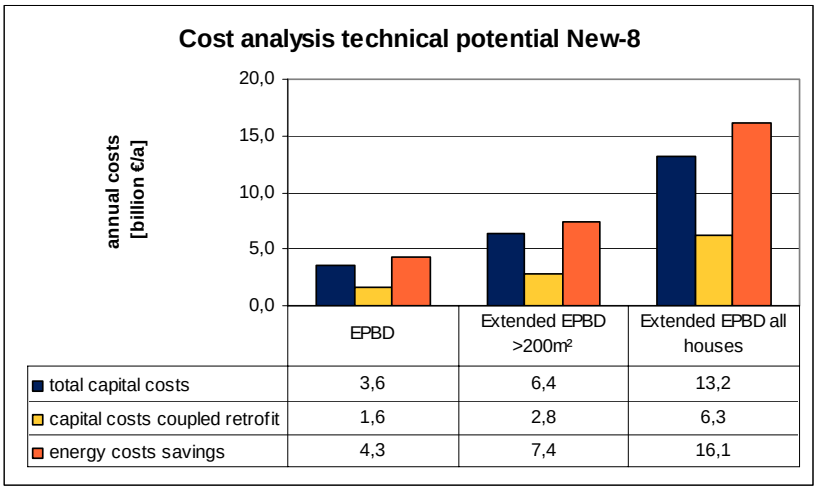


Figure 22: NEW-8 price scenario 4 phased implementation energy cost-savings

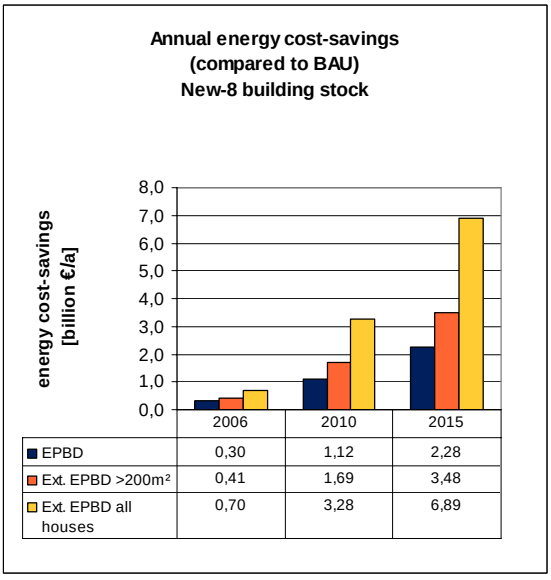
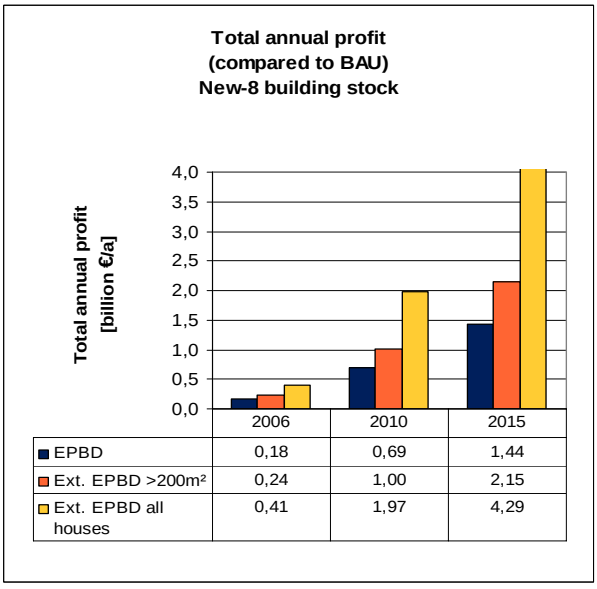
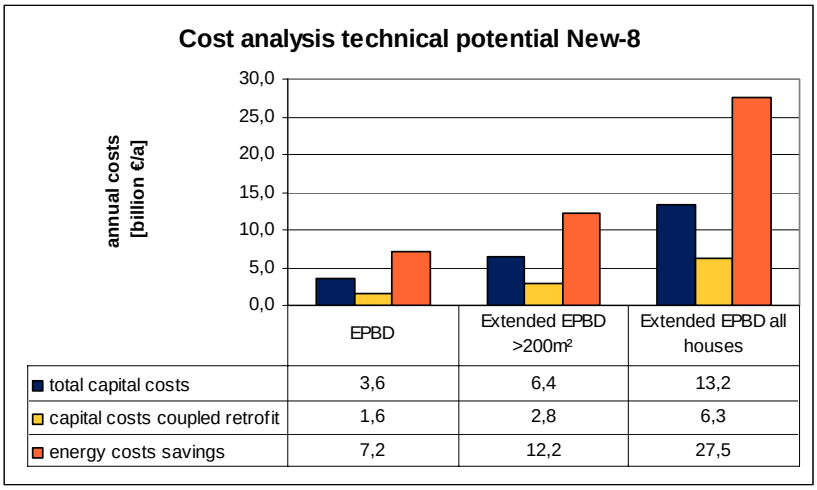


Figure 23: NEW-8 price scenario 4 phased implementation annual profit



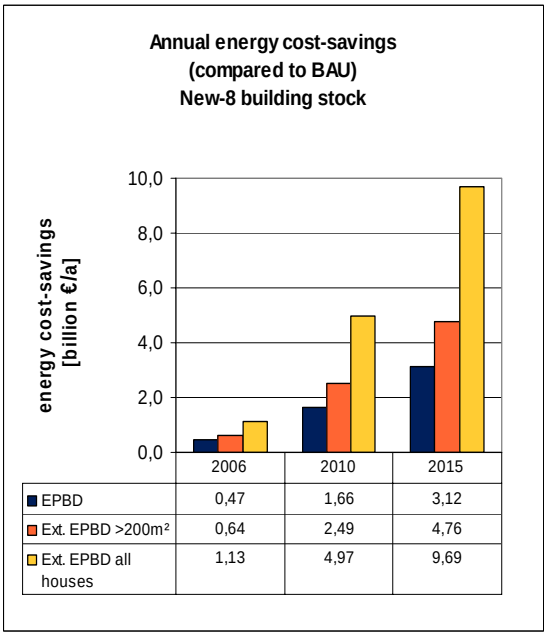
3.6 New-8 Price scenario 5

Figure 24: New-8 price scenario 5 cost analysis technical potential



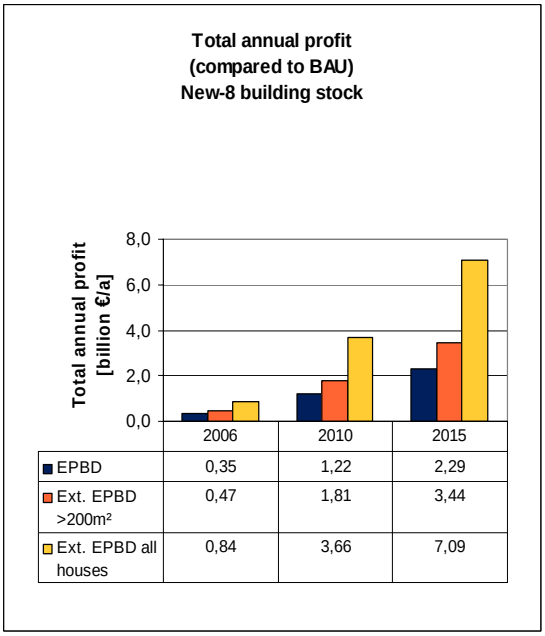
	EPBD	Extended EPBD >200m²	Extended EPBD all houses
total capital costs	3,6	6,4	13,2
capital costs coupled retrofit	1,6	2,8	6,3
energy costs savings	7,2	12,2	27,5

Figure 25: NEW-8 price scenario 5 phased implementation energy cost-savings



	2006	2010	2015
EPBD	0,47	1,66	3,12
Ext. EPBD >200m²	0,64	2,49	4,76
Ext. EPBD all houses	1,13	4,97	9,69

Figure 26: NEW-8 price scenario 5 phased implementation annual profit



	2006	2010	2015
EPBD	0,35	1,22	2,29
Ext. EPBD >200m²	0,47	1,81	3,44
Ext. EPBD all houses	0,84	3,66	7,09

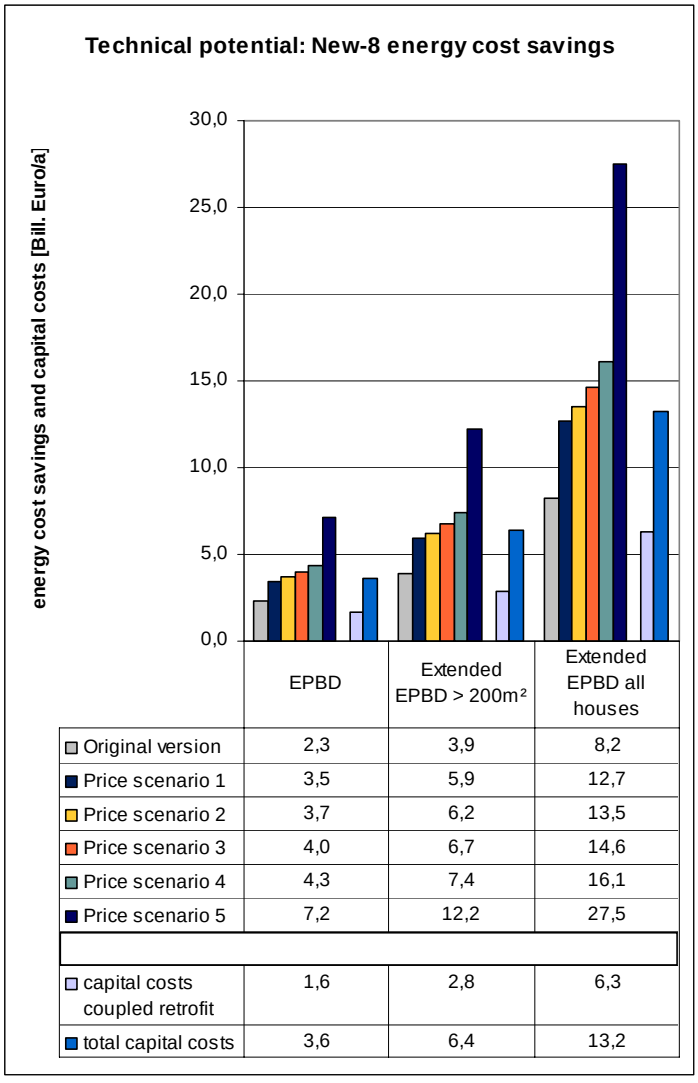
3.7 New-8 Price Summary scenarios

In this section the effects of modified energy prices on the economic results for the new member states are summarised.

For the technical potential Figure 27 presents the energy cost savings in the New-8 member states. Compared to the original scenario the the energy cost savings for sceanrio 5 are more than trippled.

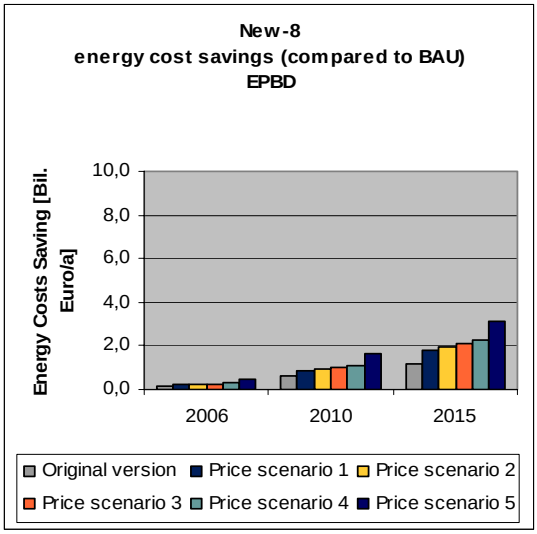
Figure 28 summarises the influences of all price scenarios on the phased implementation of the EPBD and possible extensions and shows the resulting energy cost savings as well as the total annual cost savings for the New-8. In case of price scenario 5 the extension of the EPBD to all houses would lead to an total annual profit of 3.7 billion Euro in 2010 (see Figure 28-f).

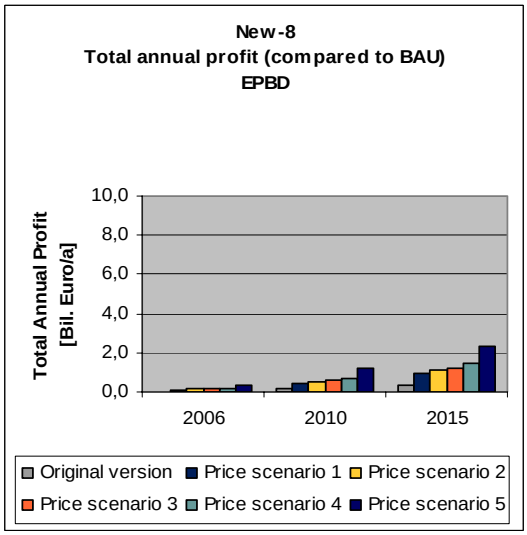
Figure 27: Overview New-8 price scenarios technical potential

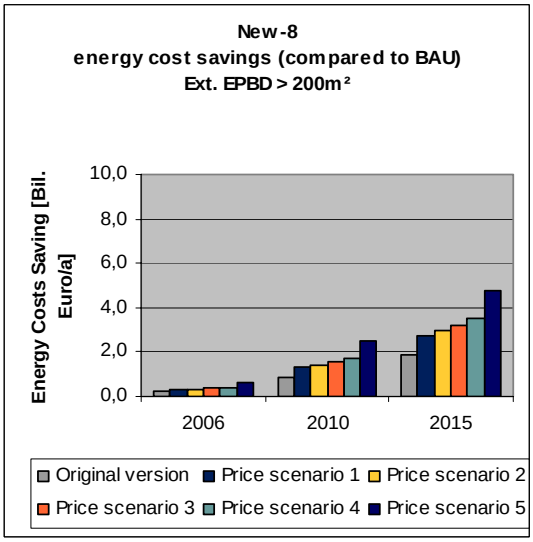


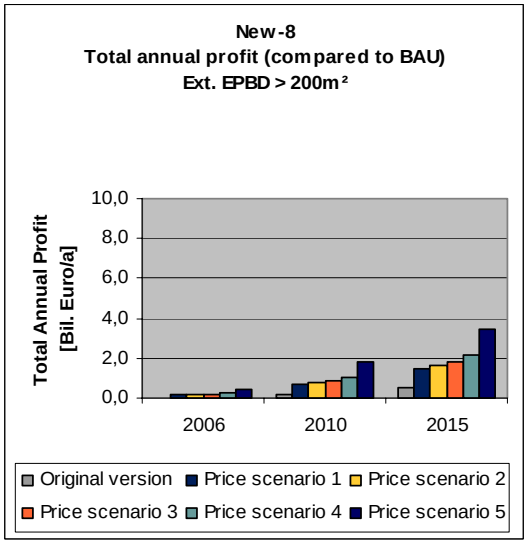
	EPBD	Extended EPBD > 200m²	Extended EPBD all houses
Original version	2,3	3,9	8,2
Price scenario 1	3,5	5,9	12,7
Price scenario 2	3,7	6,2	13,5
Price scenario 3	4,0	6,7	14,6
Price scenario 4	4,3	7,4	16,1
Price scenario 5	7,2	12,2	27,5
capital costs coupled retrofit	1,6	2,8	6,3
total capital costs	3,6	6,4	13,2

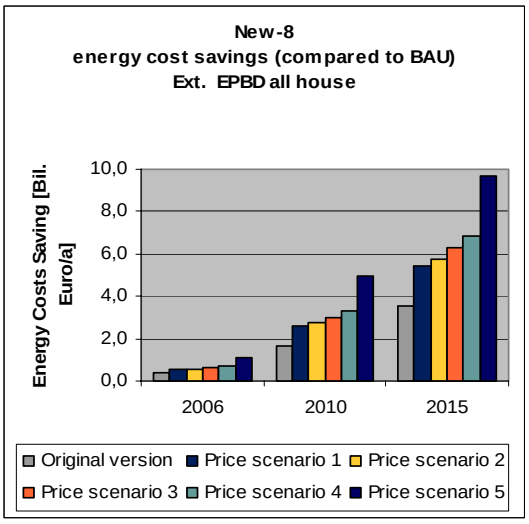
Figure 28: Overview New-8 price scenarios phased implementation

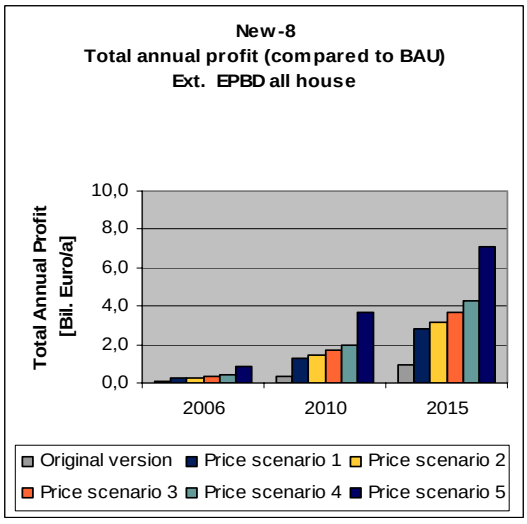












4 Sensitivity analysis EU-15

The report "Cost effective climate protection in the EU-15 Building Stock" analysed the impact of insulation and energy efficiency measures for the EU-15 building stock on the CO_2 saving potential, the investments required and their cost effectiveness. The analysis was done for the technical potentials as well as for the influences of phased implementation of the EPBD and possible extensions.

This section analyses the impact of the energy price scenarios on the economic results of the report mentioned above. The figures below show the resulting energy cost savings as well as the total annual cost savings for the EU-15 related to the technical potential and the phased implementation. The modified energy prices do neither influence the CO_2 saving potentials nor the required investements and respective annual capital costs, which all remain the same for all scenarios.

Firstly, the impact of each price scenario on the economic results for the EU-15 is presented separately. The last paragraph of this section gives an overview of the economic results for all price scenarios.

4.1 EU-15 Price scenario 1

Figure 29: EU-15 price scenario 1 cost analysis technical potential

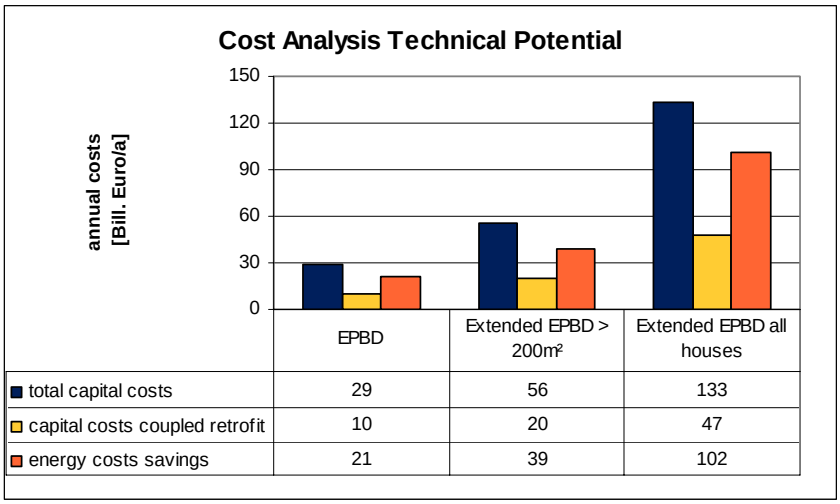


Figure 30: EU-15 price scenario 1 phased implementation energy cost-savings

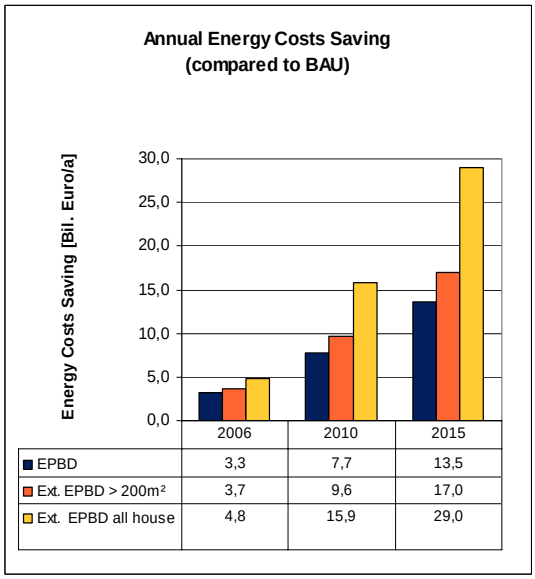
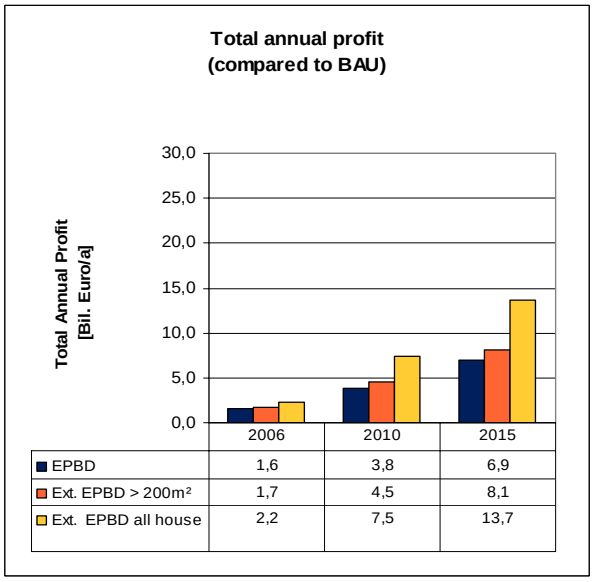


Figure 31: EU-15 price scenario 1 phased implementation annual profit



4.2 EU-15 Price scenario 2

Figure 32: EU-15 price scenario 2 cost analysis technical potential

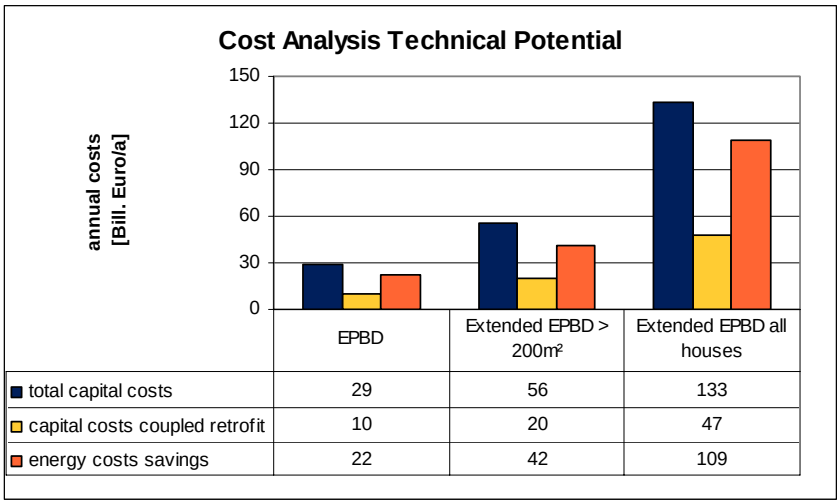


Figure 33: EU-15 price scenario 2 phased implementation energy cost-savings

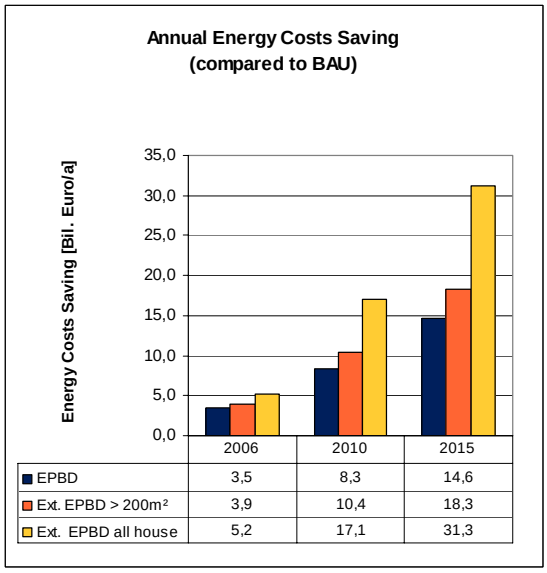
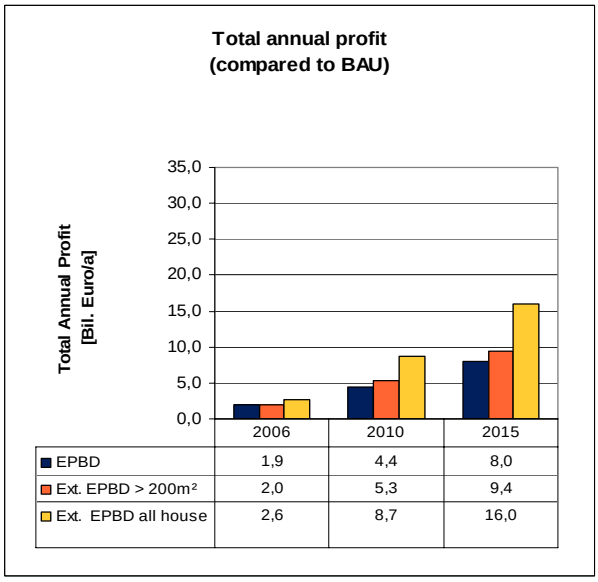


Figure 34: EU-15 price scenario 2 phased implementation annual profit



4.3 EU-15 Price scenario 3

Figure 35: EU-15 price scenario 3 cost analysis technical potential

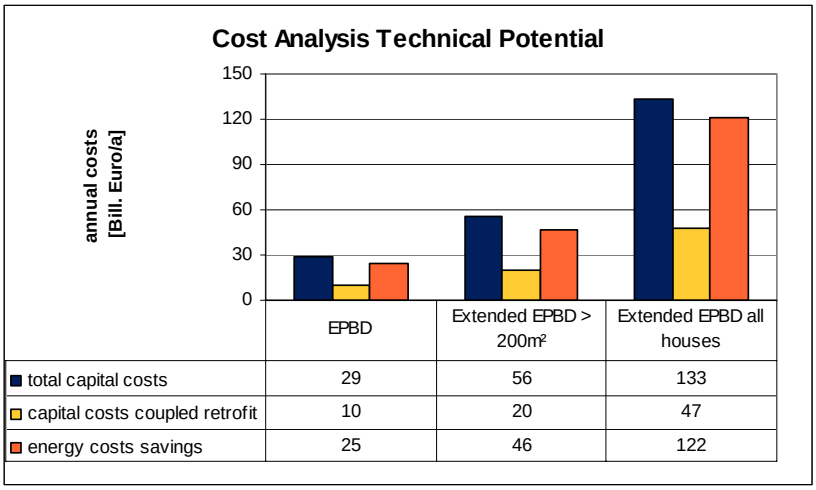


Figure 36: EU-15 price scenario 3 phased implementation energy cost-savings

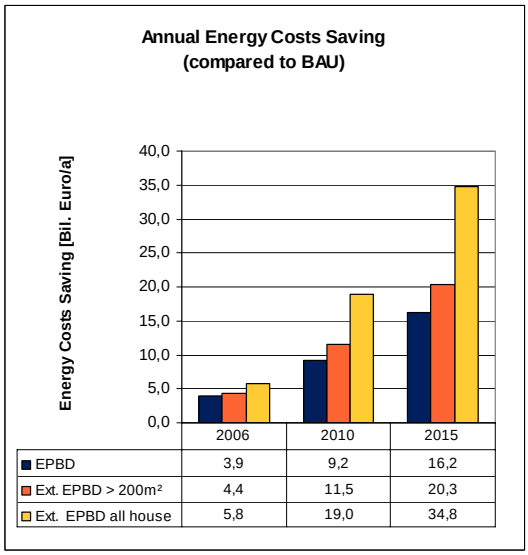
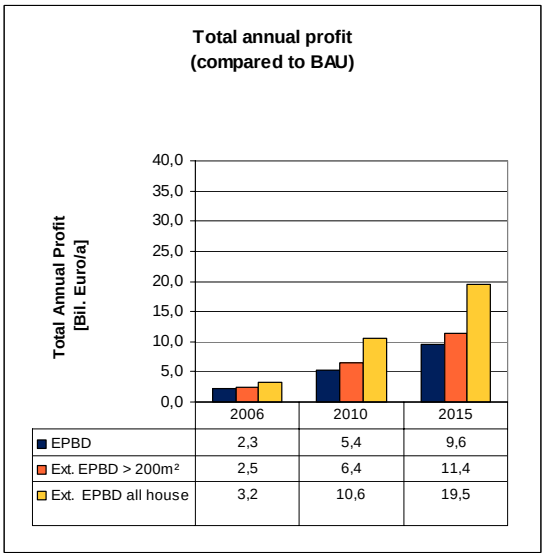


Figure 37: EU-15 price scenario 3 phased implementation annual profit



4.4 EU-15 Price scenario 4

Figure 38: EU-15 price scenario 4 cost analysis technical potential

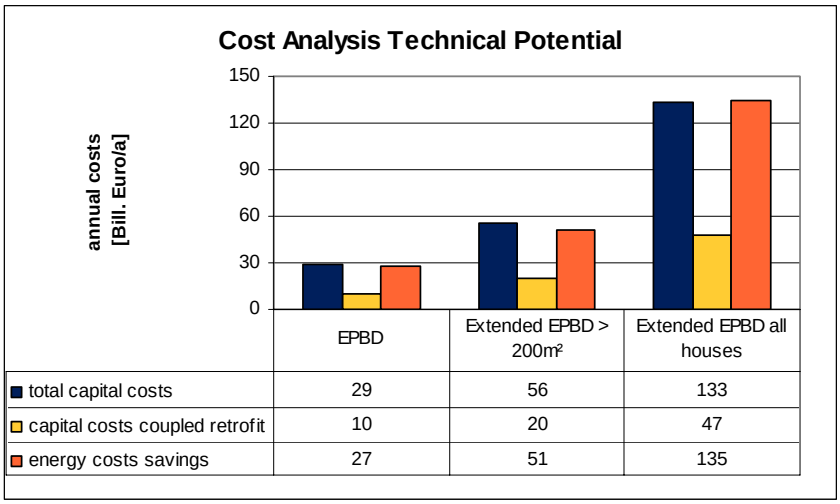


Figure 39: EU-15 price scenario 4 phased implementation energy cost-savings

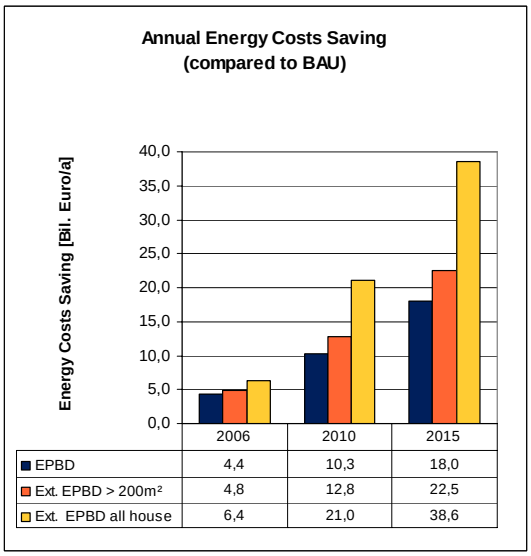
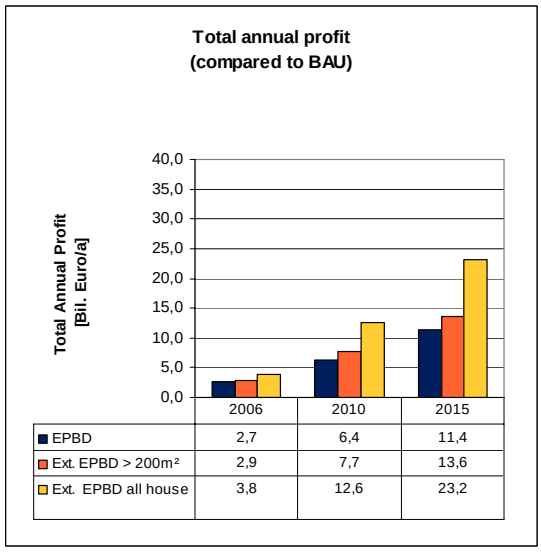


Figure 40: EU-15 price scenario 4 phased implementation annual profit



4.5 EU-15 Price scenario 5

Figure 41: EU-15 price scenario 5 cost analysis technical potential

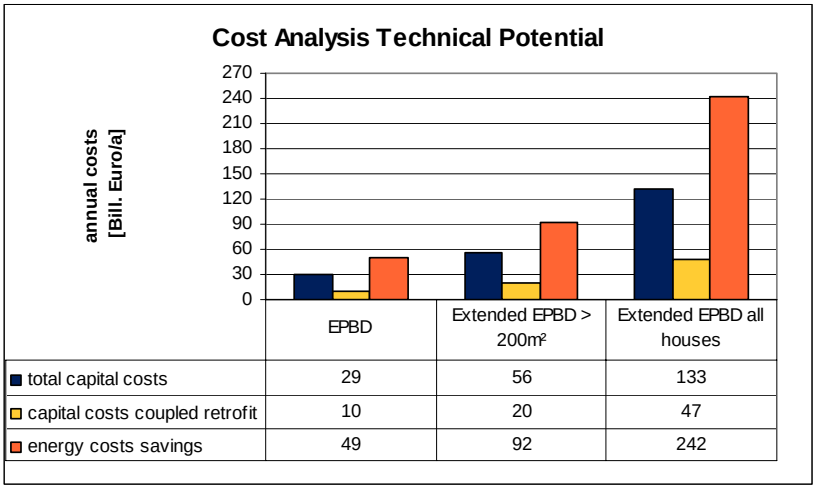


Figure 42: EU-15 price scenario 5 phased implementation energy cost-savings

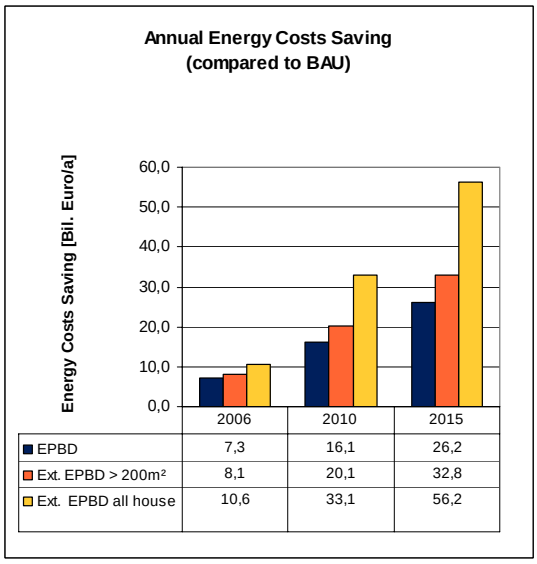
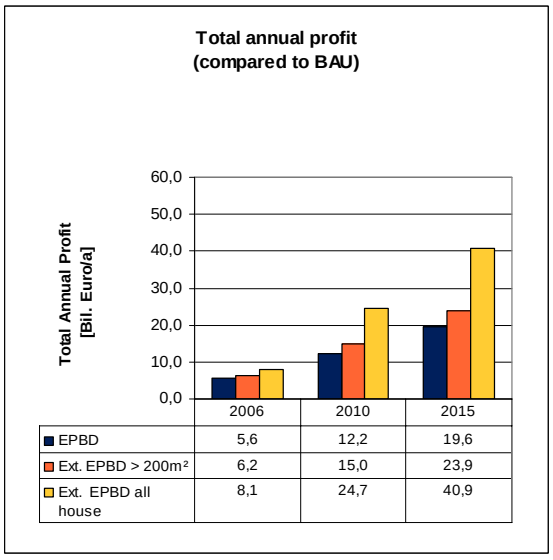


Figure 43: EU-15 price scenario 5 phased implementation annual profit



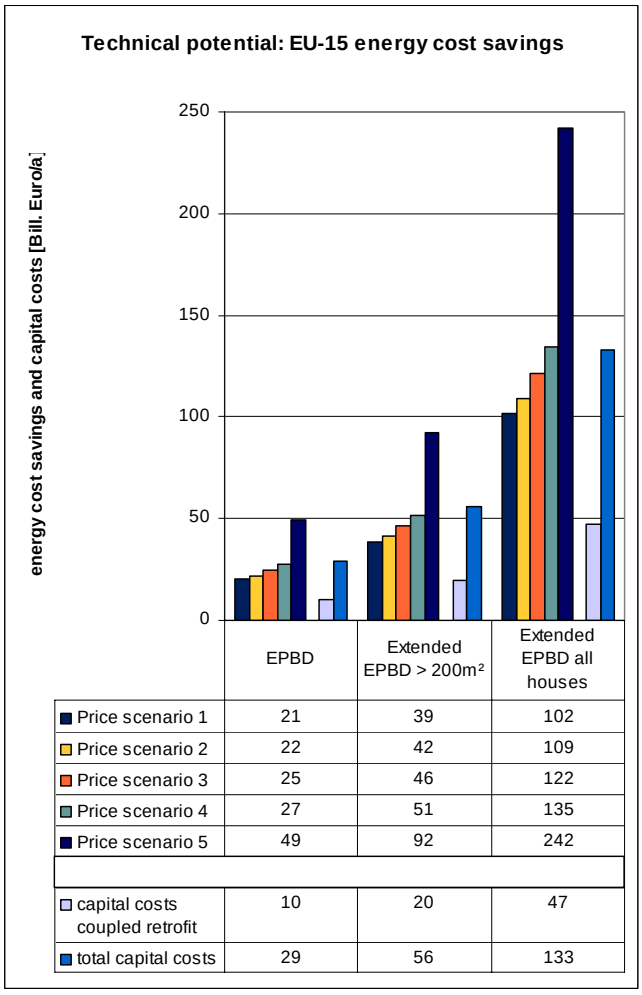
4.6 EU-15 Price Summary scenarios

In this section the effects of modified energy prices on the economic results for the new member states are summarised.

For the technical potential Figure 44 presents the energy cost savings in the EU-15. Compared to price scenario 1 the the energy cost savings for sceanrio 5 are more than doubled.

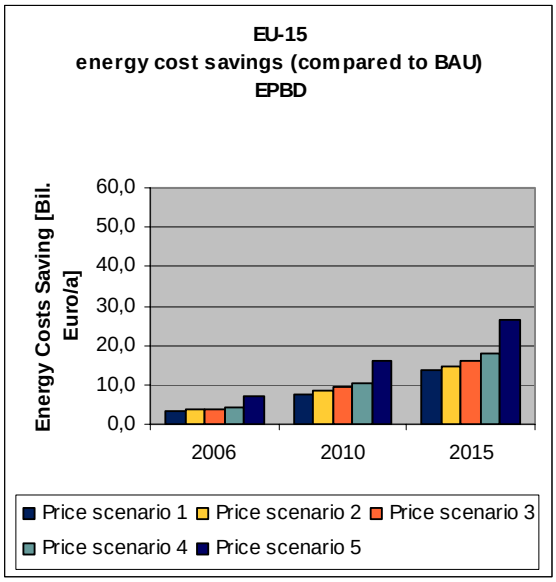
Figure 45 summarises the influences of all price scenarios on the phased implementation of the EPBD and possible extensions and shows the resulting energy cost savings as well as the total annual cost savings for the EU-15. In case of price scenario 5 the extension of the EPBD to all houses would lead to an total annual profit of 24.7 billion Euro in 2010 (see Figure 45-f).

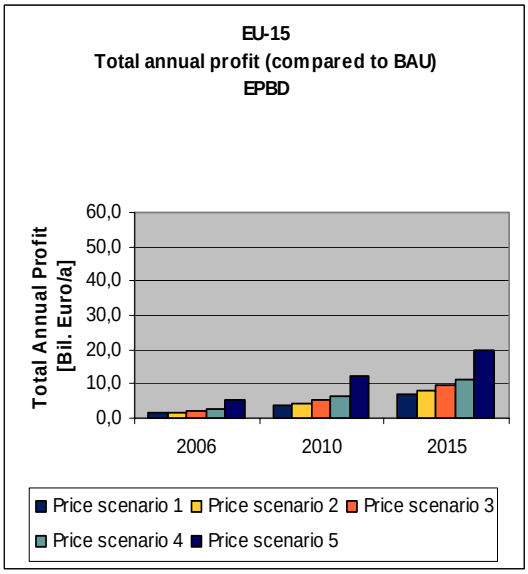
Figure 44: Overview EU-15 price scenarios technical potential

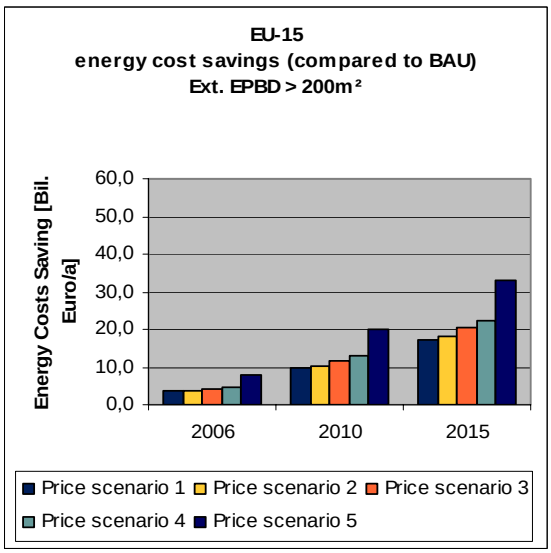


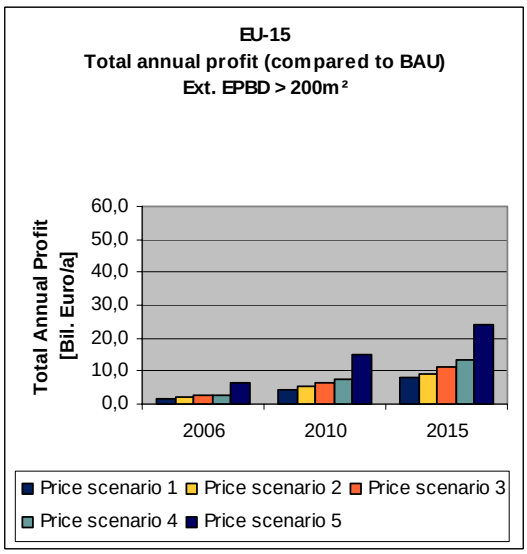
	EPBD	Extended EPBD > 200m²	Extended EPBD all houses
Price scenario 1	21	39	102
Price scenario 2	22	42	109
Price scenario 3	25	46	122
Price scenario 4	27	51	135
Price scenario 5	49	92	242
capital costs coupled retrofit	10	20	47
total capital costs	29	56	133

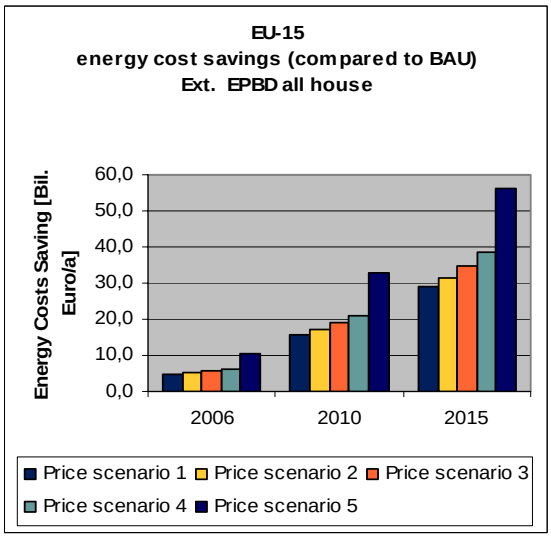
Figure 45: Overview EU-15 price scenarios phased implementation

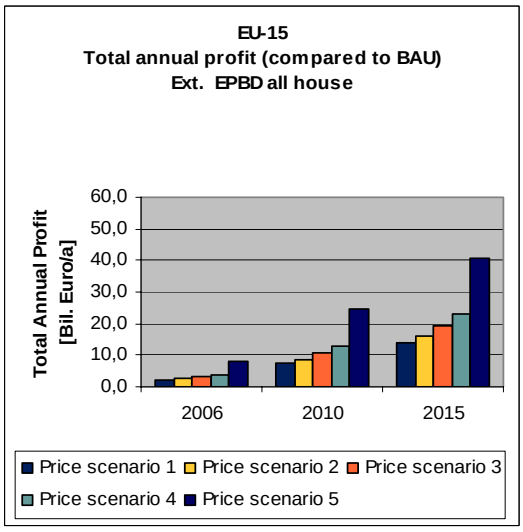












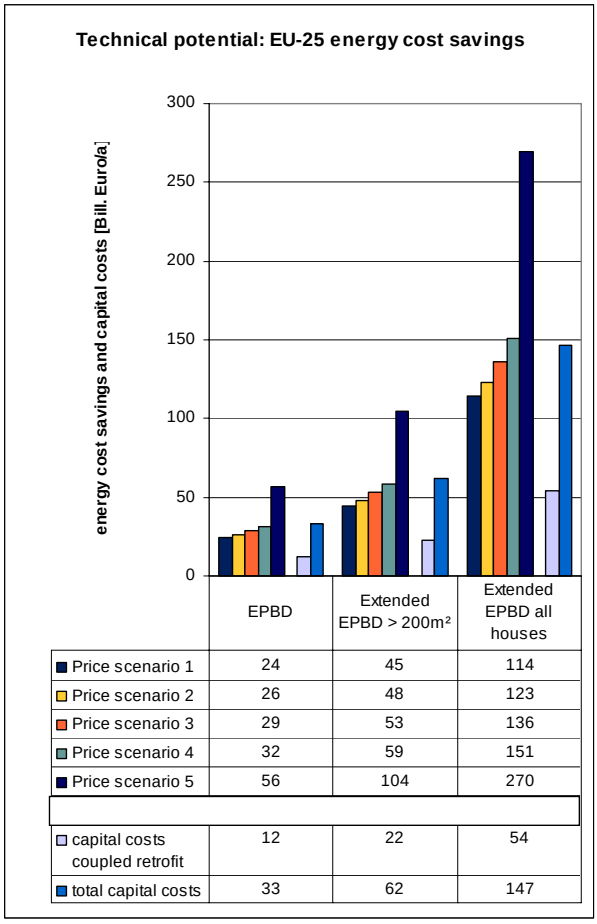
5 Aggregated results EU-25

In this section the effects of modified energy prices on the economic results for the EU-25 are summarised.

For the technical potential Figure 46 presents the energy cost savings in the EU-25. Compared to price scenario 1 the the energy cost savings for sceanrio 5 are more than doubled.

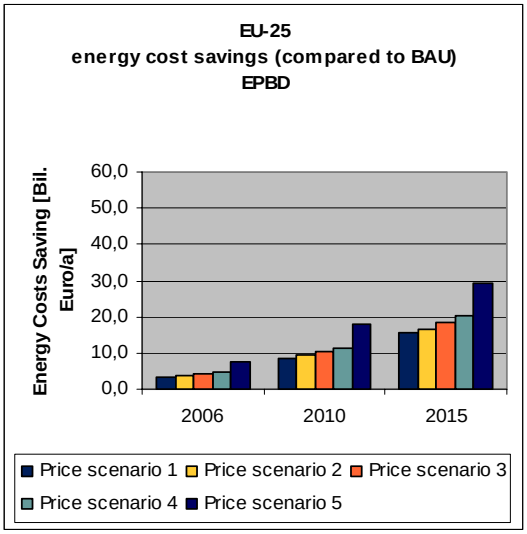
Figure 47 summarises the influences of all price scenarios on the phased implementation of the EPBD and possible extensions and shows the resulting energy cost savings as well as the total annual cost savings for the EU-25. In case of price scenario 5 the extension of the EPBD to all houses would lead to an total annual profit of 28.3 billion Euro in 2010 (see Figure 47-f).

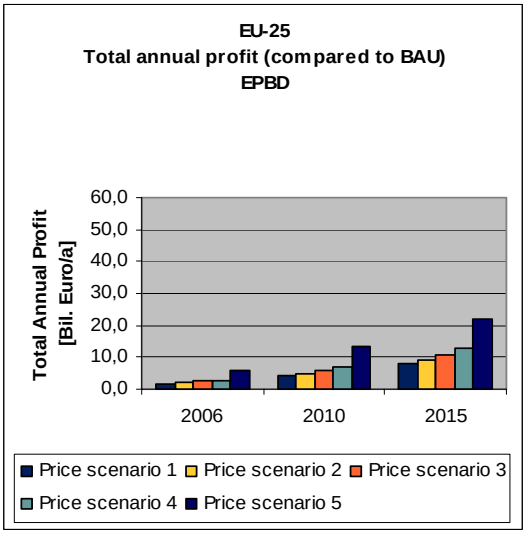
Figure 46: Overview EU-25 price scenarios technical potential

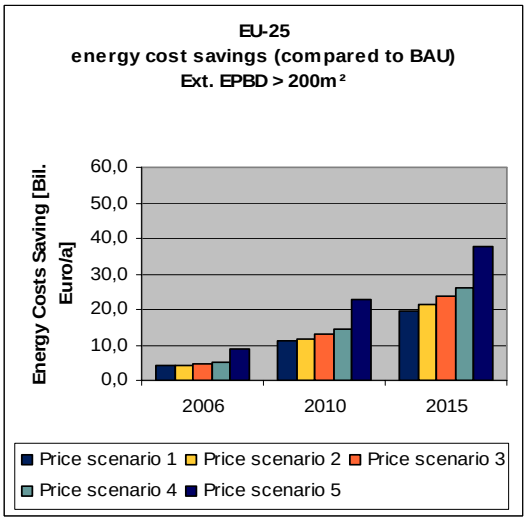


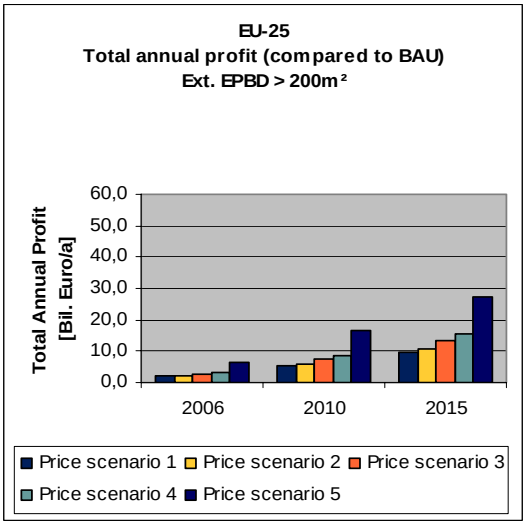
	EPBD	Extended EPBD > 200m²	Extended EPBD all houses
Price scenario 1	24	45	114
Price scenario 2	26	48	123
Price scenario 3	29	53	136
Price scenario 4	32	59	151
Price scenario 5	56	104	270
capital costs coupled retrofit	12	22	54
total capital costs	33	62	147

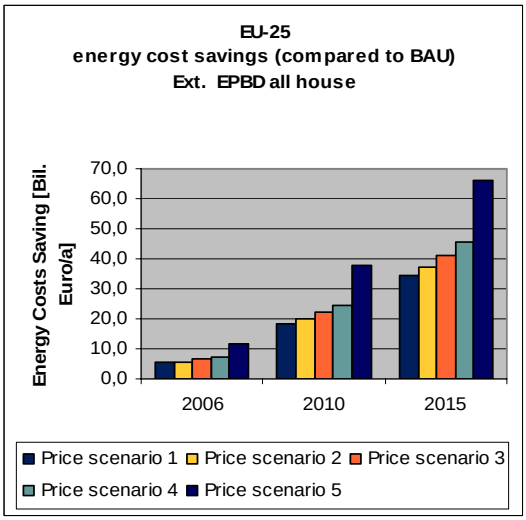
Figure 47: Overview EU-25 price scenarios phased implementation

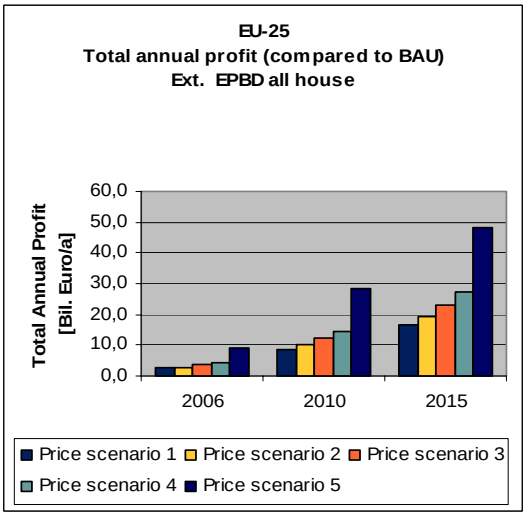












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