Energy Savings Lifetimes of Measures: Will the New European Harmonized Lifetimes Account for Less Energy Savings Compared to the Policy Induced Energy Savings Measures?

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Abstract

In early 2006, the new Directive on energy end-use efficiency and energy services (ESD) came into force for all 27 member states of the European Union. To facilitate reporting by member states, the European Commission is developing a harmonized system of bottom-up energy savings calculations. These calculations ask for, among other inputs, the lifetime of implemented measures. The European Committee for Standardization (CEN) assisted in updating the provisional list by organizing a CEN Workshop Agreement on lifetimes of energy efficiency improvement measures in bottom-up calculations.[1]

This paper deals with discussions on the definition of the lifetime. Which definition is most appropriate: the saving period: the design lifetime, the economic (pay back) lifetime or the social lifetime? And, how is this selection related to energy saving calculations? How does the market penetration of ever more efficient saving options influence actual savings and lifetime? Should yearly savings be processed into one (relative short time) simple number, or a longer one with savings that slow down over time? The paper also presents the options available to countries: an EU harmonized lifetime figure, a country-specific calculated lifetime figure or even a more sophisticated one. For several technical measures the applicable method to determine the lifetime is given as well as the differences between the harmonized lifetime and the conservative default value. The paper concludes that the savings lifetimes are in most case longer than the economic pay back period. As the default values give less credit to the accountable savings for the policy measures, this approach encourages countries to determine a country specific lifetime.

Introduction

On 17 May 2006 the European Union Directive on energy end-use efficiency and energy services (2006/32/EC; for the remainder of this paper abbreviated as the ESD) entered into force after a long debate. The first draft was discussed in December 2003. The goals of the ESD are to enhance the cost-effective improvement of energy end-use efficiency in the Member States by the promotion of energy services and other energy efficiency improvement (EEI) measures, the use of mechanisms to remove barriers and imperfections and setting an indicative target of 9% energy efficiency improvement in end use energy by 2016. The Member States have to draft Energy Efficiency Action Plans (NEEAP's) by 1. July 2007 and report progress in 2011 and 2014. An ESD committee, with the assistance of experts from the Member States, will decide on the evaluation method to be used. The actual work on the method is executed in the project "Evaluation and Monitoring for the EU Directive on Energy End-Use Efficiency and Energy Services" (EMEEES) that started by November 2006 with 21 partners. This project should provide harmonized combinations of bottom-up and top-down methods. Most of the work, however, is on the bottom-up methods (Thomas 2007, Vreuls 2007).

[1] CEN-CWA 15693 *Saving lifetimes of Energy Efficiency Improvement Measures in bottom-up calculations,* CEN, 2007, www.cen.eu

The bottom-up calculation of energy efficiency improvements for the ESD demands saving lifetimes for each type of EEI measure. The ESD holds a short preliminary list of average lifetimes of different technologies, but announced an update by the end of 2006. To ensure that all Member States apply the same lifetimes for similar measures, this list should be updated and extended with harmonized lifetimes at an European level. As there was this strong need for consensus on this issue within Europe, the European Commission asked the European Committee for Standardization (CEN) to take the lead. Due to the urgency of getting results CEN activated a procedure, called the CEN Workshop Agreement, that is very suitable for reaching cross-European consensus within a very short timescale.

This paper starts with a short explanation of the procedure of a CEN Workshop Agreement (CWA), the process of formulating harmonized lifetimes and the main actors involved during the period August 2006 – March 2007. Then we present the main factors in calculating energy savings: initial savings, saving period and changes in savings over time. The factors that define the saving period (the design lifetime, the economic (pay-back) lifetime and the social lifetime) are described. Also the factors that define the changes in yearly during the saving period are highlighted. Agreement on the factors to be used resulted in defining the energy savings lifetime. For this lifetime the Workshop Agreement also holds three options: an EU harmonized lifetime figure, a country specific calculated lifetime figure or an estimated conservative default lifetime. For a selection of technical measures we present in more detail the applicable method to determine the calculated lifetime, the harmonized lifetime and the conservative default value. We conclude that the energy savings lifetimes - as it is now introduced – holds in most case a longer period than the economic pay back period.

CEN Workshop Agreement on saving lifetimes of EEI measures in bottom-up calculations

The European Commission contacted late 2005 the European Committee for Standardization (CEN) to give attention to harmonize energy savings. The CEN Technical Board decided early 2006 that work for energy efficiency and savings calculations (CEN resolution BT C018/2006). Early 2006 the Dutch standardization body (NEN), as one of the Members of CEN, started the standardization process to update the provisional list with lifetimes in the ESD. At that moment there was not enough agreement by experts in the European Union to start a classical standardization process (leading to an EN standard). Also there was only a short time period (less than one year) to update the list. So the CEN decided to use a procedure called the CEN Workshop Agreement (CWA).

Figure 1 outlines the main phases of this process. In the summer of 2006 Mr. Boonekamp (chair) and Mr. Pauwels (secretariat) drafted a first business plan for the CWA that was discussed with the participants at the kick-off meeting on the 30th of August and finalized during the second meeting. During the second half of 2006 participants from over 15 EU Member States discussed the drafts of the CWA, resulting in a final draft by March 2007. The official publication of this CWA 15693 was in April 2007. This paper holds the main elements from this CWA that deals with lifetime of energy efficiency improvement (EEI) measures and concepts on savings and related periods, but not with the resulting savings.

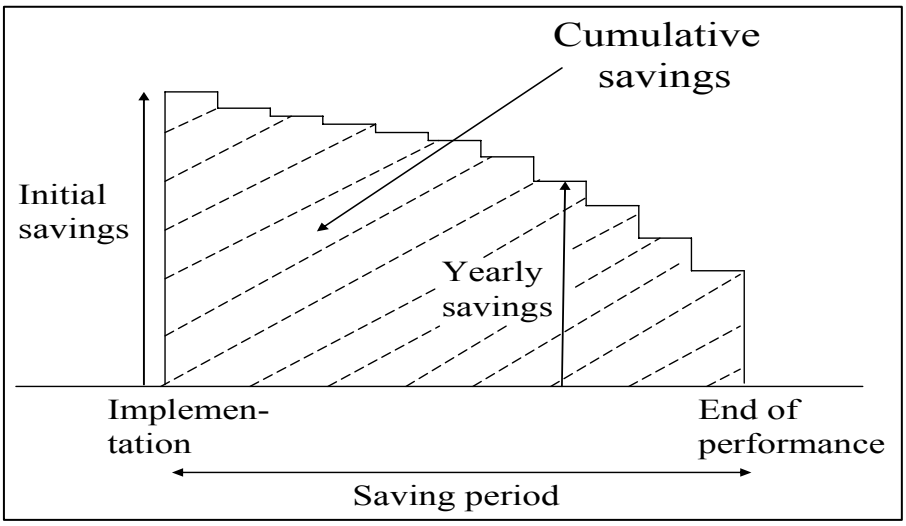
Figure 1 Different steps to publish a CEN Workshop Agreement

Phases	***Main acitivity***	*Main topics*			
Business Plan	***Describing***	*Scope*	*Objectives*	*Financing*	*Schedule*
Kick-off Meeting	***Confirming***	*Business Plan*	*Rules of the Workshop*	*Acceptance nominated Chairmanship*	*Confirm secretariat*
Drafting & adoption of CWA	***Consensus process***	*Consensus by workshop participants*	*Public consultation as appropriate*		
Publication of CWA	***Announced***	*By CEN National Members*			

The main factors in calculating cumulative energy savings

In practice the lifetimes of individual Energy Efficiency Improvement measures of the same type show a (wide) range of values. The objective of the CWA was to agree as much as possible on average values for the most commonly applied measures in bottom-up calculation of total energy savings. The use of saving lifetimes in bottom-up calculations for the ESD should enable a reasonable accurate picture of total energy savings, to be expected or realized, in the years between 2008 and 2016. The total savings are the sum of yearly savings over all measures, applied from 1995 on (in some cases 1991) and still contributing in the chosen year. Therefore, all factors that define the yearly savings of the measures should be discussed for incorporation in the calculation of lifetimes as to meet ESD demands.

Figure 2: Development of energy savings for a specific EEI measure



The amount of cumulative savings is dependent on a number of influencing factors, some influencing the saving period (x-axis in figure 2) and others hand the level of yearly energy savings (y-axis in figure 2).

These cumulative savings are defined by three elements: the saving period, the initial energy savings and the divergence from initial energy savings during this period. In figure 2 we illustrate these elements: after some years the annual savings declines, while at some moment (end of performance) the energy savings come to an end. The yearly savings are the product of initial savings and relative change in savings.

After implementation of the measure, the initial savings become less due to aging and the maintenance regime. For technical systems, *deterioration* of the saving effect means that the initial saving

effect erodes due to aging, e.g. by fouling of the heat exchanger in the boiler. In some publications this is indicated as "performance degradation". For behavioral measures, the factor deterioration represents a change (mostly a loss) in saving performance for the group of participants. For instance, after stopping a campaign to turn off unused lights people will "forget" to turn off the lights more and more and revert back to old habits. For many technical measures the quality of maintenance influences the level of yearly energy savings achieved. The maximum influence on the level of savings is equal to the difference between no maintenance and optimal maintenance. Maintenance could compensate to a certain extent for the loss in yearly energy savings due to other factors.

Another factor that could influence yearly (ex ante assumed) savings is a change in the pattern of use of the energy saving systems that changes the intensity of use and subsequently the yearly savings. For instance, retirement of household members influences occupation rates and space heating demand, and thus the savings of energy efficient boilers. Expansion of activities in companies could increase the savings due to an energy management program. And (policy induced) mitigation of car use decreases the savings of fuel efficient motors. Such factors could lead to a yearly energy savings of measures that is lower than the initial value. Total bottom-up savings decrease as well, as these are the sum of yearly energy savings over all measures. To take account of these lower energy savings the initial savings can be corrected. However, after ample discussions the CWA participants agreed that these factors are not included in this specific CWA.

Lifetime Options and the Primary Determining Factors

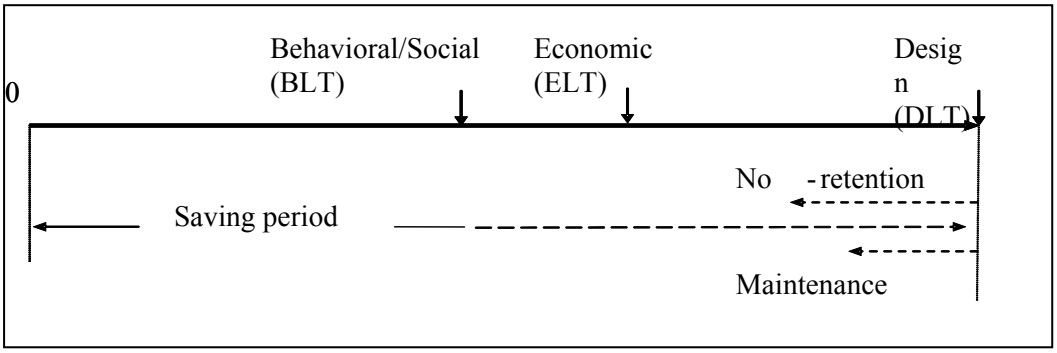
The lifetime during which an EEI measure performs will depend on factors that determine the end-of-performance moment. There are 3 options for defining lifetime:

1. **design lifetime**: intended lifespan, in terms of functioning time, number of functioning cycles, etc., foreseen by the manufacturer when he designs the product, provided that it is used and maintained by the user as intended by the manufacturer;
2. **economic lifetime**: period during which the measure (well maintained) is sufficiently economically attractive as to keep the saving measure in service;
3. **social or behavioral lifetime**: number of years until the device, with improved energy efficiency, is replaced for other reasons than technical failure or economic unattractiveness.

The design and economic lifetime is mostly used for technical measures, but the end of use could also be caused by behavioral reasons. For behavioral and organizational measures, focusing on the efficient use of existing energy using systems, no "design" lifetime can be defined, and only the behavioral/social lifetime is to be used.

The design lifetime is the intended lifetime of a technical measure, provided that it is used and maintained as foreseen by the manufacturer. Replacement of a system is most often due to system malfunction. The design lifetime will normally define the maximum length of the saving period (see figure 3). In some cases technical systems are replaced earlier or switched off for economic reasons, although from the technical point of view they are still functioning well. Therefore, the e*conomic lifetime* will normally be shorter than the design lifetime (see figure 3). For example, smaller CHP units are sometimes switched off because the ratio between fuel prices (costs) and electricity prices (benefits) has become too unfavorable. Consumer electronic appliances are frequently replaced before the end of their technical ore economic lifetime due to behavioral or social reasons, e.g. because audio- or video systems with new features enter the market. The *behavioral/social lifetime* will be shorter than the design lifetime and often shorter than the economic lifetime (see figure 3).

Figure 3: Saving period as result of design-, economic- and behavioral/social lifetime



Maintenance, or more correct the lack of maintenance, can lower the design lifetime. Another factor is the so-called n*on-retention.* Measures are often part of a superior system, e.g. insulation is part of a dwelling and an efficient engine is part of a car. Non-retention of a measure means that the measure is not saving any more because the superior system stops operating and thus non-retention may shorten the saving lifetime of measures even if the measure itself is able to function. For instance, longer time vacancy in older office buildings limits or even ends (in case of demolition of the building) the saving effect from building insulation.

The lasting saving effect of measures is also dependent on the possibilities for change in performance or removal. In this respect the measure can be divided into the four categories: not removable (e.g. cavity wall insulation), easily removed (e.g. draught strips), reversible (e.g. smaller CHP-units turned on or off) and behavioral and organizational actions (e.g. switching off unused lights). In figure 4 we combine these four categories with the three types of lifetime and show whether these factor can be relevant (depicted as Yes or No). The Yes in brackets means that this case is of low relevance.

In case of non-removable measures the saving lifetime cannot be shortened for economic of behavioral/social reasons. However, non-retention and maintenance (affecting the saving period) can play a role and need to be taken into account. In case of easily removable measures the saving lifetime can be shortened for economic and behavioral/social reasons. For reversible measures the economic lifetime of implemented efficient systems will be the deciding factor. If this is the case, non-retention and maintenance will be of less importance. For behavioral measures it is assumed that behavior/social reasons will be decisive for the saving lifetime. Maintenance is not relevant and non-retention will be of less importance.

Figure 4: Relevant factors per category of EEI measure type

EEI measure category	**Economic lifetime**	**Behavioral/ social lifetime**	**Design lifetime**	
			Non-retention	Maintenance regime
Not removable	No	No	Yes	Yes
Easily removed	Yes	Yes	Yes	(Yes)
Reversible	Yes	No	(Yes)	(Yes)
Behavioral/ organizational	No	Yes	(Yes)	No

The energy savings lifetime

During the meetings of the CEN Workshop Agreement the participants discussed the lifetime to be used in bottom-up calculations of ESD energy savings. The term 'energy savings lifetime' was introduced to avoid confusion with the lifetime of products, used by manufacturers in e.g. a guaranty on duration of

the product. Additionally, the agreed lifetimes were restricted to the ESD, and as such does not supersede saving lifetimes used in Member States for other purposes.

The energy savings lifetime is defined as the number of years actually used in calculations of bottom-up energy efficiency improvement. The saving lifetime can take into account, explicitly or implicitly, factors that influence the energy savings during the saving period of measures or measure types.

In providing this saving lifetime the Workshop Agreement holds three options: an EU harmonized saving lifetime figure for all EU countries, a country specific calculated lifetime figure or an EU default saving lifetime figure. *EU harmonized saving lifetime* figures constitute an average saving lifetime for a given measure type across all EU Member States, to be used in the context of the ESD after acceptance by the European Commission. For part of commonly applied measure types a harmonized saving lifetime has been defined (see table in the Annex). To this end a survey of presently applied lifetimes in different countries was executed. This survey generally offered up to five figures per measure type. These results have been discussed at the CWA meetings and complemented with saving lifetime values supplied by experts. For measure types with sufficient matching between the available values an average saving lifetime value was agreed. Figure 5 holds harmonized saving lifetime for the technical measures in commercial and public buildings.

Figure 5: EU harmonized savings lifetime for the technical EEI measures in commercial and public building.

EEI measure in commercial/public sector	Harmonized Saving lifetime (in years)
Windows/glazing	24
Insulation: building envelope	>25
Heat recovery systems	17
Energy efficient architecture	>25
Heat pumps (commercial sector)	20
Efficient chillers in AC	17
Efficient ventilation systems	15
Motion detection light controls	10
New/renovated office lighting	12
Public lighting systems	13

It proves that for measure types with relatively long saving lifetimes harmonized saving lifetimes are the standard (see later on the section on choice of method). In defining the harmonized saving lifetimes all factors directly influencing the saving period (as presented earlier) have been (implicitly) taken into account. Factors that influence the yearly savings of measures have not been taken into account. As there is in Europe only limited evidence on actual saving lifetimes available we assume that during the implementation of Energy Efficiency Action Plans in the Member States more information will become available and over time, the list of EEI measure types with harmonized saving lifetimes and the values of saving lifetimes can be adapted and revised.

A country specific calculated lifetime figures results from a prescribed process taking into account the agreed factors that might influence saving lifetimes of specific measure types. To use a country specific lifetime, a Member State should follow the following procedure and the results should be transparent.

A. For technical measures the design lifetime is identified, whether by means of technical standards or based on information of manufacturers.
B. An analysis is made of the possible influence of economic lifetime, behavioral/social lifetimes, maintenance regime and non-retention.
C. If economic and/or behavioral/social lifetimes are relevant the design lifetime is corrected, resulting in a shorter saving period than the design lifetime.
D. If the factors non-retention and/or maintenance are relevant the saving period is corrected, resulting

in a calculated saving lifetime shorter than the saving period.

E. The size of the correction is calculated based on the influence on cumulative energy savings. This average correction does not account for differences over the saving period.

Translated into a formula, the saving lifetime SLT of a certain measure type is calculated as follows:

$$SLT = MIN \{DLT*CFnr* CFm, ELT, BLT\}$$

where:

SLT = saving lifetime DLT = design lifetime ELT = economic lifetime BLT = behavioral/social lifetime, CFnr and CFm = correction factors for non-retention and maintenance

For technical measures all factors in the formula can be relevant, for behavioral measures only the BLT factor counts. The inputs for the calculated saving lifetimes will be country specific.

To assure reliable and transparent results the determination method has to fulfill certain quality demands. At least the he following aspects should be dealt with in the documentation of the country specific savings lifetime:

- information sources
- method: engineering estimates, measurements, etc.
- level of reliability
- check with other Member-States if available
- last update of the value.

The *default saving lifetime values* is based on a conservative estimate of actual lifetimes. They are used in those cases where neither a harmonized lifetime nor a determined saving lifetime is available. In the CWA default saving lifetimes for the most relevant measure types are included in case there where no harmonized saving lifetime. In this way Member States can always choose to either determine (by calculation or survey) saving lifetimes or rely on default saving lifetimes.

For reasons of simplicity default values for a specific measure type are valid for all Member States. Default values are conservative expert estimates of saving lifetimes. This approach is intended to prevent too optimistic bottom-up saving figures and induce Member States to perform calculations or surveys on actual saving lifetimes and correction factors, at least for measures with a large contribution to total ESD-savings. Especially in the case of organizational and behavioral measure types with a high contribution to the total ESD-target preference should be given to the calculation method or alternatives, such as surveys.

These default values are partly based on available lifetime figures that diverged too much between the countries as to have harmonized lifetimes. If no such data was available the default values have been based on expert opinions. Figure 6 presents default saving lifetime for selected technical measure in industry

Figure 6 EU default saving lifetime for selected technical EEI measure in industry

EEI measure in industry	Default Saving lifetime (years)
Combined heat and power	8
Waste heat recovery	8
Efficient compressed air systems	8
Efficient electric motors/variable speed drives	8
Efficient pumping systems	8

Choice of method in determining saving lifetimes

Given the demands specified in the ESD, preference is given to the use of harmonized saving lifetimes by all EU Member States. If no harmonization is possible for specific EEI measure types the next choice is determination (by calculation or survey) of the saving lifetimes by each Member State (MS). If no data are available or the effort is too large, MS may choose to use default values.
The choices with respect to the defining saving lifetimes will also depend on the lifetime compared to the length of the ESD-period and on the application of the saving lifetime figures (ex-ante or ex-post).

The Energy Service Directive regards measures that will be implemented beginning in 2008. But MS can also take so-called "early action" measures into account. Early actions are measures implemented from 1995 on (in some cases even 1991). These early measures should "reward" MS that started earlier with the implementation of measures. But these early measures should – like the new one - contribute to the 9% total energy savings target by the end of 2016. Measures with a long saving lifetime will always contribute to the ESD-target, but for short saving lifetimes the contribution will depend on the exact lifetime.

With the maximum period of 25 years (1991 to 2016) in mind, for ESD-evaluation methods three groups are distinguished: shorter than 10 years, from 10 to 25 years and longer than 25 years (see figure 7). With regard to the contribution to the ESD-target a distinction is made between new measures and early action measures.

Figure 7: Contribution of lifetime groups to ESD-savings in 2016 and method to define saving lifetimes

Lifetime group	Contribution EEI measure category		Method to be applied
	Early action	New measures	
< 10 years	No	Part	All methods
10-25 years	Part	Full	Harmonized (new measure)
> 25 years	Full	Full	Harmonized

Measures in the group "< 10 years" will not always contribute to the ESD-target in 2016. For instance a measure implemented in 2010 with a saving lifetime of 5 years will have 'disappeared' by 2016. Earlier implemented measures with a short lifetime will have disappeared anyway in 2016. All new measures with a saving lifetime equal or greater than 10 years, and all earlier measures with a saving lifetime > 25 years, will always contribute to the ESD target. For earlier implemented measures with a saving lifetime of 10-25 years this will depend on the year of implementation and the exact saving lifetime.

Differences between countries with respect to saving lifetimes > 25 years are of no importance for the ESD-evaluation. Therefore, saving lifetimes of measures that are sufficiently long can be harmonized in all cases (see Annex). If only new measures are regarded, the same is true for saving lifetimes > 10 years.

In ex-ante evaluations for the ESD there is a choice between harmonized saving lifetimes, use of (conservative) default values or determined (calculation or survey) saving lifetimes. The following ex-post evaluation - that should check the saving lifetimes anticipated beforehand- will gather data on actual developments. Also, the ESD demands will be more stringent for ex-post evaluations, asking for sufficient quality of inputs, such as saving lifetimes. This is especially important for measures where the anticipated lifetime coincides with the year 2016.

The choice of method in the ex-post evaluation can differ from that in the ex-ante evaluation, because more information has become available and/or because more certainty on actual saving lifetimes is needed. Figure 8 shows the ex-post alternatives for each choice in the ex-ante evaluation. Normally harmonized saving lifetimes will be used both ex-ante and ex-post. However, it is possible that for specific

measures the actual saving lifetime diverges from the harmonized values for many countries. In these cases, Member States should deliver their newly gained evidence on actual lifetimes for a revision of the harmonized lifetime. A method change from harmonized to calculation/survey must be restricted as far as possible, as to prevent a selective choice (e.g. only when it leads to a more favorable lifetime figure). A method change should be limited to cases where it could have a substantial effect on total ESD-savings for a country.

Figure 8: Choices as to methods applied in ex-ante and ex-post evaluations

Ex-ante choice	Possible ex-post choices		
Harmonized	Harmonized	Revised harmonized	(Calculation/survey)
Calculation	Calculation/survey	(Harmonized)	
Default	Calculation/survey	Default	Harmonized

Energy savings lifetime for selected EEI measures for households

For technical measures in households in general the energy savings period is the design lifetime. As figure 9 shows the economic lifetime is only relevant for the micro-CHP that is now moving into the market. The behavioral or social factors are only in a very few measures relevant: draught proofing, heating control, consumer electronic goods and efficient bulbs. For the majority of the measures it was possible to agree on harmonized EU saving lifetimes and these are all over 10 years and several even over 20 years. Exceptions are large boilers (default lifetime of 17 years) and CFLs (default value given at 6000 hours a year).Especially for the measures where behavioral of social factors are relevant no harmonized, but (conservative) default values are given (see figure 10).

Figure 9: Information on EU saving lifetimes for commonly applied technical EEI measures for households

EEI measure	Factors				Saving lifetime (years)	
	Economic lifetime	Behavior /Social	Non-retention	Mainte-nance	Harmonized	Default
Insulation: building envelope					>25	
Draught proofing		X				5
Windows/glazing					24	
Replace hot water storage tank					15	
Insulation of hot water pipes					>25	
Heat reflecting radiator panels					18	
Small boilers					17	
Large boilers				X		17
Heating control		X		X		5
Heat recovery systems					17	
Hot water saving faucets					15	
Heat pump (household)					17	
Efficient chiller or room air conditioner					10	
New/upgraded district heating					20	
Solar water heating					19	
Efficient cold appliances					15	
Efficient wet appliances					12	
Consumer electronic goods		X	X			3

EEI measure	Factors				Saving lifetime (years)	
	Economic lifetime	Behavior /Social	Non-retention	Mainte-nance	Harmonized	Default
Efficient bulbs CFL		X	X			(6000 h)
Luminaire with ballast systems					15	
Energy efficient architecture					>25	
Micro-CHP	X			X		8
PV-panels					23	

For three of the four behavioral measures in households the EU default saving lifetime is short: 2 years. Only for the hydraulic balancing of heating there is a longer and harmonized saving lifetime of 10 years.

Figure 10: Information on EU saving lifetimes for commonly applied behavioral EEI measures for households

EEI measure	Factors				Saving lifetime	
	Economic lifetime	Behavior /Social	Non-retention	Mainte-nance	Harmonized	Default
Hydraulic balancing of heating					10	
Electricity saving		X				2
Heat saving		X				2
Feedback on use from smart meters		X				2

Conclusions

The newly defined energy savings lifetimes, as now introduced for the EU Member States for energy savings actions for the Energy Savings Directive hold in most case a longer period than the economic pay back period. For the industry the conservative EU default saving lifetime for the technical EEI measures is 8 years (with exception of good energy management and monitoring that is 2 years). For the commercial and public buildings all EU harmonized saving lifetimes are over 10 years and half of these even over 15 years. Only for energy efficient office appliances the default saving lifetime is 3 years. For commercial refrigeration and CHP the default saving lifetime is 8 years. For transport there are only default values, for the technical measures mainly as total number of kilometers (50,000 or 100,000 km) and for behavioral 2 years. For household the majority of the technical measures has a harmonized saving lifetime for over 15 years while only the measures that have default values have a lifetime of 5 years or less (e.g. 3 years for consumer electronic goods)

The EU harmonized default savings lifetimes are shorter than the design lifetime.. This new system sets also an end to the habit that energy savings are accounted for as impacts during the technical lifetime. As the default values give less credit to the accountable savings for the policy measures, this approach stimulates countries to prove that their lifetimes are longer than the default value. But the practice in the coming years has to prove whether Member States will start to develop country specific lifetimes that will result in longer lifetime values than the default values, or that these conservative defaults will be used in reporting.

In general the new harmonized saving lifetimes for measures are, at the most equal, to the design lifetime. As many countries probably refrain from calculating the lifetime, they have to fall back on conservative default lifetime values. Therefore, in our opinion, the energy savings that EU Member States will report during the first period until 2011 will not overestimate savings, but may even underestimate savings.

References

European Commission, Directive 2006/32/EC of the European Parliament and of the Council of 5 April 2006 on energy end-use efficiency and energy services (ESD), Official Journal of the European Union 27.4.2006, L 114/64

CEN, Technical Board, 2006, Resolution BT C018/2006 Energy management: proposal for two new BT Task Forces.

CEN, Workshop 27 Business Plan Lifetimes of Energy Efficiency Improvement Measures in bottom-up calculations, WS 17 N001 Rev. Version 4 2006-08-30

CEN Workshop Agreement 15693, CEN, April 2007.

Stefan Thomas, Lars J. Nilsson, Wolfgang Eichhammer, Harry Vreuls, Jean-Sébastien Broc, Didier Bosseboeuf, Bruno Lapillonne and Klemens Leutgöb, How much energy saving is 1 % per year? Proceedings ECEEE summer study 2007, paper 4.056

Vreuls, Harry H.J., Broc, Jean-Sébastien and Thomas, Stefan, Developing a Process For Harmonised Bottom-Up Evaluations in European Union Member States, Proceedings IEPEC 2007

Annex: Preliminary list of EU saving lifetimes for commonly applied EEI measure types

	EEI measure **in industry**	Factors				Saving lifetime (*)	
		Economic lifetime	Behavior /Social	Non-retention	Maintenance	Harmonized	Default
	Technical						
52	Combined heat and power	X					8
53	Waste heat recovery						8
54	Efficient compressed air systems	X					8
55	Efficient electric motors/variable speed drives						8
56	Efficient pumping systems			X			8
	Organizational						
57	Good energy man. & mon.	X			X		2
	EEI measure in **commercial and public sector**	Factors				Saving lifetime (*)	
		Economic lifetime	Behavior /Social	Non-retention	Maintenance	Harmonized	Default
	Technical						
28	Windows/glazing					24	
29	Insulation: building envelope					>25	
30	Heat recovery systems					17	
31	Energy efficient architecture					>25	
32	Heat pumps (commercial sector)					20	
33	Efficient chillers in AC					17	
34	Efficient ventilation systems					15	
35	Commercial refrigeration		X	X			8
36	Energy efficient office appliances	X		X			3
37	Combined heat and power	X					8
38	Motion detection light controls					10	
39	New/renovated office lighting					12	
40	Public lighting systems					13	
	Organizational						
41	EMS (monitoring, ISO)	X					2
	EEI measure **in transport**	Factors				Saving lifetime (*)	
		Economic lifetime	Behavior /Social	Non-retention	Maintenance	Harmonized	Default
	Technical						
42	Efficient vehicles						(100000 km)
43	Low resistance tyres for cars		X				(50000 km)
44	Low resistance tyres for trucks	X					(100000 km)
45	Side boards on trucks						(500000 km)
46	Tyre pressure control on trucks						(500000 km)
47	Fuel additives	X	X				2
	Organizational						
48	Modal shift		X				2
	Behavioral						
49	Econometer		X				2
50	Optimal tyre pressure		X				1
51	Efficient driving style		X				2

(*) Sometimes expressed in km and hours that are used to determine the saving lifetime