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PART 3/3

COMMISSION STAFF WORKING DOCUMENT

IMPACT ASSESSMENT

Accompanying the document

Proposal for a Directive of the European Parliament and of the Council amending Directive 2012/27/EU on Energy Efficiency

{COM(2016) 761 final}
{SWD(2016) 406 final}

6.2 Analytical approach for Articles 9-11

For Articles 9-11, no formal analytical models were used in the assessment of impacts.

The quantitative **estimates of the potential** for energy savings from implementation of the existing EED provisions on sub-metering of heating in multi-flat buildings were produced using an ad-hoc bottom-up/engineering spreadsheet-based model created by consultants Empirica under a specific contract. The methodology is outlined below.

As regards the **estimate of each option's contribution to realising this potential**, and the additional potential represented by enhanced consumption feedback, these were also based on a simple bottom-up approach set out in the main report.

There is strong evidence that introducing heat meters and heat cost allocators, to provide A) consumption-based cost allocation (i.e. "pay in relation to your actual/own consumption") and B) consumption information services (e.g. more frequent, informative billing information), leads to more careful use of energy by building occupants, and that this behaviour change results in significant energy savings. Multiple studies provide evidence of the percentage energy savings triggered, however, it is now known that the percentage resulting from the same change in user behaviour is not constant but varies with building quality. A model recently developed for Germany[121] applies key building characteristics to convert between percentages and behaviour effects. Extension of this energy saving conversion model for application to the EU-28 requires the following data set:

1) Building characteristics:
    a) Building performance (i.e. building envelope) and user control (over settings, windows)
    b) Climate at the location of the building (e.g. heating degree days)
2) Behavioral effects:
    a) Average reduction in internal temperature through care in temperature settings
    b) Average reduction in air changes per hour (ACH) through more careful ventilation (e.g. with regard to how windows are used)

Evidence of behavioural effects

Evidence of the behavioural effects is derived from savings shown in multiple studies followed by application of the energy saving conversion model. Existing evidence[122] collected in several studies (some of which are shown in the figure below, is that, in older buildings, the energy savings achieved by the introduction of consumption-based cost allocation amounts to around **20%** of actual final consumption.

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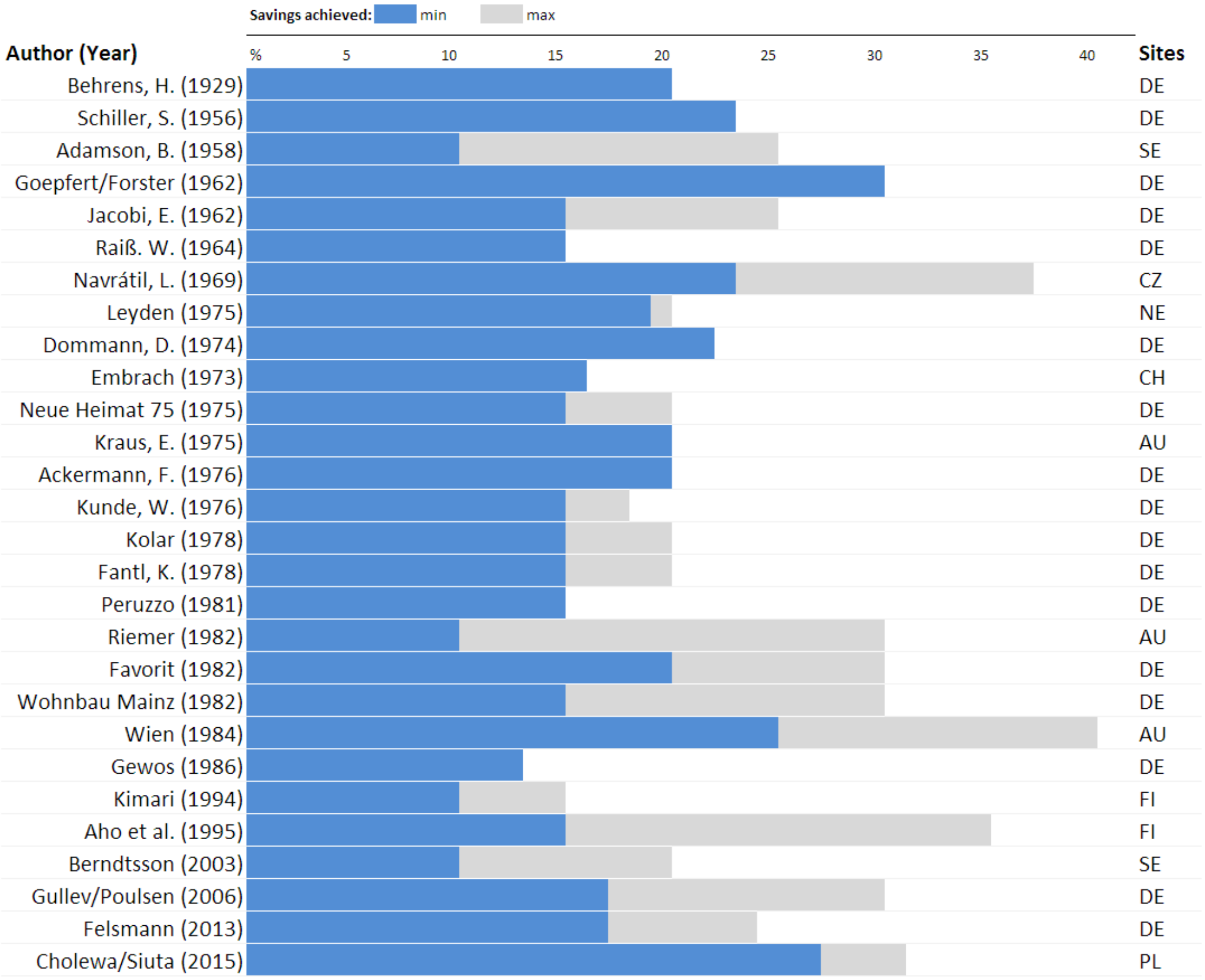
[121] Bert Oschatz: Heating Cost Allocation Cost Efficiency Assessed for Buildings in Germany, Berlin 2015.

[122] Cf. empirica (2016) Guidelines on good practice in cost-effective cost allocation and billing of individual consumption of heating, cooling and domestic hot water in multi-apartment and multi-purpose buildings, Available at https://ec.europa.eu/energy/sites/ener/files/documents/MBIC_Guidelines20160530D.pdf.

Figure 1: Literature review: energy savings through heat sub-metering (in %)



Source: Empirica literature review

Based on a set of studies in buildings of known performance characteristics and in known climate locations, also showing 20% savings, and assuming neither behavioural effect is dominant (50-50 split), the following behavioural effects can be shown for the introduction of consumption-based cost allocation:

- Temperature reduction by 1.1 Kelvin
- Ventilation reduction by 0.25 per h (ACH)

Additional savings are achieved through changes in user behaviour by introducing consumption information service. Over many studies the median estimate for the additional savings triggered by a variety of such services amount to some **3%.** Reusing the results of the energy saving conversion model for consumption-based cost allocation, the following additional behavioural effects can be shown for the introduction of consumption information services**::**

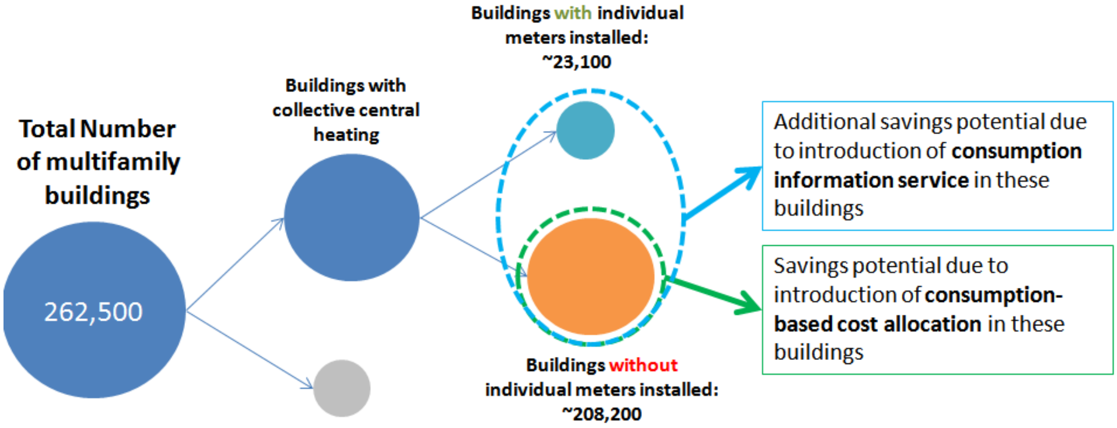
- Temperature: 1.1 * 3%/20% = 0.165 Kelvin
- Ventilation: 0.25 * 3%/20% = 0.0375 per h

Based on figures for hot water consumption researched in the UK (DEFRA/energy saving trust[123]), and on an analysis of 13 studies by Sønderlund et al.[124], the 20% saving for consumption-based cost allocation is applied to a baseline consumption of hot tap water of 46 and 26 litres per day, per dwelling and per person respectively (total dwelling consumption = 46 + 26*N litres / day)[125]. An additional 3% savings are achieved by introducing consumption information services. Household size is based on the most recent data available on eurostat[126]. Delivery temperature is assumed to be 60°C following health recommendations[127].

Building stock - multi-unit buildings

The energy saving potential from EED metering and billing provisions in EU-28 depends on the building stock to benefit from the measures, that is, on the characteristics of existing buildings and their location. The building stock relevant here is the stock of multi-unit buildings not already being provided with consumption-based cost allocation (or consumption information services, respectively). The calculation of the relevant numbers in a Member State is illustrated in the figure below (with data for the UK):

Figure 2: Illustration of methodology for calculating potential energy saving (in this case for the UK)



Source: empirica calculations based on data from BPIE and estimates from JRC and EVVE

Using statistics available for all the EU-28 (see figures below), the existing residential building stock in a country is reduced to that proportion which falls under the provisions of the EED Article 9(3) and is not already provided with consumption-based cost allocation. These are the buildings able to benefit from the introduction of consumption based cost allocation.

This assessment is conservative in that commercial multi-purpose buildings are not included due to lack of data.

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[123] DEFRA(2008) Measurement of Domestic Hot Water Consumption in Dwellings

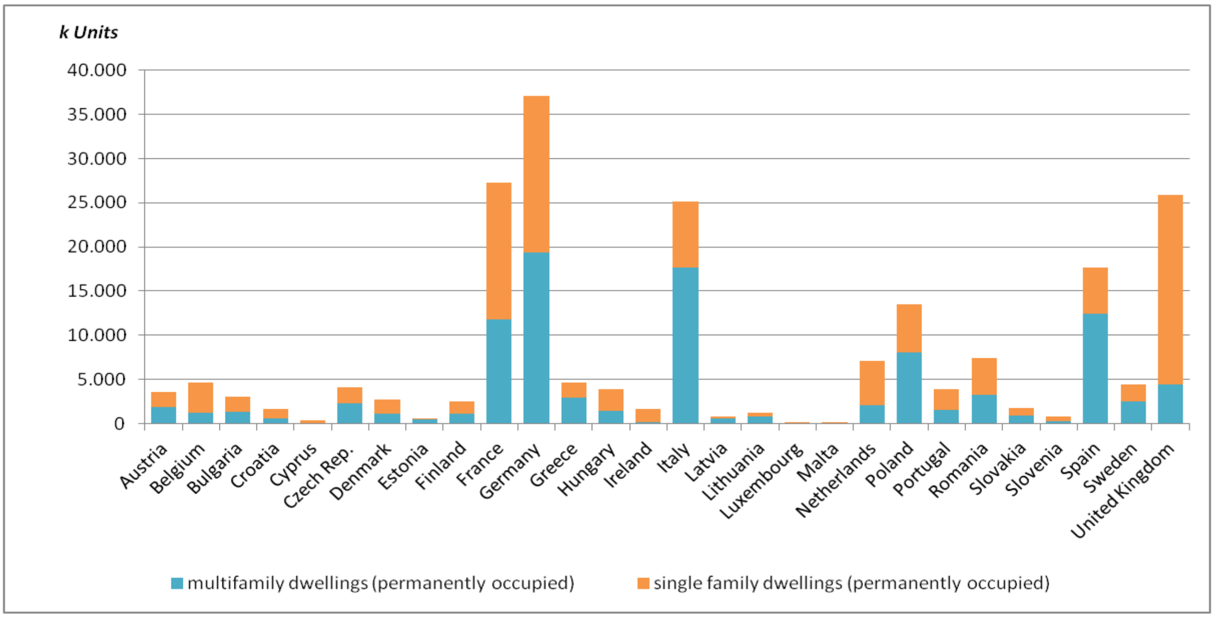
[124] Sønderlund, A.L., Smith, J.R., Hutton, C., Kapelan, Z. (2014) Using Smart Meters for Household Water Consumption Feedback: Knowns and Unknowns, Procedia Engineering 89, 990-997.

[125] Member state specific values on individual daily consumption were used for Denmark (18.1l), Finland (23.8l) and Sweden (49.3l)

[126] Eurostat (2015) Average household size - EU-SILC survey [ilc_lvph01]

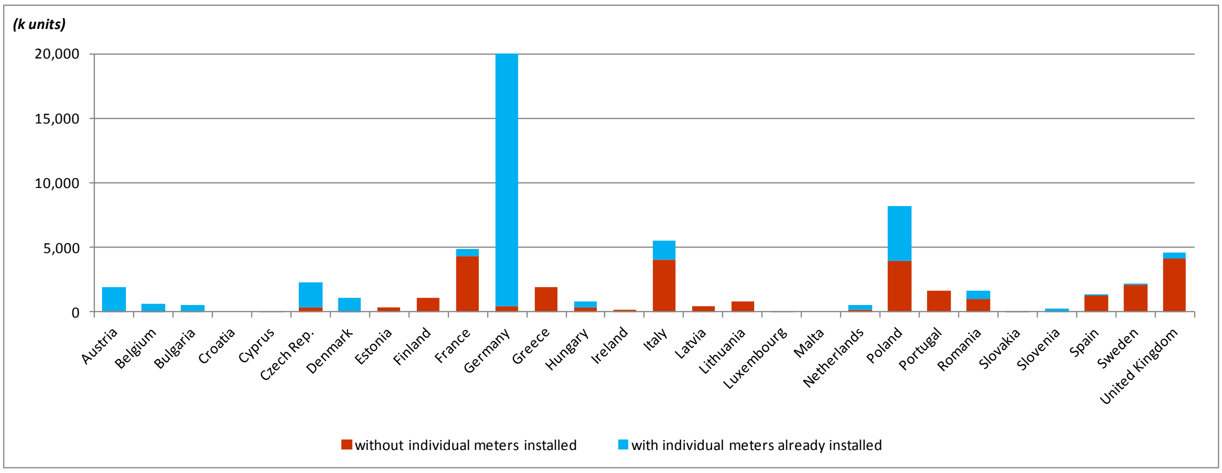
[127] WHO (2007) LEGIONELLA and the prevention of legionellosis

Figure 3: Composition of residential building stock per country



*Source: Odyssee (*BG; CY; CZ; IT; LV; LT; LU; PL – estimates based on entranze dataset)*

Figure 4: Stock of dwellings in multi-apartment buildings with collective central heating systems



Source: Empirica calculations based on JRC and EVVE estimates and ODYSSEE data

Building performance and climate

The impact of EED related sub-metering measures on different buildings in Europe vary with climate and insulation quality. These are taken into account in the energy saving conversion model. Climate is accounted for using existing statistics of degree days and production days. Differences in the quality of insulation of the elements of the building envelope - outside walls, windows and roof - are reflected in the heat transfer coefficient (U, in W/m²•K) of each element.

Recent statistics on average U values for the main building elements, coupled with transparent assumptions of the relative area of the different elements in an average building, yield the average value of the heat transfer coefficient of building stock in each Member State (see table below).

Table 1: U-values (weighted average based on stock)

Regions	Countries	WALL (30%)	WINDOW (20%)	FLOOR (25%)	ROOF (25%)	u-value
Southern Dry	Portugal	1.31	4.07	1.97	2.48	**2.32**
	Spain	1.76	4.61	1.74	1.15	**2.17**
Mediterranean	Cyprus	1.20	2.97	0.00	1.47	**1.32**
	Greece	1.34	3.77	2.29	1.96	**2.22**
	Italy	1.47	4.98	1.68	1.76	**2.30**
	Malta	1.61	5.80	2.44	1.87	**2.72**
Southern Continental	Bulgaria	1.42	2.49	0.95	1.14	**1.45**
	France	1.77	3.67	1.43	1.78	**2.07**
	Slovenia	1.20	2.09	0.95	0.94	**1.25**
Oceanic	Belgium	1.73	4.17	0.95	1.99	**2.09**
	Ireland	1.38	3.99	1.12	0.73	**1.67**
	United King	1.40	4.40	1.41	1.42	**2.01**
Continental	Austria	1.00	2.62	1.21	0.61	**1.28**
	Czech Rep.	0.90	2.87	1.00	0.74	**1.28**
	Germany	0.96	2.92	1.04	0.98	**1.37**
	Hungary	1.34	2.45	0.93	0.96	**1.36**
	Luxembour	1.27	3.03	1.00	0.00	**1.24**
	Netherlands	1.30	3.26	1.40	1.29	**1.72**
Northern Continental	Denmark	0.75	2.50	0.57	0.34	**0.95**
	Lithuania	0.79	2.03	0.83	0.67	**1.02**
	Poland	1.11	3.05	1.23	0.62	**1.41**
	Romania	1.57	2.44	1.29	1.23	**1.59**
	Slovakia	1.04	3.28	1.61	1.09	**1.64**
Nordic	Estonia	0.38	1.50	0.40	0.38	**0.61**
	Finland	0.43	1.92	0.40	0.26	**0.68**
	Latvia	0.95	2.54	0.78	1.05	**1.25**
	Sweden	0.35	2.79	0.20	0.32	**0.79**

Source: empirica calculations based on data from iNSPiRe (2014)[128]

Results – EU wide potential

The estimated impact/potential in each of the EU-28 Member States (MS) is given by applying the energy saving conversion model to the two behavioural effects (ventilation and temperature) for the relevant building stock in each MS. For each MS the thermal transfer coefficient is taken from Table 1 and weighted averages across the country's climate are used for degree days and production days.

Total outstanding annual savings in EU-28 due to full implementation of EED provisions on **consumption based cost allocation** is estimated at around **13.46 Mtoe** in final energy consumption terms.

Table 2: Estimated savings potential from full/"perfect" implementation of current EED provisions on cost allocation and information for space heating and hot water in multi-family buildings

Measure	**Mtoe**
Space heating: Consumption based cost allocation	12.06
Space heating: Consumption information services	4.00
Hot water: Consumption based cost allocation	1.38
Hot water: Consumption information services	0.44
Total	**17.88**

Source: empirica estimations based on Guidelines for good practice[129]

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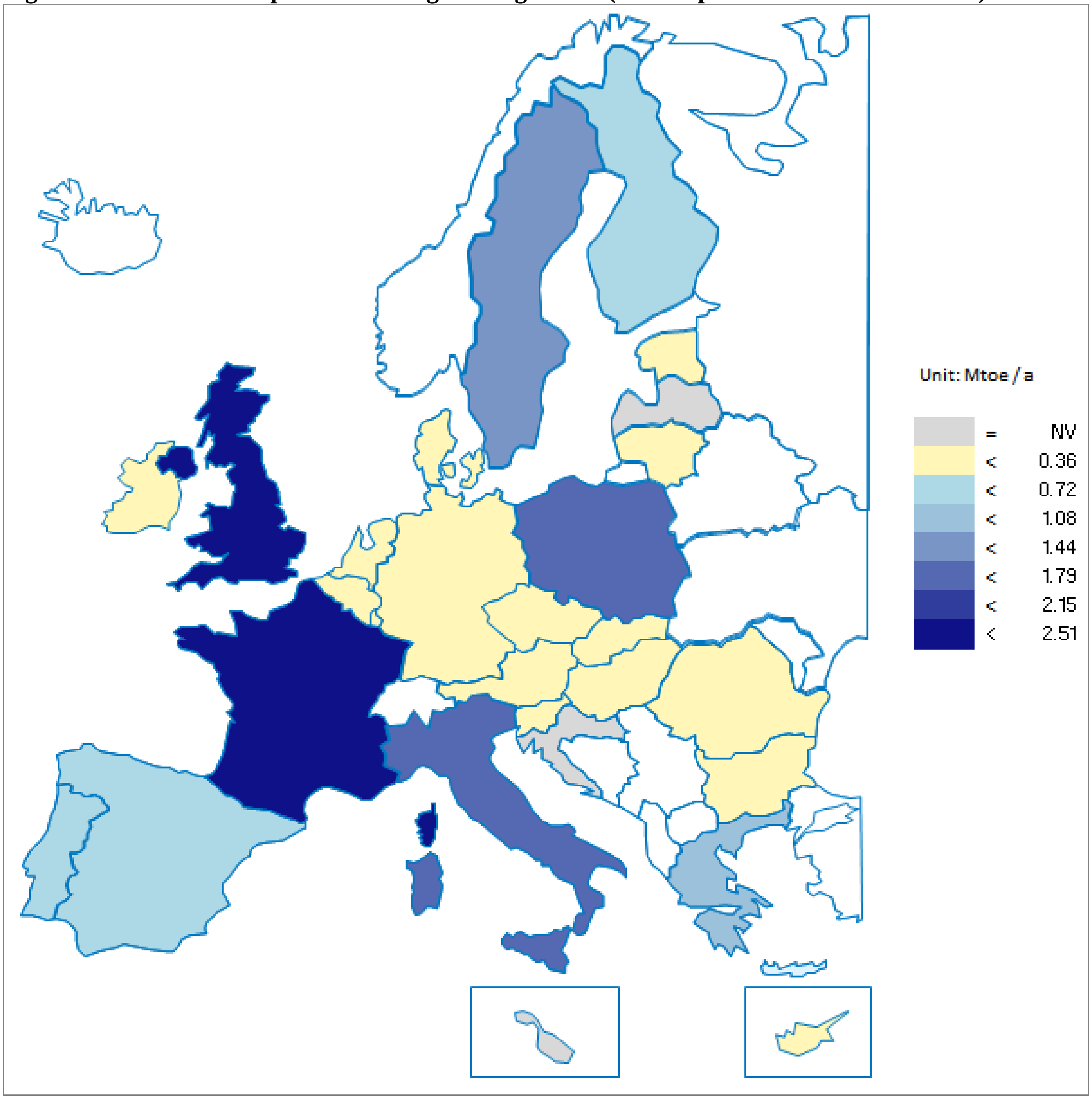
[128] iNSPiRe (2014) Survey on the energy needs and architectural features of the EU building stock

The total outstanding annual savings potential in EU-28 due to implementation of EED provisions on **consumption information services** is estimated at around **4.4 Mtoe** with the existing building stock.

Figure 5: Distribution of potential savings among EU-28 (consumption based cost allocation)



Source:empirica estimates (2016)

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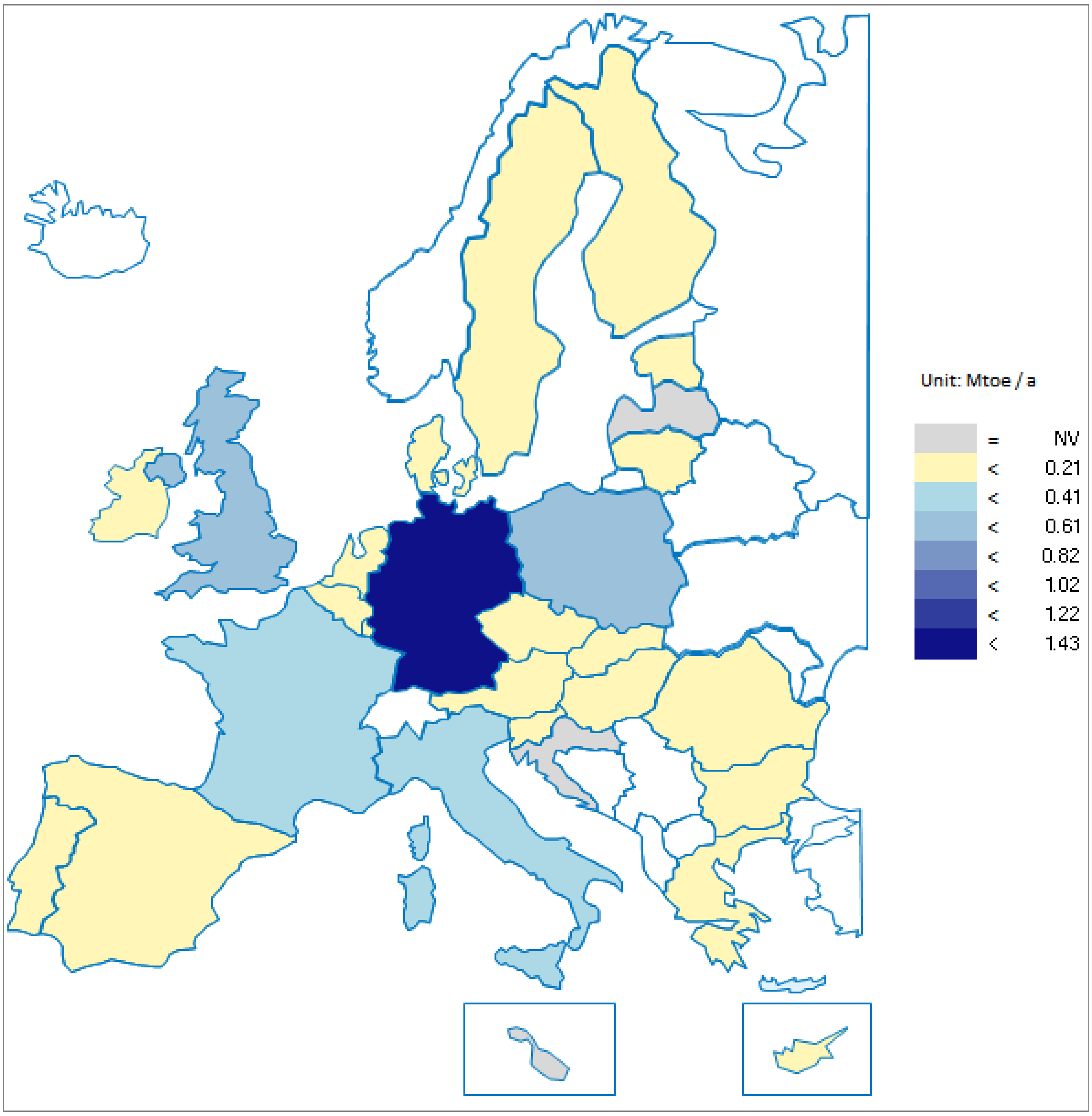
[129] empirica (2016) Guidelines on good practice in cost-effective cost allocation and billing of individual consumption of heating, cooling and domestic hot water in multi-apartment and multi-purpose buildings, Available at https://ec.europa.eu/energy/sites/ener/files/documents/MBIC_Guidelines20160530D.pdf

Figure 6: Distribution of potential savings among EU-28 (consumption information services)



Source: empirica estimates (2016)

7 Annex – Tables and figures on Article 7[130]

Table 3: Notified baselines for the calculation of the national savings requirements for period 2014-2020

Member State	Final energy consumption (ktoe)	Adjusted baseline (ktoe)*	Transport excluded (ktoe)	Energy production for own use and non-energy use, if excluded (ktoe)
Austria	26,570	16,508	8,565	1,497
Belgium	30,171	21,940	8,231	Yes (not specified for all regions)
Bulgaria	9,116	6,167	2,956	-
Croatia	6,151	4,113	2,037	-
Cyprus	1,863	767	1,023	73
Czech Republic	26,228	14,491	5,864	3,219
Denmark	15,086	9,833	4,973	277
Estonia	2,872	1,938	787	146
Finland	25,534	13,373	4,939	7,222
France	153,850	99,567	49,380	4,903
Germany	215,845	133,324	61,192	21,329
Greece	18,335	10,580	7,328	427
Hungary	15,859	11,681	4,172	5
Ireland	11,295	6,873	4,422	-
Italy	121,961	80,960	41,001	-
Latvia	3,970	2,702	1,109	159
Lithuania	4,768***	3,188	1,556	-
Luxembourg	4,267	1,636	2,631	-
Malta	451	179	272	-
Netherlands	37,045	36,591	Yes (not specified)	454
Poland	64,610	47,040	17,570	-
Portugal	17,571	8,039	6,903	2,629
Romania	22,722	17,415	5,307	-
Slovakia	9,466	7,252	2,214	-
Slovenia	4,974	2,999	1,911	64
Spain	85,965	50,727	35,239	-
Sweden	Not provided	27,438	-	Yes (not specified)
UK	142,132	88,392	53,740	-
Total	**1,078,676****	**725,715**	**335,322****	**42,404****

Source: Ricardo AEA/ CE Delft

* *Adjusted means the value after subtracting 'energy use by transport' and 'generation for own use', where relevant*
** *Not specified by all Member States.*
*** *New final energy consumption for years 2010-2012 as 4768 ktoe notified without changes to the savings requirement.*

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[130] This Annex contain the updated information per Member State (for the existing period 2014-2020) obtained trhough the structured dialogue with Member States and updates reported by Member States through the annual reports 2016.

Table 4: Notified sum of expected cumulative energy savings (and share by EEOS) by 2020, perMember State[131]

Member State	Notified target (ktoe)	Notified sum of expected savings (ktoe)	Percentage to be delivered by EEOS (%)
Austria	5,200	9,145	42%
Belgium	6,911	7,268	
Bulgaria	1,942	1,943	100%
Croatia	1,296	1,295	41%
Cyprus	242	243	
Czech Republic	4,841	5,186	
Denmark	3,841*	7,355*	100%
Estonia	610	611	5%
Finland	4,213	7,531	
France	31,384	31,131	87%
Germany	41,989	45,302	
Greece	3,333	3,333	Not provided
Hungary	3,680	3,689	
Ireland	2,164	2,243	48%
Italy	25,502	25,800	62%
Latvia	851	851	65%
Lithuania	1,004	699	
Luxembourg	515	515	100%
Malta	56	67	14%
Netherlands	11,512	11,270	
Poland	14,818	14,818 ***	100%
Portugal	2,532	2,532	
Romania	5,817	5,863	
Slovakia	2,284	2,288	
Slovenia	945	945	33%
Spain	15,979	14,361**	44%
Sweden	9,114	11,505	
UK	27,859	34,041	24%
Total	**230,434**	**251,830**	**35%**

Source: Ricardo AEA/ CE Delft

** Denmark's notified the energy savings target is 4,130 ktoe, this however includes savings in energy transformation, distribution and transmission sectors. Savings in these sectors accounted for 6% of the total reported savings in 2012, in 2013 for 5% and in 2014 for 7%. A reduction of 7% has been applied for the purposes of this report and the energy savings target and expected savings have been reduced accordingly.*
*** Excludes 1,619 ktoe of savings notified by Spain in related taxation measures, as these arise in 2013, so cannot count towards the 2014 - 2020 saving period.*
**** The expected amount of savings is the same as the target, as only annual savings for 2016 and 2020 were notified by Poland.*

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[131] The total amount of expected energy savings contain also the savings achieved under exemptions (c) and (d) of Article 7(2) for the relevant Member using these exemptions.

Table 5: Overview of policy measures per Member State (period 2014-2020)[132]

	Energy efficicncy obligation scheme	Energy Efficiency National Fund	(a) Energy or CO_2 taxes	(b) Financing schemes or fiscal incentives (including grants)	(c) Regulations or voluntary agreements	(d) Standards and norms mandatory and applicable in MS under EU law	(e) Energy labelling schemes	(f) Training and education in reducing end-use energy consumption	i) Any other policy measures, and/or category not clear	Total number of policy measures
Austria	1		1	4	1	1			1	9
Belgium		1		12	4	3			1	21
Bulgaria	1									1
Croatia	1			10						11
Cyprus				3					2	5
Czech Republic				23						23
Denmark	1									1
Estonia	1		1	1						3
Finland			1	1	2	1			3	8
France	1			1				1		3
Germany[133]		1	1	20	3		1	13	67	106
Greece	1			15	1	1		1		19
Hungary				29	1			4		19
Ireland	1			2		4		3		10
Italy	1			2						3
Latvia	1			4	1				1	7
Lithuania			1	4	1				2	8
Luxembourg	1									1
Malta	1*			14	19					34
Netherlands									31	31
Poland	1									1
Portugal		1		1	1				2	5
Romania				20	1			2	6	28
Slovakia[134]								7	59	66
Slovenia	1	1								2
Spain	1		1	10				2	1	15
Sweden			1							1
UK	3**		1	4	6	3			3	20
Total [number of measures]	**18**	**4**	**8**	**180**	**41**	**13**	**1**	**33**	**179**	**477**
Total [number of MS]	**16**	**4**	**8**	**20**	**12**	**6**	**1**	**8**	**13**	**28**

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[132] These measures were notified by Member States and are subject to possible changes. Notified EEOSs do not necessary mean that they are all operational , -four Member States are still to put in place the scheme.

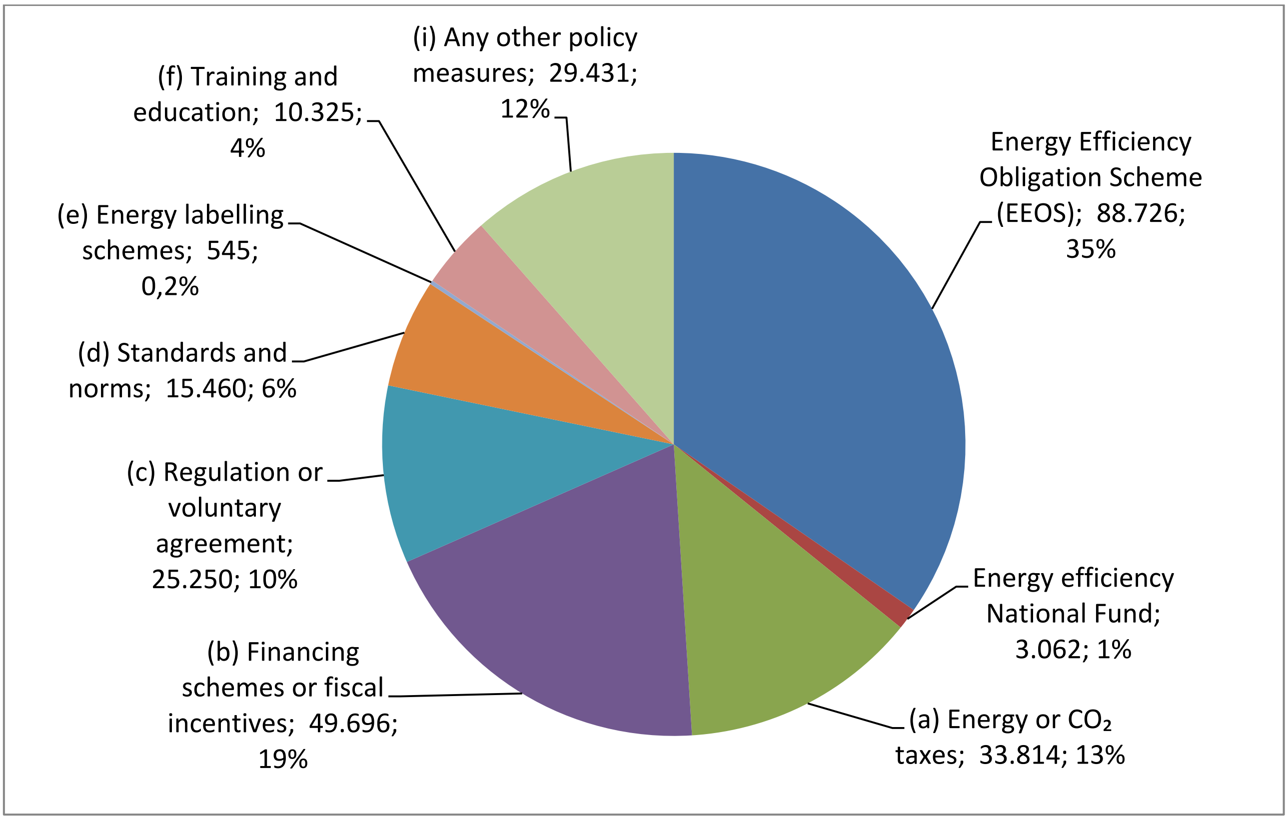
[133] Germany notified 65 policy measures that are implemented by the German States (Länder).

[134] Slovakia provided savings per group of policy measures, targeted to a specific sector; not savings per individual policy measure.

Source: Ricardo AEA/ CE Delft

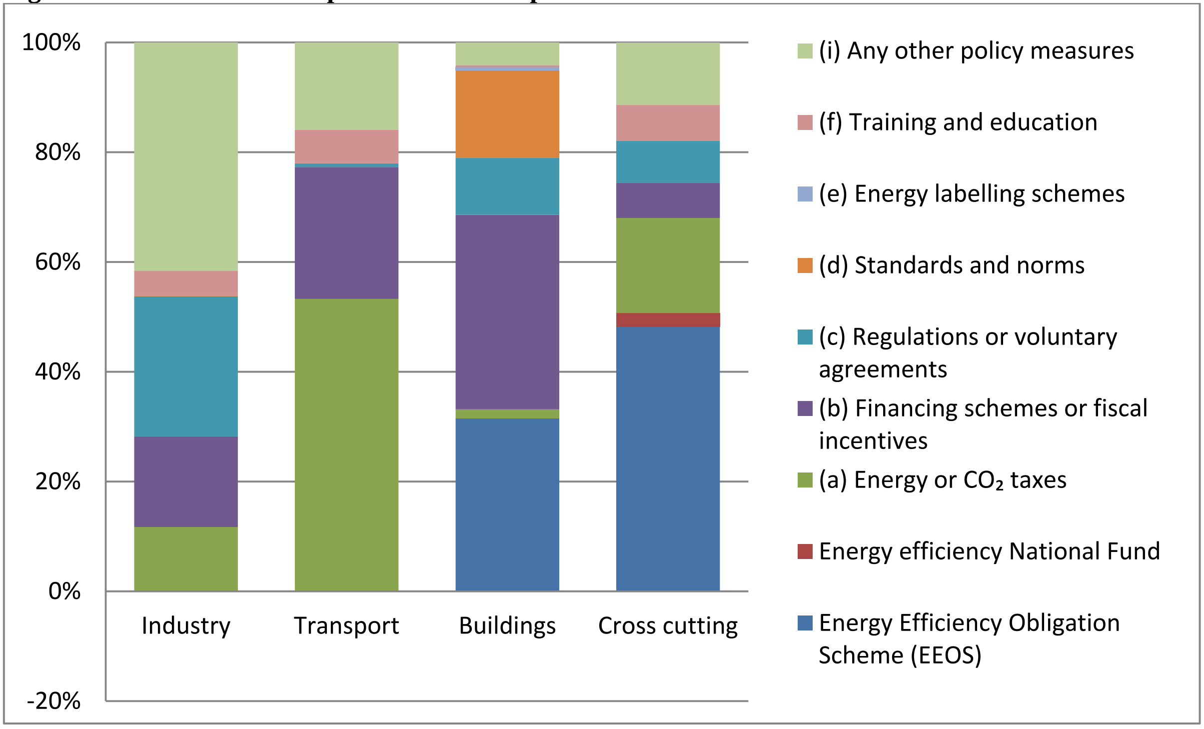
** Malta notified 4 measures labelled as EEOS (which are individually included in the total of 35 measures for Malta). In practice these are four separate measures that form part of a single EEO scheme, and thus represents just one policy measure. This is recorded as a single EEOS, but as 4 measures in the total column.*
*** The UK notified three EEOS. Two of the schemes ran from 2010-2012 and are now expired, so only one scheme is planned to be operational for the 2014 to 2020 commitment period.*

Figure 7: Breakdown of expected energy savings by type of policy measure (ktoe)



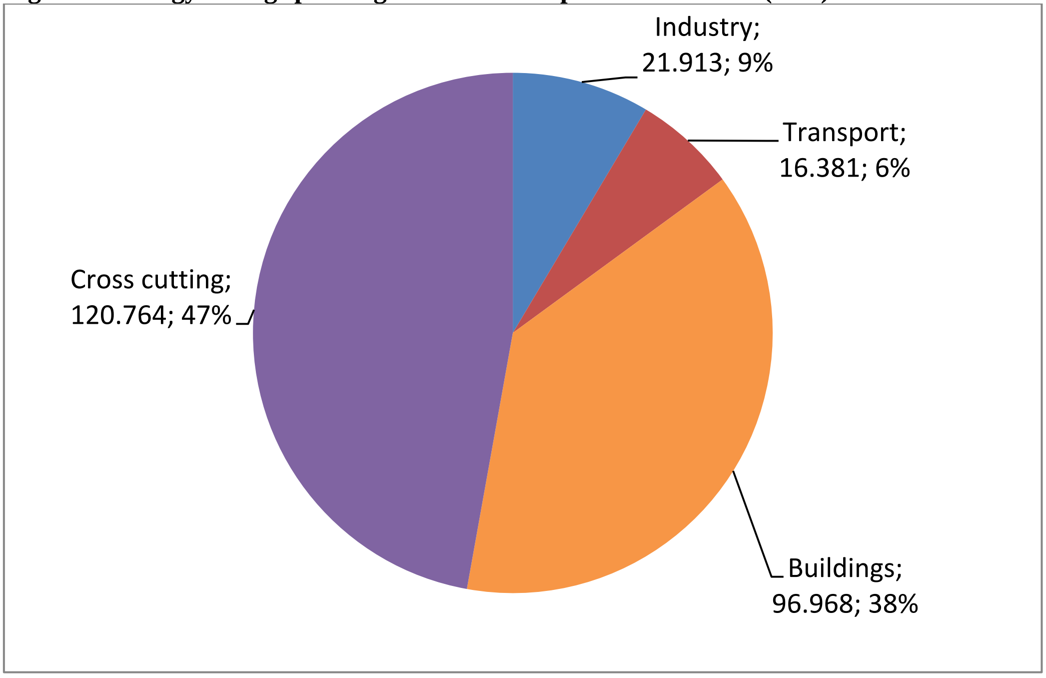
Source: Ricardo AEA/ CE Delft

Figure 8: Notified measures per sector for the period 2014-2020



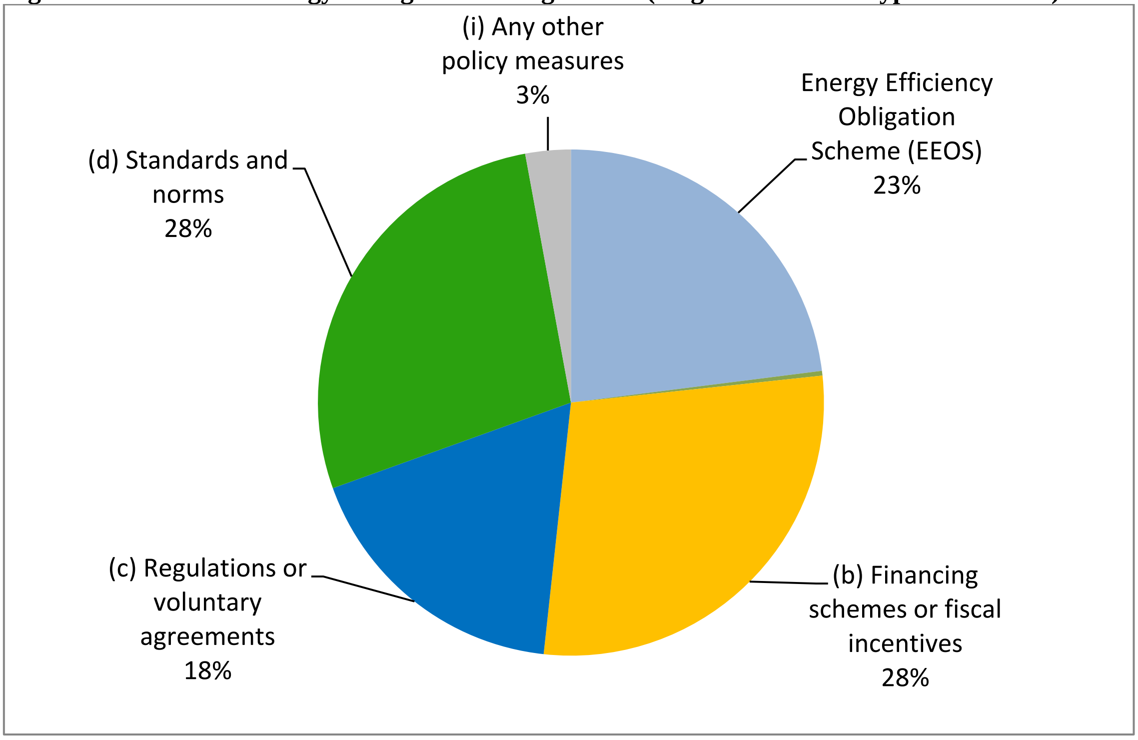
Source: Ricardo AEA/ CE Delft

Figure 9: Energy savings per target sector in the period 2014-2020 (ktoe)



Source: Ricardo AEA/ CE Delft

Figure 10: Division of energy savings in buildings sector (long lifetimes over type of measure)



Source: Ricardo AEA/ CE Delft

Table 6: Application of exemptions under paragraph, per Member State for period 2014-2020

Member State	% exemptions used	Sum of exemptions used (ktoe)	Calculated effect per exemption (ktoe)			
			slow start 7(2)(a)	**ETS Industry** 7(2)(b)	**supply side** 7(2)(c)	**early actions** 7(2)(d)
Austria	25%	1,733	-	-	-	1,733
Belgium	25%	Yes (not specified)	Yes (not specified)	Yes (not specified)	-	Yes (not specified)
Bulgaria	25%	648	540	-	-	108
Croatia	25%	431	359	72	-	-
Cyprus	25%	81	41	40	-	-
Czech Republic	25%	1,604	1,268	-	-	336
Denmark	7%*	289	-	-	289	-
Estonia	25%	204	170	25	-	9
Finland	25%	1,404	-	-	-	1,404
France	25%	27,750	-	14,500	-	13,250
Germany	25%	13,996	-	-	-	13,996
Greece	25%	1,111	554	557	-	-
Hungary	25%	1,226	1,022	204	-	-
Ireland	25%	721	601	120	-	-
Italy	25%	8,501	7,083	-	-	1,418
Latvia	25%	283	236	47	-	-
Lithuania	25%	335	279	-	28	28
Luxembourg	25%	172	143	29	-	-
Malta	25%	19	16	-	-	3
Netherlands	25%	3,794	3,187	607	-	-
Poland	25%	4,939	-	3,439	-	1,500
Portugal	25%	844	703	141	-	-
Romania	21%	1,531	1,531	-	-	-
Slovakia	25%	761	635	-	-	126
Slovenia	25%	314	262	-	52	-
Spain	25%	5,326	4,438	888	-	-
Sweden	21%	2,408	2,408	-	-	-
UK	25%	9,286	7,739	1,548	-	-
Total		**89,711**	**33,215**	**22,217**	**369**	**33,911**

Source: Ricardo AEA/ CE Delft

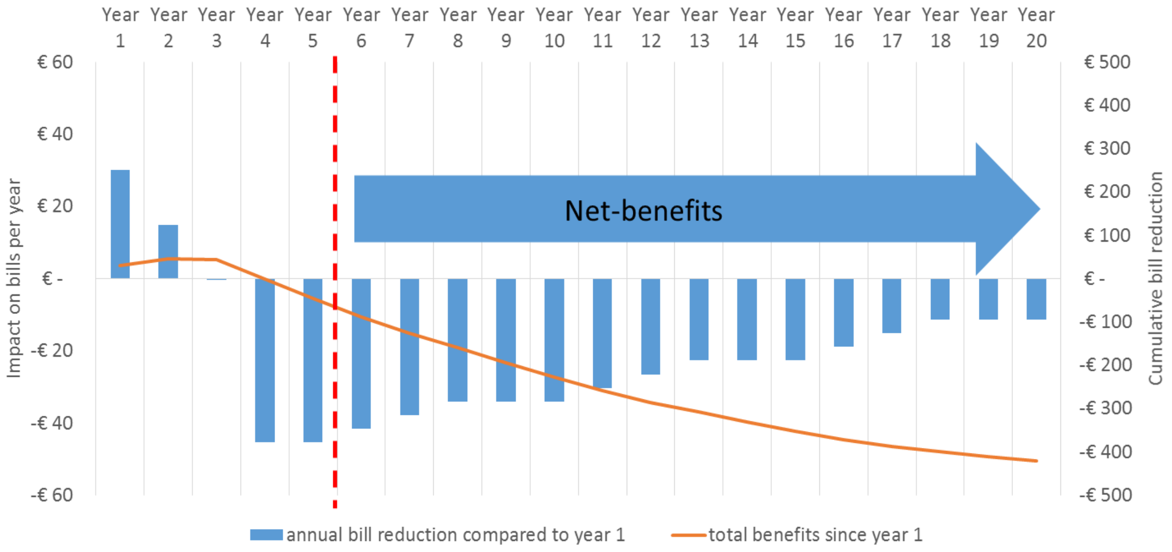
* *The energy savings under exemption paragraph 2(c) are calculated in Denmark on the basis of the achieved savings. Savings in these sectors accounted for 6% of the total reported savings in 2012, in 2013 for 5% and in 2014 for 7%. A 7% reduction has been assumed for purposes of this report.*

Table 7: Impact on energy consumption due to the measures implemented under the EEOS[135]

	Time period	Final energy savings per year (ktoe)	Reduction of final energy consumption per year	Sector
UK	2008-2012	237	0.5%	household sector
Denmark	2015	291	4.2%	all sectors
France	2011-2013	377	0.4%	all sectors
Italy	2015	500	0.4%	all sectors
Austria	2015	136	0.9%	household and industry sectors
Vermont, U.S.	2012-2014	10	1.7%	all sectors except transport
California, U.S.	2010-2012	384	1%	all sectors except transport

Source: Regulatory Assistance Project

Figure 11: Illustrative long-term impact of EEOSs on energy bills[136]



Source: Regulatory Assistance Project

Figure 12: Breakdown of the average household energy bill in the UK (2014)

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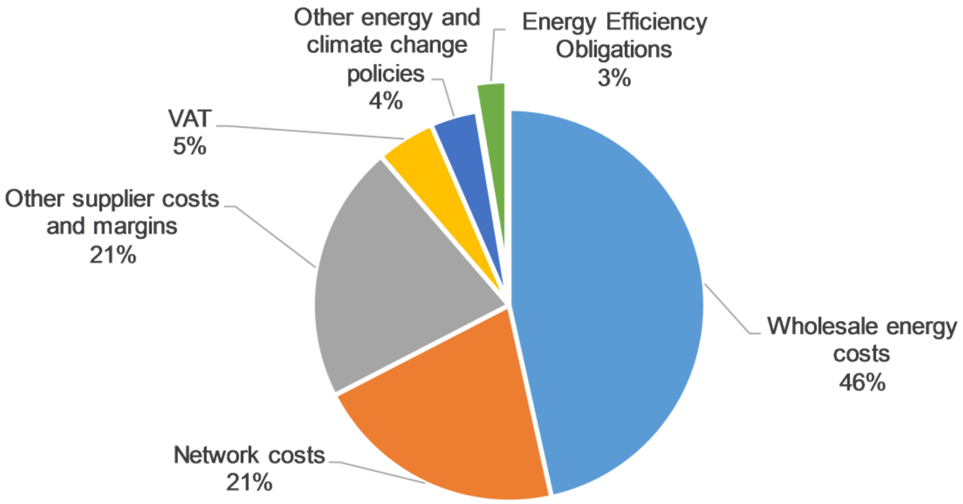
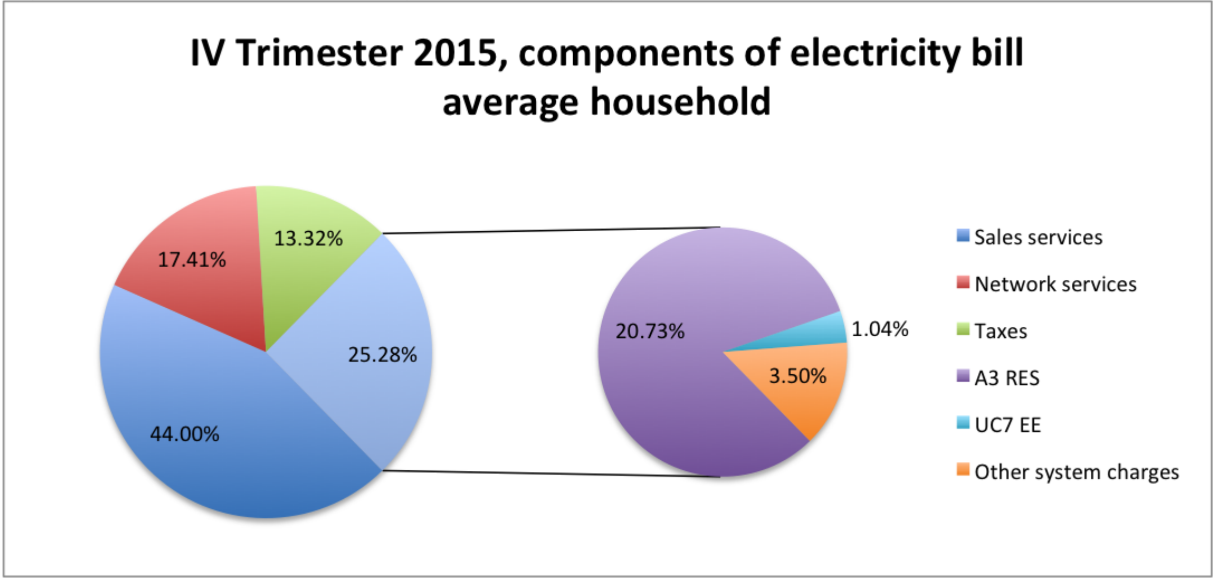
[135] The reduction of final energy consumption per year is expressed in both absolute values and as a percentage of anticipated consumption under a BAU scenario).

[136] The data presented are based on: 3 year operational period and termination thereafter; assuming no EEOS in place before; only applies to household sector; average yearly savings of 1%; average cost as share of total energy bill of 3%; split of lifetimes of measures: 25% 5 years, 25% 10 years, 25% 15 years and 25% 20 years; and average annual household energy bill of 1,500 Euro.



Source: DECC (2014a)

Figure 13: Breakdown of the average household energy bill in Italy (2014)



Source: Regulatory Assistance Project

Table 8: Reported energy savings achieved in 2014 under Article 7, ktoe[137]

Member State	Savings achieved in 2014	Expected savings in 2014 (if notified[138])	Cumulative savings requirement by 2020	Compared to expected savings in 2014 (if notitified)	Estimated savings on the basis of annual rate 2014[139]	Compared to estimated savings on the basis of annual rate[140]	Compared to total cumulative savings requirement by 2020
Austria	714	400	5,200		186	384%	14%
Belgium	180[141]	247	6,911		247	73%	4%
Bulgaria	15	69	1,942	22%	69	22%	0%
Croatia	2.5	29	1,296	9%	46	7%	0%
Cyprus	2.2	7	242	34%	9	22%	1%
Czech Republic	65	173	4,841		173	38%	1%
Denmark	204	238[142]	3,841	86%	137	149%	5%
Estonia	41	48	610	87%	22	186%	7%
Finland	561		4,213		150	374%	13%
France	1,585	738	31,384	215%	1121	141%	5%
Germany	2,548	2,844	41,989	90%	1500	170%	6%
Greece	74	100	3,333	74%	119	62%	2%
Hungary	75	75	3,680	100%	131	57%	2%
Ireland	71	73	2,164	97%	77	92%	3%
Italy	1,232	850	25,502	145%	911	135%	5%
Latvia	5	6	851	78%	30	17%	1%
Lithuania	38		1,004		36	106%	4%
Luxembourg	8.6	25	515	35%	18	50%	2%
Malta	1.5	1	56	238%	2	50%	3%
Netherlands	666	373	11,512	179%	411	162%	6%
Poland	403		14,818		529	76%	3%

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[137] All savings reported by Member States have been converted into ktoe to ensure consistency of data presented.

[138] Expected savings in 2014 were not notified for all policy measures therefore is it not reflected in column 4.

[139] This column provides an indication of savings estimated for 2014 on the basis of the annual rate of the notified total cumulative savings requirement (target) by 2020 per each Member State on the assumption that Member States would achieve new savings each year (in reality Member States have freedom how they phase the achievement of their savings over the whole obligation period, which most of the Member States have notified to the Commission). It serves purely as a theoretical reference to allow monitoring progress of the savings per country and across EU-28.

[140] This column provides an indication of savings estimated for 2014 on the basis of the annual rate of the notified total cumulative savings requirement (target) by 2020 per each Member State on the assumption that Member States would achieve new savings each year (in reality Member States have freedom how they phase the achievement of their savings over the whole obligation period, which most of the Member States have notified to the Commission). It serves purely as a theoretical reference to allow monitoring progress of the savings per country and across EU-28.

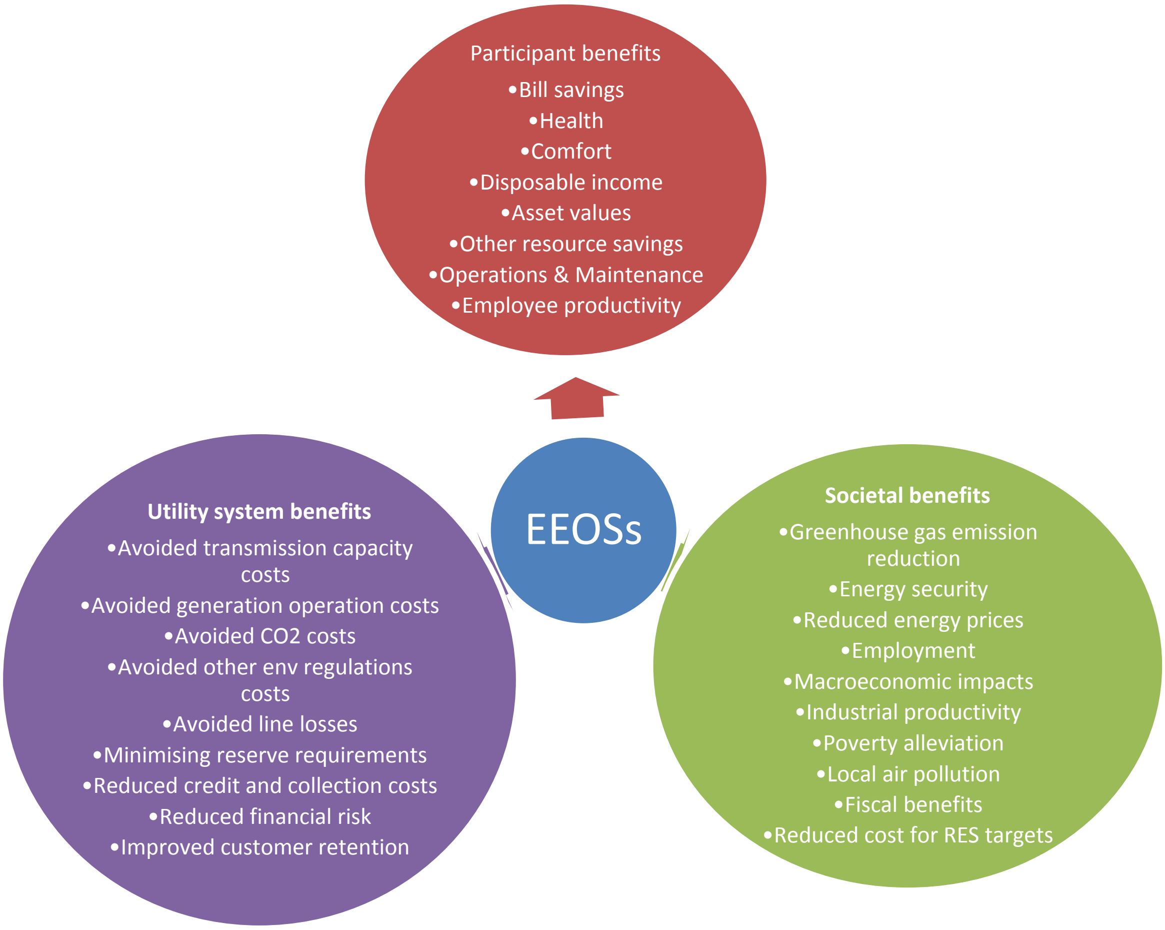
[141] Belgium has notified 301.85 ktoe in energy savings in total (summed up for each region). Since these savings contain also 122.03 ktoe stemming from early actions, this of have been deducted.

[142] Denmark has notified the energy savings target and expected savings inclusive of savings in energy transformation, distribution and transmission sectors (exemption (c) under paragraph 2). Savings in these sectors accounted for 6% of the total reported savings in 2012, in 2013 for 5% and in 2014 for 7%. The expected savings have therefore been reduced by 7%.

Portugal	46	53	2,532	88%	90	51%	2%
Romania	364	346	5,817	105%	208	175%	6%
Slovakia	72	71	2,284	101%	82	88%	3%
Slovenia	18	23	945	76%	34	53%	2%
Spain	565	493	15,979		571	99%	4%
Sweden	252	997	9,114	25%	326	77%	3%
UK	2,382[143]	2,347	27,859	101%	995	239%	9%
Total	**12,191**	**10,626**	**230,434**	**95%**	**8,230**	**113%**	**4%**

Source: Ricardo AEA/ CE Delft

Figure 14: Multiple benefits of Energy Efficiency Obligation Schemes[144]



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[143] UK notified total for all policy measures 27.7 TWh (28 TWh as rounded).

[144] Rosenow and Bayer (2016) based on IEA (2014) report on multiple benefits of energy efficiency

8 Annex – Energy efficiency investments

The exact size of the energy efficiency market is difficult to estimate. Investments in energy efficiency are challenging to track because they are carried out by a multitude of agents, private households and companies, often without external financing. They also frequently constitute only a portion of broader investments and are not accounted for separately. There are broadly two possible methodologies to estimate energy efficiency investment flows[145]:

- *Bottom-up* approaches involve counting the individual exchanges of goods and services that increase energy efficiency. This method can provide a robust estimate of the size of the market, as long as the appropriate data are available and aggregation systems are in place. A bottom-up approach tracks the many individual activities that take place within homes and businesses. Bottom-up calculation requires relatively detailed data over time to compute stock adoption, the energy performance of each different stock type and behaviour changes down to the individual or business level. Typically, these data are not currently available, at least at an economy-wide or other broad level.

- In the absence of available granular data, a *top-down* method can evaluate trends in energy consumption and economic growth to estimate the scale of investment required to improve efficiency. In light of data challenges, this can be a more practical approach. Top-down methods sacrifice accuracy but still provide insight on the size of the market and changes over time.

The market size also varies significantly depending on the definition of energy efficiency investment. For example, it is possible to make the distinction between autonomous investments and motivated investments. Autonomous investments happen by themselves (e.g. replacement of equipment, normal refurbishment of buildings, etc.). In that case, energy efficiency is not the primary motivation for investing, and market actors might undertake such investment without knowing that it will deliver energy savings. On the contrary, motivated investments are typically induced by policies, where investments are explicitly designed to achieve energy efficiency objectives.

Most of the studies presented below have tried to estimate the additional investment costs for improving energy efficiency. This means the capital expenditure necessary to go beyond business-as-usual investment for autonomous investments, and the whole up-front costs for the motivated investments. For instance, in the case of energy efficient equipment, the additional investment cost represents the difference of purchasing costs between an energy efficient appliance and a "regular" one. The main challenge is therefore to define what is meant by "regular" (i.e. to define a baseline), which is by definition moving over time because of continued technological improvements[146].

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[145] https://www.iea.org/publications/freepublications/publication/EEMR2014.pdf.

[146] A caveat of this methodology is that it does not show larger market dynamics that also contribute to energy efficiency improvements. For instance, for some appliances, one can buy a more energy efficient equipment without any additional costs. In that case, no monetary contribution is taking into account in the estimated energy efficiency investment flows.

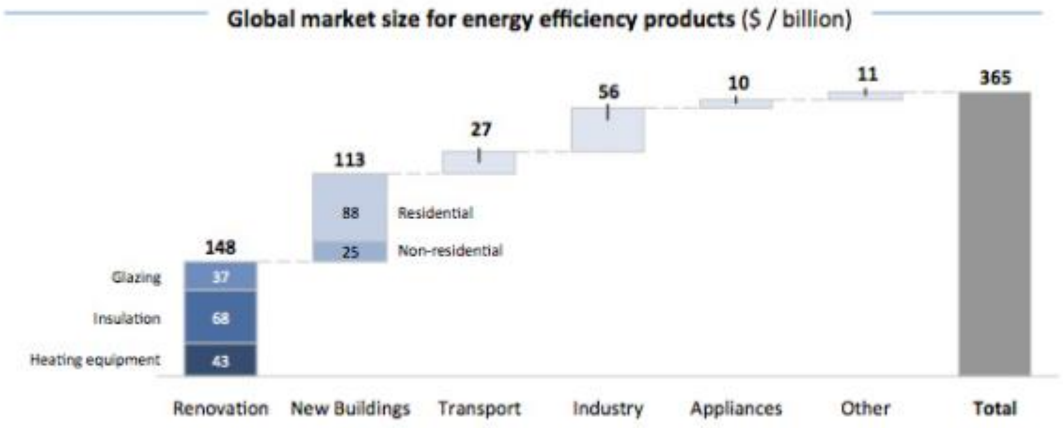
At the global level, several top-down and bottom-up studies estimate energy efficiency investments in the range of EUR 100 – 300 billion per annum[147]. This is summarised in the table below.

Table 9: Studies estimate energy efficiency investments

Source	Estimate	Comments
World Energy Investment Outlook (IEA, 2014)[148]	$130 billion per year	The estimate refers to energy efficiency investments by end-users in 2013 to increase the efficiency of devices above the 2012 stock efficiency level (**bottom-up** estimate).
Energy Efficiency Market Report (IEA, 2014)[149]	$310 – 360 billion per year	In their 2014 Energy Efficiency Market Report, IEA presents six different **top-down** methods to estimate the size of the energy efficiency market.
Sizing energy efficiency investment (HSBC, 2014)[150]	$365 billion per year	The estimate refers to 2012 and includes investment in the purchase of energy efficient equipment in the transport, buildings and industry sectors.

The HSBC study (referred above) also provides a detailed break-down by sector. The following graph illustrates the segments leading to their estimated total market size of $365 billion.

Figure 15: Global market size for energy efficiency products (HSBC study)



Source: HSBC

At the EU level, a number of bottom-up and top-down studies broadly outline current or expected energy efficiency investments in different market sectors, as shown in the table below.

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[147] The average EUR/USD exchange rate in 2000-2015 (1.21) is used to convert the estimates provided in USD to EUR

[148] https://www.iea.org/publications/freepublications/publication/WEIO2014.pdf

[149] https://www.iea.org/publications/freepublications/publication/EEMR2014.pdf

[150] https://www.research.hsbc.com/R/20/K2kb6gL5ynU7

Table 10: Sectorial bottom-up and top-down studies estimating energy efficiency investments

Source	Sector	Estimate	Comments
BEAM² model	All buildings (new and refurbished)	€120 billion per year (in 2016)	This figure refers to the estimated current costs of building envelope related measures (such as insulation and windows) and the costs of energy efficient technical building systems. It includes both new and refurbished buildings. This capital expenditure should be compared with the overall EU market for building renovation which represents annually around EUR 500 billion and the market for new construction of around EUR 400 billion.
Supporting study for the fitness check on the construction industry[151]	Residential buildings (new and refurbished)	€80 billion per year (in 2010-2014)	In this study, the EE-related market for buildings renovations is defined as the value of the works and related goods and services utilized to upgrade the energy efficiency of dwellings. Around €73 billion is for renovations, and €7 billion would be the additional energy efficiency cost for new buildings.
Ecodesign Impact Accounting report[152]	Ecodesign Products	€62 billion per year (in 2020)	This is an estimate of the extra acquisition costs for more energy efficient products in 2020. These acquisition costs represent around 12% of the yearly capital expenditures and they are expected to trigger €173 billion of gross savings on running costs (91% energy).

These studies show that the European market for energy efficiency is already sizeable and that it represents investments well above €100 billion per year.

One important question related to investment is to identify, for different policy scenarios, the sectors where additional energy efficiency investments will be the most needed in the future. One way to answer that question is to use the PRIMES model by looking at the investment gap between the EUCO27 policy scenario and the more ambitious ones for the period 2021-2030. By taking this approach, it is possible to disregard the investment related to the 2030 GHG and RES targets that are included in PRIMES investment figures, and solely focus on energy efficiency investments. The table below shows the results of this approach.

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[151] Supporting Study for the Fitness Check on the Construction Industry – Draft Final Report.

[152] https://ec.europa.eu/energy/sites/ener/files/documents/Ecodesign%20Impacts%20Accounting%20%20-%20final%2020151217.pdf.

Table 11: Energy efficiency investment gap

Investment Expenditures	EUCO27 Average annual values 2021-2030 (billion €'13)	EUCO30	EUCO+33	EUCO+35	EUCO+40
Total energy related investment Expenditures	1,036	8%	19%	28%	51%
Industry	17	6%	36%	69%	192%
Residential	168	28%	71%	101%	171%
Tertiary	40	72%	200%	295%	547%
Transport [153]	731	1%	0%	0%	1%
Grid	39	-8%	-12%	-21%	-33%
Generation and boilers	42	0%	-4%	-11%	-14%

Source: PRIMES

According to the PRIMES projections, the energy efficiency investment expenditure increases in all scenarios compared to EUCO27 - more significantly in more ambitious scenarios and mostly in the residential and tertiary sectors. For instance, in the EUCO30 scenario, the model estimates the need to increase by 28% the energy related investment expenditures in the residential sector, and by 72% in the tertiary sector, compared to the investments foreseen in the EUCO27 scenario.

When estimating future energy efficiency investments, the level of cost intensity[154] of future energy efficiency measures is as important as the level of achievable energy savings. However, predicting the cost intensity of future energy saving measures is difficult as it depends on many factors. For instance, it depends on the nature of the remaining energy saving potential, on future technological progress or on future price reductions of energy efficiency solutions due to e.g. increased sales volumes, more efficient installation procedures, or improved productivity. The table below illustrates the disparity in cost intensity factor based on past experiences and modelling assumptions.

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[153] Investment in transport equipment for mobility purposes (e.g. rolling stock but not infrastructure) and energy efficiency; excluding investments in recharging infrastructure.

[154] The capital expenditure required to achieve 1 Mtoe of energy saving per year (e.g. billion EUR/Mtoe).

Table 12: Cost for energy efficiency improvement measures[155]

Source	**Methodology**	**Sector**	**Energy efficiency cost intensity [bn EUR/Mtoe]**
CONCERTO database	Cost intensity based on the monitoring of 58 pilot cities in 23 Member States	Buildings: energy renovation	11,6
Projects supported under ELENA	Cost intensity based on the monitoring of 21 energy efficiency projects	Buildings: energy renovation and street lighting	15,7
Study Fraunhofer-ECOFYS ISI 2011	bottom- up and top down approach estimating the required upfront-investments for the period 2011-2020	Buildings: additional upfront investments	5,3
BEAM²	building cost modelling	Buildings: renovation and new buildings (2016-2030)	20,1
Study on renovating Germany's building stock - BPIE	This report investigates a number of scenarios for improving the energy performance of Germany's building stock. The focus is on the economic viability of different levels of renovation from the perspective of the investor or building owner. The reported figure is the one from the Business as usual scenario.	Buildings: renovation (2015-2030)	23,6

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[155] Sources: Concerto (http://smartcities-infosystem.eu/concerto/concerto-archive); Study on renovating Germany's building stock, BPIE (http://bpie.eu/wp-content/uploads/2016/02/BPIE_Renovating-Germany-s-Building-Stock-_EN_09.pdf), Study Fraunhofer-ECOFYS (http://www.isi.fraunhofer.de/isi-wAssets/docs/x/de/publikationen/Building-policies_Brochure_Final_November-2012.pdf); BEAM² (EPBD Impact Assessment SWD).

9 Annex – Review of the default coefficient – Primary Energy Factor for electricity generation referred to in Annex IV of Directive 2012/27/EU

CONTEXT

In the context of energy efficiency implementation, a so-called Primary Energy Factor (PEF) has been used to determine the primary energy consumption to generate one kWh of electricity. Directive 2012/27/EU on energy efficiency (EED) establishes in Annex IV a default coefficient of 2.5 for savings in kWh electricity[156], to transform electricity savings into primary energy savings. This coefficient is a single value for the EU. Member States may apply a different coefficient provided they can justify it.

Article 22 of the EED empowers the European Commission to review the default coefficient.

For the PEF review a study was tendered from August 2015 to April 2016[157] and three meetings[158] took place at the European Commission premises:

1. On 11 December 2014 and on 17 June 2016, two consultative joint meetings of Member States' representatives for the EED with the consultation forum under art. 18 of the Ecodesign of energy-related products Directive 2009/125/EC, including stakeholders (minutes are available online[159]). The reason for the joint meetings is that the PEF value from the EED is used by several implementing regulations under the Ecodesign and Energy Labelling Directives, for comparing the efficiency of products using electricity and products using other fuels such as gas or liquid fuels. The PEF review in the EED would have implications in existing or forthcoming Ecodesign and Energy Labelling Regulations[160, 161].
2. On 21 January 2016, a technical meeting with Member States' representatives for the EED and stakeholders: this meeting was a relevant input to the tendered study[162].

Most Member States and stakeholders argued that the current 2.5 value is outdated and should be revised.

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[156] Which means an average, European-wide conversion efficiency of 40% (excluding grid losses).

[157] Contract No. Reference: ENER/C3/2013-484/02/FV2014-558/SI2.710133 "Review of the default primary energy factor (PEF) reflecting the estimated average EU generation efficiency referred to in Annex IV of Directive 2012/27/EU and possible extension of the approach to other energy carrier" – Contractor: Trinomics. Technical leadership: Fraunhofer ISI.

[158] Together with EU Member States, EEA countries and over 50 European associations were involved.

[159] 11 December 2014 meeting minutes: http://ec.europa.eu/transparency/regexpert/index.cfm?do=groupDetail.groupDetailDoc&id=18412&no=2 17 June 2016 meeting minutes: http://ec.europa.eu/transparency/regexpert/index.cfm?do=groupDetail.groupDetailDoc&id=24733&no=2

[160] However, even if the value is revised in the EED, no instantaneous change of its value within the Ecodesign or the Energy Labelling Regulations should take place. Any review would take place in the context of the relevant regulation.

[161] The discussion about the PEF value is also relevant in the context of the establishment of a common EU voluntary certification scheme for non-residential building under the Directive 2010/31/EU on the energy performance of buildings where a PEF for electricity has to be determined to calculate, in a default setting, the energy performance of buildings.

[162] The scope of this meeting was to provide an analysis of the whole range of calculation options from a scientific perspective. Main points of discussion were on marginal or average approach, which method to adopt for renewables – and non-combustible renewables – and the weighting of the options.

The tendered study was requested to look in particular at how to measure the efficiency of electricity generation, including the following aspects: average vs. marginal electricity generation; current, future or desired efficiency of the electricity generation; time of use of energy. The study also looked at if the use of PEF should be extended to other energy carriers.

APPROACH

The basic concept to calculate the PEF for electricity is to relate the raw primary energy demand of electricity generation with the electricity produced.

The calculation process of the PEF for electricity is made of two consequential steps that can be structured according to the following formula:

$$PEF\ Electricity = \frac{PEF\ of\ Fuel}{Conversion\ efficiency}$$

The first step is to determine the "PEF of Fuel", i.e. how much energy was needed to get one unit of *ready-to-use* fuel (before being converted into electricity). This is done for each fuel. In this document, all energy sources are named as “fuel”[163]. In this step, issues like system boundaries counts, e.g. transmission and distribution losses or the energy used to extract, clean and transport coal.

The second step is to determine the conversion efficiency of the electricity generation process, for each *ready-to-use* fuel.[164] Hence, a PEF for electricity for each fuel is calculated (e.g. a PEF for electricity from coal; a PEF for electricity from wind; etc). The total PEF for electricity is the weighted sum of the single PEFs according to the relative amount of every fuel in the total primary energy.

The tendered study selected four calculation methods for examination that looked into different options for the two steps:

- Calculation method 1 is designed to be in line with the Eurostat calculation for primary energy and electricity production.
- Calculation method 2 is designed to reflect the total consumption of non-renewable sources only.
- Calculation method 3 is a variation of method 1 in order to analyse the impact of changing the allocation method for CHP from the “IEA method” to the “Finish method”[165].
- Calculation method 4 modifies calculation method 3 by adding the life cycle perspective to the conventional fuels.

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[163] This also includes wind, solar or hydro which are normally not called “fuel” in the classical sense E.g. Eurostat refers to them as energy products. Elsewhere (e.g. some UN standards) they are also called energy sources or carriers.

[164] Regarding non-conventional fuels, such as wind, solar PV, hydro, geothermal or nuclear, there is a range of methodological choices to be made to define the primary energy content.

[165] The IEA method attributes the primary energy to the outputs power and heat in relation to their relative output shares. The Finish method takes into account the average efficiency in single heat and power plants as a reference. The Finish method attributes a higher share of primary energy consumption to electricity. The Finish method is the method in Annex II of the EED for determining the efficiency of the cogeneration process..

All calculated PEF values after the year 2015 are below 2.5.

Calculations are based on the PRIMES 2016 Reference Scenario – the most recent available version. PRIMES contains projections of the development of the European electricity mix by taking into account the impact that will generate from current policies (e.g. from EU energy policies to 2030 a higher share of renewable sources of energy). The historical years in PRIMES are calibrated based on official statistics from Eurostat, i.e. reaching consistency with real data as for the previous years. The focus is on the time framework 2005-2020.

The analysis looked into 51 options in total (Table 1) and the results were weighted according to policy objectives (Table 2). Each calculation method was the result of a decision tree (Table 3).

Table 13: Options for PEF calculation

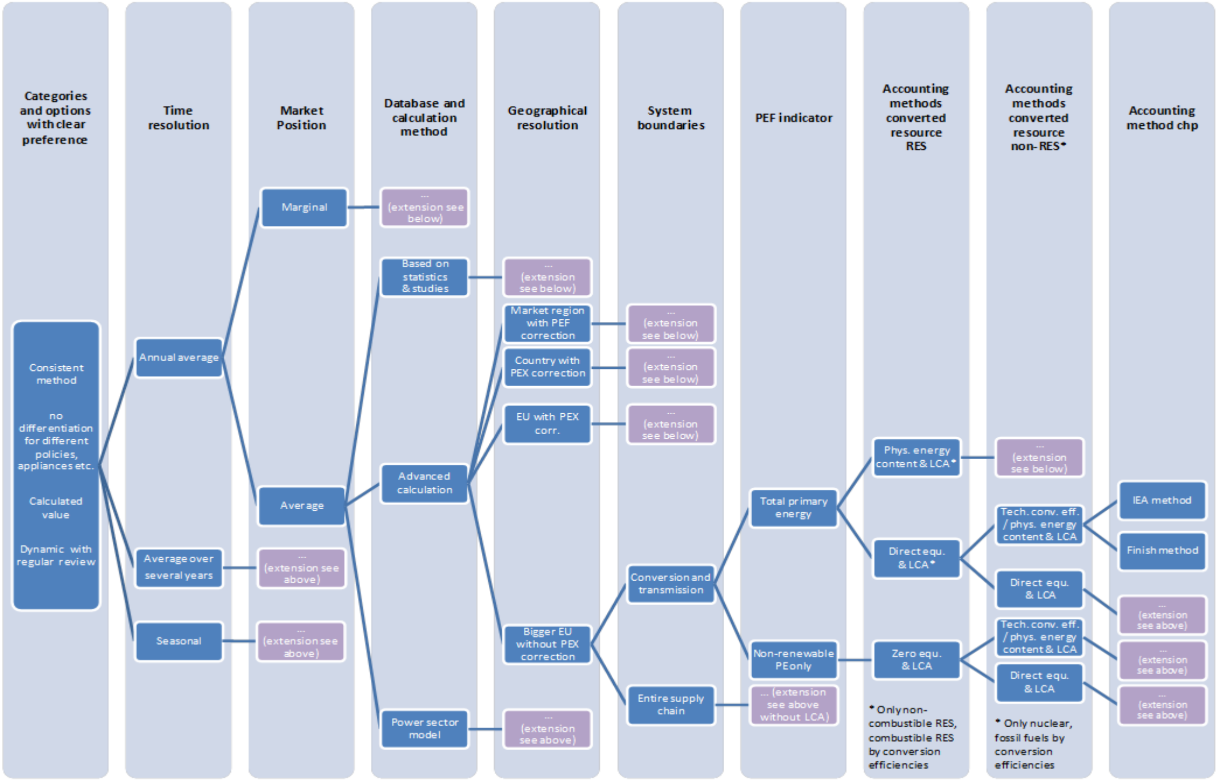
Category	Option	
Strategic and political considerations		
PEF purpose	Desired	
	Calculated	
Applicability	Abolish the use of a PEF	
	No differentiation	
	Different for different policies	
	Different for different electric appliances	
	Different for different policies <u>and</u> electric appliances	
	Different for delivered and produced electricity	
Adjustment and review process	Constant over time	
	Regular review/adjustment	
Database and calculation method	Based on statistics and studies	
	Advanced calculations based on statistics and studies	
	Power sector model calculations	
Representation of the electricity sector		
Geographical resolution	Bigger EU (EU+Norway)	With Power Exchange (PEX) correction
		No PEX Correction
	EU	With PEX correction
		No PEX Correction
	Member States	With PEX correction
		No PEX Correction
	Market regions	With PEX correction
		No PEX Correction
	Subnational regions	With PEX correction
		No PEX Correction
Development over time	Constant	
	Dynamic	
Time resolution	Average over several years	
	Annual average	
	Seasonal	
	Hourly time of use	
Market position	Average electricity production	
	Marginal electricity production	
General PEF methodology		
PEF indicator	Total primary energy	
	Non-renewable energy only	

System boundaries	Entire supply chain
	Energy conversion and transmission/distribution
Accounting method for nuclear electricity (and heat) generation	Technical conversion efficiencies
	Direct equivalent method
	Physical energy content method
Accounting method for power (and heat) generation using non-combustible RES	Zero equivalent method
	Substitution method
	Direct equivalent method
	Physical energy content method
	Technical conversion efficiencies
Accounting method electricity (and heat) generation using biomass	Zero equivalent method
	Technical conversion efficiencies
Accounting method for cogeneration (CHP)	IEA method
	Efficiency method
	Finish method
Methodological consistency	Same method in all Member States
	Different methods in different Member States
	Different methods in different Member States with correction mechanism

Table 14: Policy evaluation criteria with weightings

Methodological Suitability						Acceptance					
70 %						30 %					
Precision	Data Availability					Target: internal market (including Energy Union)	Target: 2020 climate	Target: 2020 security of supply	Target: Long-term decarbonisation (including Electrification)	Complexity	Transparency
	20 %										
	Effort required	Credibility	Data quality	Uncertainty	Flexibility						
50 %	2 %	4 %	6 %	6 %	2 %	8 %	4 %	4 %	6 %	4 %	4 %

Figure 69: Decision tree



RESULTS

The following conclusions apply to all the four calculation methods:

- It appears appropriate for the approach of **single PEF value for electricity in the EU to be kept** (for use in the contexts where it is currently used) and the same PEF value for electricity to be used **in all EU legislation** where it is appropriate. This is to avoid distortions, take account of the interconnected European electricity system and be consistent with the EU Internal market vision. Where the same requirements or labels are applied to products using different fuels, a PEF is needed in order to obtain comparable information. In addition, since the Regulations published under the Ecodesign and the Energy Labelling Directives are directly applicable in all EEA countries (Norway, Liechtenstein and Iceland) and the free movements of goods needs to be maintained, a single European PEF value needs to be used.
- The analysis covers **EU28 and Norway**, because of the relevance of Directive 2012/27/EU for the EEA countries, of which Norway is the most relevant trading partner. This choice is a trade-off between precision and data availability and complexity. Since the PRIMES dataset does not contain Norway, the contractor developed an extra dataset for Norway based on ENTSO-E[166] data, which the Norwegian representatives verified at the Technical meeting.

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[166] ENTSO-E is the European network of transmission system operators for electricity. It provides freely accessible data on the electricity system in Europe. https://www.entsoe.eu/disclaimer/Pages/default.aspx

- It seems appropriate for the PEF value to be a **calculated value and to be revised regularly**, in order to reflect reality (and forthcoming reality) at best. The projected development of the electricity sector changes regularly and especially technologies such as nuclear, renewables and CHP are subject to political influence, which may change their future development over time.
- The time of use of energy is based for all methods on **annual average values**. Seasonal values – the most relevant alternative option – are excluded because they would require complex calculations: most statistical and projected data exists on a yearly basis and hence seasonal values would need to be deduced from a power sector model, with detriment to transparency and impartiality of the results.
- Regarding the accounting methods for primary energy, as for **nuclear** electricity (and heat) generation, the **Physical energy content method** is used. As for electricity (and heat) generation using **biomass**, the **Technical conversion efficiency** method is used. This is in line with the Eurostat approach.
- An **average market position** is favoured for all calculation methods over a marginal position. The dimension "Market position" concerns the question, which power generator is taken as the basis for the calculation. While the average generation mix is easy to estimate, determining the marginal generation unit requires more complex assumptions. The rationale behind using the marginal generation unit is that relatively small changes in consumption lead to changes only in the generation of electricity in the last units used to cover demand. If an efficiency measure reduces power consumption in hours of high demand, renewable energies and base load power plants will continue to produce and only the peak load plants (mostly gas and oil turbines) will adjust their power generation accordingly. The primary energy consumption of the marginal generator often differs substantially from the average generation: the party in favour of a marginal position claims this would better show the primary energy consumption of new appliances. Yet, normally the effect of one single new appliance in the system is marginally low. Complex and time-consuming power system model calculations would have to be carried out to determine the marginal supplier for a specific point in time.
- For fossil fuels and directly combustible renewable fuels, the **conversion efficiency** is given by the heat value generated during combustion of the fuels (output) divided by the raw primary energy demand (input). For non-combustible renewables a conversion efficiency of 100% is assumed. For geothermal power stations a conversion efficiency of 10% is assumed, while for nuclear power stations a conversion efficiency of 33% applies. These values are commonly applied and in line with Eurostat.

The four calculation methods differ for three aspects:

1) the **system boundaries,**

2) the **treatment of renewable energy sources (RES),** and

3) the **allocation method used for CHP**.

These three aspects are represented in the last five columns of the decision tree in Table 3.

The category **"System boundaries"** defines if only the primary energy that is used within the conversion and distribution process is considered or if also additional energy consumption, related to the (entire or partial) life cycle of the conversion, transmission and distribution infrastructure. Calculation methods 2 and 4 take into account the life cycle perspective.

As for **RES**, the issue is if to consider the primary energy at the origin of RES as *total* primary energy or *non-renewable* primary energy. In the latter case, the guiding question being "How much *non-renewable* primary energy was used to get 1 unit of fuel to be converted into electricity?" and the answer being "Zero", the *Zero equivalent method* is applied. The PEF of fuel for all RES would therefore be 0. It would instead be of value 1 with the *Total primary energy method* ("How much *total* primary energy was used to get 1 unit of fuel to be converted into electricity?"). The Zero equivalent method is applied in Calculation method 2, while methods 1, 3 and 4 apply the Total primary energy method.

As regards **CHP**, there is the need to identify how much of the fuel input that goes into a CHP plant is used to produce heat and electricity, i.e. what is the quota of primary energy that is used to produce respectively heat and electricity. Various methods exist. The study shed light on two methods: the *IEA method* and the *Finish method* (also known as Alternative production method). The IEA method attributes the primary energy to the power and heat outputs in relation to their relative output shares. The Finish method takes into account the average efficiency of single heat plants and single power plants as a reference. As a result, the IEA attributes a higher share of primary energy to heat than the Finish method, i.e. the efficiency of electricity production in CHP with the IEA method results higher than with the Finish method. Thus, heat production in CHP appears less efficient with the IEA method than in reality is: the Finish method allows for results that are more realistic. The IEA method is used by Eurostat as a default method when Member States do not provide own calculations.

For the calculation in the Finish method, it is necessary to get data on average conversion efficiencies. The most recent data available from Eurostat are used: 40% for reference power plants, 90% for reference heat plants and 70% overall efficiency for CHP plants.

Calculation method 1 applies the IEA method, while methods 2, 3 and 4 apply the Finish method.

The calculations below show the difference between the IEA method and the Finish method:

STARTING DATA (FROM PRIMES 2016)	**Operator**	**Indicator**	**2015**	**Unit**
CHP OUTPUT		CHP El. Generation	397	TWh
	+	CHP Heat Generation	941	TWh
	=	Total CHP Output	1337	TWh

CHP INPUT		Primary energy	1911	TWh

RESULTS			
With IEA method		**With Finish method**	
Primary Energy share of electricity	**567 TWh**	**Primary Energy share of electricity**	**931 TWh**
PEF for electricity from CHP	**1.43**	**PEF for electricity from CHP**	**2.34**
PEF for heat from CHP	**1.43**	**PEF for heat from CHP**	**1.03**

The results show that according to the IEA method 1.43 TWh of primary energy are needed to produce 1TWh of electricity from a CHP plant (and the same amount is needed to produce 1TWh of heat), while with the Finish method the result is 2.34 TWh to get 1 TWh of electricity and 1.03 to get 1TWh of heat. The Finish method is closer to reality, because heat production is much more efficient than electricity production (in single plants, as well as in CHP), as confirmed by latest studies and documents by the European Commission[167].

CHP stakeholders and Member States investing in CHP are in favour of getting heat production valorised as much as possible: the Finish method allows for this more than the IEA method.

CONCLUSIONS AND PROPOSAL

The PEF of 2.5 is not adequate and should be revised: all calculation methods show a decrease of the PEF due to the projected growth of electricity generation from RES.

Table 15: Results PEF for electricity from the tendered study*[168]*

Calculation method	2005	2010	2015	2020
Method 1	2,35	2,25	1,98	1,88
Method 2	2,33	2,12	1,73	1,54
Method 3	2,48	2,38	2,09	1,99
Method 4	2,60	2,48	2,17	2,06

The analysis shows that no calculation method can claim absoluteness. On balance, it appears appropriate to proceed with **Calculation method n.3 and an appropriate value for the default coefficient in the EED for electricity production is 2.0.** The reasons for choosing method n.3 are the following:

- With the exception of CHP, it is in line with the primary energy calculation made by Eurostat, the official EU statistics body fed with national statistics;
- Calculation method n.3 applies the Finish method for **CHP**, which gives a more realistic result of the primary energy share used for electricity production in CHP plants than the IEA method, applied by Eurostat. This choice is also justified by the fact that Eurostat is working with DG Energy on CHP reporting forms to be integrated in the annual Eurostat questionnaire to Member States probably in the next 2-3 years, in the context of the requirements under Art. 24(6) of the EED. The new reporting forms will allow moving from aggregation on plant level to the aggregation on the unit level and will enable to make calculations in line with the Finish method[169];
- The Finish method is the methodology in the EED – Annex II to determine the efficiency of the CHP process;
- As for **RES**, calculation method n.3 applies the Total primary energy method for the primary energy at the origin of RES. The reasons to prefer this method are the following:

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[167] See Eurostat energy balances. See Review of the Reference Values for High-Efficiency Cogeneration – RICARDO-AEA. Report for EC DG Energy ENER/C3/2013-424/SI2.682977 ED59519. See Best Available Techniques (BAT) Reference Document for Large Combustion Plants Industrial Emissions Directive 2010/75/EU (Integrated Pollution Prevention and Control) JOINT RESEARCH CENTRE Institute for Prospective Technological Studies Sustainable Production and Consumption Unit European IPPC Bureau Final Draft (June 2016), http://eippcb.jrc.ec.europa.eu/reference/BREF/LCP_FinalDraft_06_2016.pdf. Other calculation methods exist, some of which aim to valorise the heat production in CHP (e.g. the 200% heat efficiency in Denmark).

[168] Compared to the tendered study, these calculations are updated with the last available PRIMES Reference Scenario from 2016.

[169] Eurostat will continue using the IEA method only in case no better data exist for the preparation of energy balance (annual questionnaires) at national level.

    - The PEF value from the EED is used by several implementing regulations under the Ecodesign and Energy Labelling Directives, to compare the performance of products such as electric heaters and gas heaters. The share of renewable energy in electricity generation is heading for 35%. By using a PEF of 0 for RES, that would mean that 35% of the electricity used would be ignored when comparing the performance of electricity and gas appliances. The choice for PEF of 0 for RES could undermine the credibility of a consumer-serving label;
    - A PEF as 1 for RES recognises that it makes sense to place value on, and save where possible, all types of energy including renewable energy;
    - The role of RES for sustainable and climate policies is already recognised by the assumption of full conversion efficiency into electricity (100%) – i.e. by the use of a factor of 1 rather than the higher values used for other technologies.
- As for **system boundaries**, calculation method n.3 applies no life cycle approach. The reasons are the following:
    - Neither the tendered study nor literature and Member States' experiences show clear and consistent data on the consumption of primary energy in the upstream chain of fuels from being raw to becoming fuels ready to be converted into electricity. There are also doubts on how far to go in the upstream chain;
    - The application of the PEF for electricity in the Ecodesign and Energy Labelling Directives to compare the performance of products leads to the question, whether or not a similar method has to be applied to other energy carriers as well, such as coal or gas. Currently, their final energy consumption is calculated to be equivalent to its primary energy consumption. By choosing method n.3 there is consistency with the approach adopted so far in the Ecodesign and Energy Labelling Directives.

The value of 2.0 is the projected result for the year 2020. The choice of the year 2020 seems reasonable to take into account the effect of on-going energy policies in the forthcoming years and at the same time to keep limited the uncertainty from modelling. This approach is in line with the intention to have a regular review of the PEF value, notably every five years.

An alternative option would be to make an extrapolation (linear or exponential) of the η factor developed by Eurostat[170]. The η factor is the efficiency of electricity generation: PEF would be = 1/ η. As of 2020, the extrapolated PEF would result in 2.1 (see Tables 5 and 6).

Before comparing the result from method n.3 and the Eurostat extrapolation, two passages are needed. First, the extrapolated value has the IEA method for CHP and it is necessary to adapt the value with the Finish method. According to calculations from the study, a factor of 0.1 needs to be added (2.1+0.1=2.2). Second, the extrapolation of historical data from Eurostat does not show the evolution of on-going energy policies (notably growing quota of RES, which mean a lower PEF) – while PRIMES do. 1/η will be higher than the result of any method from the study.

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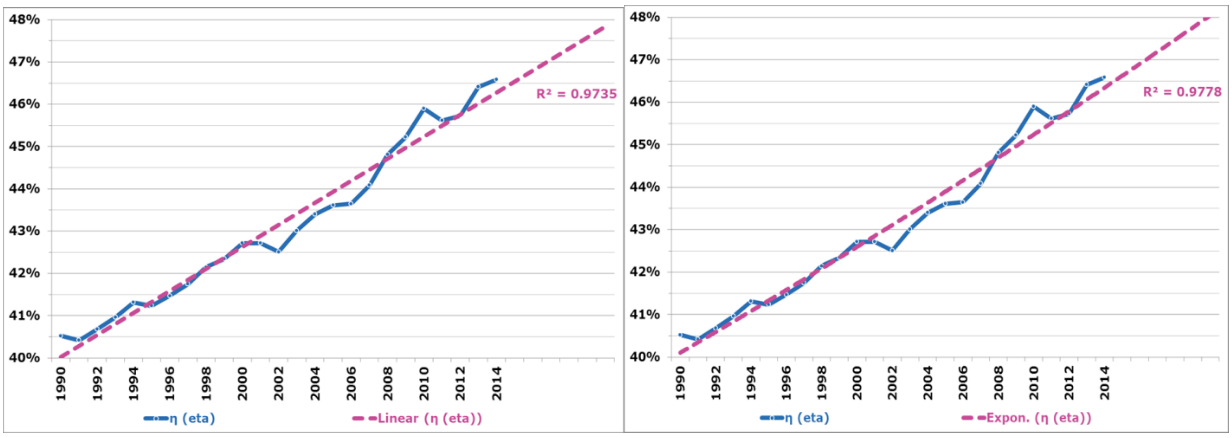
[170] http://ec.europa.eu/eurostat/documents/38154/43500/ETA_time_series.xlsx/8d4ae449-8795-44d8-b903-ddd6ff36ba42

Figure 70: Extrapolation of η factor by Eurostat (as of 2020: η =48%, PEF=2,08)



In conclusion, the result from method n.3 is counter proven and based on robust assumptions.