

# Evaluation and Monitoring for the EU Directive on Energy End-Use Efficiency and Energy Services

## Task 4.1 - Deliverable 4: The development process for harmonised bottom-up evaluation methods of energy savings

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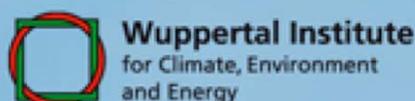
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evaluate  
energy savings<sup>EU</sup>

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## The Project in brief

The objective of this project is to assist the European Commission in developing harmonised evaluation methods. It aims to design methods to evaluate the measures implemented to achieve the 9% energy savings target set out in the EU Directive (2006/32/EC) (ESD) on energy end-use efficiency and energy services. The assistance by the project and its partners is delivered through practical advice, technical support and results. It includes the development of concrete methods for the evaluation of single programmes, services and measures (mostly bottom-up), as well as schemes for monitoring the overall impact of all measures implemented in a Member State (combination of bottom-up and top-down).

## Consortium

The project is co-ordinated by the Wuppertal Institute. The 21 project partners are:

<b>Project Partner</b>	<b>Country</b>
Wuppertal Institute for Climate, Environment and Energy (WI)	DE
Agence de l'Environnement et de la Maitrise de l'Energie (ADEME)	FR
SenterNovem	NL
Energy research Centre of the Netherlands (ECN)	NL
Enerdata sas	FR
Fraunhofer-Institut für System- und Innovationsforschung (FhG-ISI)	DE
SRC International A/S (SRCI)	DK
Politecnico di Milano, Dipartimento di Energetica, eERG	IT
AGH University of Science and Technology (AGH-UST)	PL
Österreichische Energieagentur – Austrian Energy Agency (A.E.A.)	AT
Ekodoma	LV
Istituto di Studi per l'Integrazione dei Sistemi (ISIS)	IT
Swedish Energy Agency (STEM)	SE
Association pour la Recherche et le Développement des Méthodes et Processus Industriels (ARMINES)	FR
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ISR – University of Coimbra (ISR-UC)	PT
DONG Energy (DONG)	DK
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# I- Introduction

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## I.1 Presentation of EMEEES and the role of this report in the project

The European Directive on energy end-use efficiency and energy services (abbreviated ESD in this report) was adopted by the European Parliament and Council in April 2006. Its purpose is “to enhance the cost-effective improvement of energy end-use efficiency in the Member States”, especially by requiring each Member State (MS) to adopt a national indicative energy savings target of at least 9% in 2016<sup>1</sup>. MS shall then report periodically to the Commission their National Energy Efficiency Action Plan (NEEAP), where they state their national target and the corresponding measures<sup>2</sup> planned (in 2007), and then their progress towards their target (in 2011 and 2014), in addition to an update on the portfolio of measures. This raised concerns about how to monitor and evaluate energy savings from the reported measures in a harmonised way, i.e. taking account of the different history and experiences among the 27 MS.

Annex IV of the ESD introduces the “general framework for measurement and verification of energy savings”. However, in the adopted version of the Directive, this framework includes more general specifications than concrete guidelines MS could use. Consequently, ESD article 15(2) states that the European Commission, in accordance with a Committee (the Energy Demand Management Committee, abbreviated EDMC in this report) representing the 27 Member-States’ positions, “shall further refine and complement” this general framework to form a harmonised evaluation system.

The objective of this project is to assist the European Commission and the EDMC in the elaboration of methods for monitoring and evaluation of the energy savings achieved by the Member States in the framework of the EU Directive on energy end-use efficiency and energy services (ESD). This assistance includes the development of concrete methods for the evaluation of single energy efficiency improvement (EEI) programmes, energy services and other EEI measures (mostly bottom-up), as well as schemes for monitoring the overall impact of all measures implemented in a Member State (combination of bottom-up and top-down). In particular, this includes the concrete development of up to 20 different methods for bottom-up evaluation, harmonised across the EU.

It has to be noticed that results and outcomes from EMEEES are technical inputs to the mission of the European Commission and the EDMC, but do not represent official and mandatory documents the Member States shall use (unless it is decided afterwards by the Commission and the EDMC).

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<sup>1</sup> ESD implementation covers 9 years (2008-2016). The national targets were calculated in 2007, and consist for each Member-State of 9% (or above) of its annual average energy consumption (in absolute terms (GWh)), based on a reference period (the most recent five-year period previous to 2008, for which data were available). The energy consumption taken into account in the ESD do not include those covered by the European Emission Trading Scheme (see Directive 2003/87/EC).

<sup>2</sup> The measures may be implemented by both public or private bodies.

In order for these methods to be harmonised between EU Member States in their approaches, assumptions, and calculations, a process needs to be defined, which enables the development of the methods in a way ensuring that harmonisation. This document presents this process as developed by the EMEEES project, which was applied as far as possible by the partners who developed the concrete methods (also called case applications in the EMEEES project).

The guiding principle was to be as thorough as possible in the analysis during the process of developing a method; but to be as pragmatic as possible in the proposal for the method itself that has been developed. The methods developed shall reflect the trade-off between precision on the one hand, and cost, or administrative burden, on the other hand, and search for a reasonable compromise. This principle has been confirmed and stressed as a key objective by the European Commission staff following the project.

## I.2 Objectives and general approach

### I.2.1 Objectives, expected results and target audience of task 4.1

Initial objectives and expected results as stated in the EMEEES contract:

***“Task 4.1: Definition of the process to develop harmonised bottom-up evaluation methods***  
*This task will develop and describe the process how a harmonised bottom-up evaluation method should be developed between the Member States. It will be taken into account that some countries have a longer history in monitoring and evaluating energy efficiency policies, measures and projects than others. Also attention will be given to the relation with methods for evaluating policy measures reducing GHG emissions and the reporting system for the climate change (UNFCCC and Kyoto). An important question to be answered in this task is how the key values needed for a certain method (such as energy savings per measure, annual hours of use, lifetime, amount of free-rider and spill-over effects) should be defined – either for all Member States, or specific for each Member State but in a consistent way; ex ante or ex post - and how they should be used.”*

***“Outcome and deliverable of this task:***

- *D4: developing process for bottom-up methods: An internal working paper on the process for the development of bottom-up methods for discussion in the project group and with the Commission and the Committee (a methodology describing the process how to develop a **concrete harmonised** bottom-up evaluation method)”*

The resulting methodology is first meant for EMEEES participants, for the European Commission and for the EDMC<sup>3</sup>, who are **experts** of this field (evaluation of energy efficiency activities). In particular, the first draft of this report (version of April 2007) was an internal working paper, within EMEEES. This document is therefore written for specialists, and provides detailed explanations for the main issues identified during the course of the analysis.

Within EMEEES, task 4.1 was to provide methodological materials so that concrete bottom-up evaluation methods can be developed by EMEEES partners within task 4.2, and so that reference values can be specified within task 4.3. This methodology had to ensure methods

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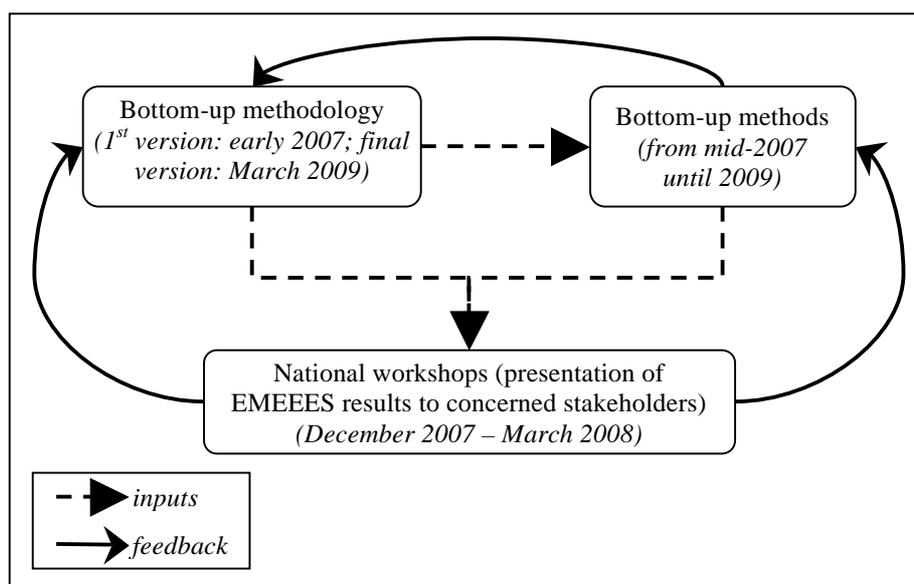
<sup>3</sup> The EDMC is also assisted by two experts working groups (one for bottom-up and one for top-down, both composed by national experts nominated by the 27 MS), which discuss the main technical issues for preparing the debates in the EDMC, which has the political legitimacy to take decisions for the 27 MS.

will be set up in a harmonised way among partners, and fitting to ESD requirements and needs.

Therefore, the **main results** of this task 4.1 are:

- a "**cook book**", presenting the advised process how to develop a bottom-up evaluation method: the **process** itself is described in **Chapter III-**, and then **detailed explanations** are in **Chapters VI- to IX-**
- **templates** for how to **present** a bottom-up evaluation **method** resulting from task 4.2 works (or for methods submitted by Member States (MS) to the Commission): **see Chapter V-**
- **templates** for how to **present the results** of an evaluation using a bottom-up method: **see Annex I**

Moreover, this report is the final revised version for task 4.1 results. The process, explanations and templates were adjusted/improved from EMEEES feedback (especially from partners applying it within tasks 4.2 and 4.3 (see also [Vreuls et al. 2008])), from MS feedback (especially based on national EMEEES workshops (see EMEEES WP9)), and from Commission and EDMC feedback (EMEEES results were presented at meetings of the EDMC and its experts groups). Task 4.1 was therefore an **iterative process**, as presented in the Figure 1.



**Figure 1 - Iterative process for defining the methodology.**

**The consultation of the Member States** is essential so that they can appropriate the proposed approach, which is a success factor in order the NEEAPs to be prepared complying with ESD requirements.

For any other reader interested in the evaluation of EEI activities, it has to be reminded that this methodology was designed for the **specific needs of the ESD** (see Chapter II-), and should not be used out of this scope without relevant precautions.

## I.2.2 General approach

The general approach used to prepare this report (in addition to the iterative process described above) includes the following components:

- 1) **listing main issues** to be addressed: baseline, normalisation and gross-to-net correction factors, calculation methods... (mainly based on experiences reviewed in EMEEES WP2 and on literature review)
- 2) **considering main possibilities** to address them, taking into account what can be done in practice (using the same material: EMEEES WP2 and literature review)
- 3) **providing:**
  - elements for the Commission and the EDMC to take decisions
  - the framework for WP4 partners to develop consistent bottom-up methods
- 4) **proposing a compromise** between trying to treat all issues and setting up a cost-effective and fair harmonised evaluation system (based on EMEEES WP2 and 3 results as well)

The authors would like to highlight that the ESD is the first European Directive requiring Member States to report for proven energy savings. MS have already their own experiences and skills in this field, but it should not be expected that all MS will be able to use up-to-date evaluation methods right away. And the Commission will also have to set up its own evaluation system to comment the Energy Efficiency Action Plans reported by the MS. Therefore, the first ESD implementation phase (for 2008-2012) should be used as a formative process for all stakeholders to issues raised by evaluating energy savings.

Taking this into account, this methodology aims to list these issues and to propose alternatives to address them. Concrete applicability of these alternatives was then discussed during the iterative process described above.

Moreover, the first objective of the ESD is the MS to undertake efforts to encourage energy efficiency improvements. The ESD approach may thus be understood as a way to control that MS undertake a minimum level of effort for energy end-use efficiency and energy services. But it is up to the MS to choose the best strategy according to their own objectives. Accounting for energy savings is then the way to monitor MS efforts.

One of the main challenges of this methodology was to enable the definition of harmonised methods. This does not mean at all that the MS already using their own evaluation systems will have to change them to use the evaluation methods resulting from the application of this methodology. These evaluation methods are to be taken as guidelines to perform evaluations for MS which may look for advice about this, and as requirements for the way to report the results.

Indeed, if each MS reports the results the way it is used to, and not complying with any requirement, it will be :

- 1) impossible for the Commission to assess all the NEEAP
- 2) impossible to compare results between MS (which would limit experience sharing, a key objective of the ESD).

In the ESD, it is repeated many times, that the idea is to use harmonised methods. So each MS can use the monitoring systems they want. But at the end, they should provide a minimum set of information (data, explanations about calculations, etc.). And that is what is meant by requirements. In many cases, it will be possible to use existing monitoring methods and schemes, but process the results according to the harmonised methods developed for the ESD implementation in order to fit ESD reporting needs.

Finally, the **harmonisation** covers the following issues:

- using the **same accounting unit** (see section II.3.2)
- using a **consistent level of evaluation efforts** (see section IV.1)
- using **common basic assumptions**, especially while defining the **baseline** (see section VI.2)
- providing a **minimum set of information** (see Annex I and WP7)

These requirements are to ensure the results are reported with a **minimum quality level**.

Besides this, the ESD approach is also to encourage dissemination of good practices (ESD article 7(3)). Indeed, bottom-up evaluations can be used to provide information to help MS to choose their strategy. Likewise, specifications for quantifying energy savings could include requirements ensuring quality of an EEI measure, especially when success factors could be identified in the past. Evaluation requirements may actually have an influence on the design of EEI measures. So these requirements should be defined to have a positive influence.

## I.3 Scope of this methodology

### I.3.1 A methodology specific to the ESD framework

The present methodology is to be used in a given regulatory framework, the ESD. Therefore it is a specific approach, designed to fit to the ESD's approach, rules and needs. It is not a global answer to all evaluation issues related to the evaluation of energy efficiency improvement activities.

Particularly, rules defined here for accounting energy savings need to be valid within ESD implementation. Indeed, **when a MS reports its NEEAP, it has to comply with ESD specifications**. Therefore, this methodology is as much as possible based on ESD definitions and objectives (see section II.3).

However, these rules are **not to be considered as reference rules to be used outside this scope**, especially by all Member-States for their own evaluation needs. A MS' evaluation scheme may apply different rules, due to different objectives and priorities. For instance, a MS can have a scheme based on accounting of lifetime-cumulated energy savings (e.g. for a white certificates scheme), whereas the ESD requires accounting of annual energy savings.

### I.3.2 EEI activities and evaluation issues covered

#### I.3.2.1 What is an EEI measure – defining targets for evaluation methods

EEI activities covered by this methodology are the ones to be accounted for in the ESD:

- energy services, as defined in ESD articles 3(e) and 4(1)
- EEI measures implemented within the public sector (ESD article 5)
- EEI measures or programmes promoted by energy suppliers (i.e. energy distributors, distribution system operators and/or retail energy sales companies) (ESD articles 6, 12 and 13)
- energy efficiency programmes and mechanisms and all other kinds of EEI measures implemented by public bodies and other actors (ESD articles 3(f), and 9 to 13)

In practice, these types of EEI activities may overlap, creating a problem of double counting (cf. section VIII.2). Moreover, not all EEI activities from one or more of these sources are covered by the ESD, especially because:

- the ESD accounts for EEI measures leading “*to verifiable and measurable or estimable energy efficiency improvement*” (article 3(h))
- the ESD does not apply to final customers already covered by the greenhouse gas emission allowance trading scheme of the European Commission (ETD)<sup>4</sup>, neither to the armed forces to a certain extent (ESD article 2(b) and (c))

Moreover, the energy savings to be accounted for the achievement of the ESD target are only these achieved in 2016 (see section IX.1 for more details). So there should be a **preliminary step** before going further in the evaluation of any EEI measure to be reported for ESD accounting. Indeed it should be checked whether the measure complies a priori with the **timing requirements**:

1. the energy savings from the end-use actions (see definition below) implemented are to be **still effective in 2016**: this could be checked with the default or harmonised values of **saving lifetimes** already available (see also section IX.2.2)
2. the end-use actions were **implemented from 2008 on**, or from 1995 on (and under special conditions from 1991 on) (see also part X- about **early actions**)

The European Commission should specify whether other criteria apply for the eligibility of EEI measures.

To clarify what is the object of monitoring and evaluation for an EEI measure as defined in the ESD, it is defined within the EMEEES project, that this object of monitoring and evaluation is usually a combination of:

- *an (energy efficiency improvement) facilitating measure (abbreviated **facilitating measure**)*, i.e., an action by an actor that is not the final consumer him-/herself, which supports the final consumer in implementing the end-use action, or implements it for the final consumer ;

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<sup>4</sup> “*undertakings involved in categories of activities listed in Annex I to Directive 2003/87/EC*”

- and an end-use (energy efficiency improvement) action (abbreviated **end-use action**), which is a technical, organisational, or behavioural action taken at an end-user's site (or building, equipment, etc.) that improves the energy efficiency of that end-user's facilities or equipment, and thereby saves energy. An end-use action may be stimulated by a facilitating measure, but this is not a priori required.

The principle of this distinction has been accepted by the Commission. Examples of end-use actions may be found in ESD Annex III. Facilitating measures are detailed in Annex II of this report. Table 1 below shows how crossing end-use actions and facilitating measures enables to define targets for evaluation methods and concrete evaluations.

				Facilitating measures				
				Example 1: energy performance contracting	Example 2: white certificates schemes	Example 3: subsidies schemes	Example 4: building regulations	Example 5: energy taxations
End-use actions	Sector	Energy end-use	Efficient Solution					
	Residential	example 1: heating	efficient boilers		B1	C1	D	E
			heat pumps		B2	C2		
			etc.			etc.		
		example 2: lighting	CFL		Bi			
			etc.					
	Tertiary	example 1: efficient boilers, heat pumps, etc.			Bj			
		example 2: lighting	CFL		etc.	Ci		
			efficient ballasts					
	etc.							
	Industry	example 1: motors and drives	electronic controls	A				
			VSD					
			etc.					
		etc.						
Transport	example 1: mode of travel used	efficient vehicles						
		efficient driving						
		etc.						
	etc.							

Table 1 – crossing end-use actions and facilitating measures to define targets for evaluation methods

In this table, the object of monitoring and evaluation for a type of EEI measure is then the crossing between a row and a column (e.g. labelled as C2).

In practice, facilitating measures may be designed to target several end-use actions at once. When facilitating measures “*focus on groups of final customers*”, they form EEI **programmes** (as defined in ESD article 3(g), e.g.: subsidies schemes, labelled as C in the table). When facilitating measures use “*general instruments*”, they form EEI **mechanisms** (as defined in ESD article 3(f), e.g. energy taxation, labelled as E). And when the end-use action is “*delivered on a basis of a contract*”, it deals with **energy services** (as defined in ESD article 3(e), e.g.: energy performance contracting, labelled as A in the table).

As mentioned in section I.2.1, task 4.1 was to provide a "cook book" to set up bottom-up methods. Then, tasks 4.2 and 4.2 were to actually set up methods. Our methodology was designed so that in priority methods can be developed covering a row or a column as presented in Table 1.

Indeed, rows should correspond to calculation methods for unitary gross annual energy savings (see part VI-), while columns should correspond to accounting methods for the number of units or participants (see parts VII- and VIII-). A calculation method is then related to a particular end-use action. An accounting method is related to a particular facilitating measure.

It could at first seem that defining an evaluation method for each cell of table 1 is an endless and resource-consuming work. But in practice, rows or columns can be addressed at once, consequently reducing significantly the number of methods to be specified. Likewise, most of the time, even if a method can not address at once a whole row or column, new methods for other cells for the same row or column can be "derived" from the existing ones. And deriving methods can also be possible between similar columns or rows (e.g. efficient solution for the same end-use). So the more methods are set up, the easier to develop new ones. For instance, such an approach is used for the French White Certificates Scheme, which already set up more than 130 calculation methods, with many of them derived from another.

Table 1 only provides examples of rows and columns to illustrate and make our presentation more concrete and clear. It must not be taken as exhaustive, not even as indicative.

### *1.3.2.2 General evaluation issues related to ESD implementation*

Three main evaluation issues are raised within the ESD:

- to **quantify energy savings** resulting from energy services and EEI measures, in order to evaluate Member States' efforts reported in their Energy Efficiency Action Plans (ESD article 14(2 and 5))
- to detect and be able to **disseminate best practices** among Member-States (ESD article 7(3)), which is also related to assessing the cost-effectiveness of EEI measures
- to evaluate the cost-effectiveness of EEI measures implemented in the ESD framework (ESD articles 4(5) and 14(3))

This methodology aims mainly at the first issue (quantifying energy savings). Some elements may also be useful for the best practices issue. But the third issue (cost-effectiveness of ESD) was out of the priority scope of this present work. However, there can be synergies in data

collection: if there is, e.g., a monitoring of energy savings per participant, it does not cost much more to monitor the additional investment, too. And it deserves mentioning that the amount of energy saved is one factor in the calculation of the economic benefits of an EEI measure. The second factor is the unit costs or price per kWh of energy saved; this is indeed out of scope for our work.

These issues are then to be tackled by Member-States or other concerned stakeholders, if they wish so.

## I.4 List of concrete case applications of BU methods developed within EMEEES

The following case applications of BU methods were developed applying this methodology within EMEEES tasks 4.2 and 4.3:

**Table 2 – List of concrete BU case applications developed within EMEEES.**

<b>Method title</b>	<b>Sector</b>
Energy performance of new buildings	residential
Building envelope improvement (residential buildings)	residential
Biomass boilers	residential
Condensing boilers	residential
Energy-efficient white goods (appliance purchased anyway)	residential
Domestic hot water (solar water heaters and heat pumps)	residential
Heating system by a water loop	tertiary
Improvement of lighting system	tertiary and industry
Improvement of central air conditioning system	tertiary
Office equipment	tertiary
High efficiency electric motors	industry
Variable speed drives	industry
Energy performance contracting	tertiary and industry
Energy audit programmes	tertiary and industry
Voluntary agreements – billing analysis method	tertiary and industry
Voluntary agreements – engineering analysis method	tertiary and industry
Vehicle energy efficiency (engines, tyres, lubricants)	transport
Modal shifts in passenger transport, including towards non-motorised transport	transport
Eco-driving	transport

The corresponding reports can be found on the EMEEES website:

[http://www.evaluate-energy-savings.eu/emeees/en/evaluation\\_tools/bottom-up.php](http://www.evaluate-energy-savings.eu/emeees/en/evaluation_tools/bottom-up.php)

A synthesis of the work done within EMEEES WP4 can also be found in [Vreuls et al. 2008].

## II- Bottom-up evaluations of EEI measures within the ESD frame

### II.1 What are “energy savings” the ESD requires to evaluate?

ESD article 3 (Definitions) specifies:

“(b) **‘energy efficiency’**: a ratio between an output of performance, service, goods or energy, and an input of energy;

(c) **‘energy efficiency improvement’**: an increase in energy end-use efficiency as a result of technological, behavioural and/or economic changes;

(d) **‘energy savings’**: an amount of saved energy determined by measuring and/or estimating consumption before and after implementation of one or more energy efficiency improvement measures, whilst ensuring normalisation for external conditions that affect energy consumption;

(e) **‘energy service’**: the physical benefit, utility or good derived from a combination of energy with energy efficient technology and/or with action, which may include the operations, maintenance and control necessary to deliver the service, which is delivered on the basis of a contract and in normal circumstances has proven to lead to verifiable and measurable or estimable energy efficiency improvement and/or primary energy savings;”

**ESD energy savings** are the amount of energy savings that Member States have to prove to the European Commission for fulfilment of their indicative cumulative annual energy savings target of 9 % by 2016. This target shall be reached by way of energy services and other energy efficiency improvement measures.

The **task** is, therefore, to monitor and verify, i.e. to evaluate, the energy savings achieved by energy services and other energy efficiency improvement measures in a way consistent with the ESD.

It should be noted that this energy savings figure is a figure relevant, a priori, **only** for monitoring purposes of the ESD and may, hence, differ from other figures that Member States or private actors use for other evaluation purposes, e.g., for national white certificates schemes, monitoring the effects of climate policy, or billing of energy services to customers.

This methodology therefore deals with energy savings. And within the ESD, the covered energy savings are these gained through an “*energy efficiency improvement*”, which is an “*increase in energy end-use efficiency*”, meaning there is a change in the ratio between the output (energy-related need<sup>5</sup>) and the input (corresponding energy consumption).

The ESD aims at improving energy efficiency, and not at reducing/managing demand for energy-related needs. So we made the assumption that ESD energy savings mean **smaller energy consumption for a given output/energy-related need at present time** (difference of

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<sup>5</sup> Energy service in the ESD has a double meaning, being the physical benefit etc., but also being something that is sold to a customer to provide that physical benefit in an energy-efficient way, hence in itself a combination of an (EEI) facilitating measure and one or more end-use actions. To clarify this, we use “energy service” when dealing with facilitating measures, and another term, “energy-related needs” as introduced in [Thomas et al. 2002 (in German: energierelevante Bedürfnisse)], when dealing with the physical benefit.

the energy consumption before/after an EEI measure for the present level of energy-related need).

In practice, it has to be taken into account, that **the growth of demand for energy-related needs does not reduce the amount of energy savings**. For instance, if dwellings tend to be bigger and/or the average number of persons per dwelling tends to decrease, **normalisation factors** (e.g. occupancy level, see ESD annex IV(1.2) and section VI.3) have to be applied so that the energy consumption determined 'before' and 'after' EEI measures corresponds to the same normalised level of energy-related need.

Within EMEEES, it has to be ensured that bottom-up and top-down evaluation methods apply the same normalisation factors in the same (or at least in a consistently harmonised) way when addressing the same EEI measures.

## II.2 Bottom-up evaluation, what is it? and what for?

### II.2.1 What is a "bottom-up" evaluation?

The ESD makes a distinction between two main approaches to assess energy savings: "top-down" and "bottom-up" calculations (ESD Annex IV(1)).

Top-down calculation is then defined as follows:

*“A top-down calculation method means that the amount of energy savings is calculated using the **national or larger-scale aggregated** sectoral levels of energy savings as the starting point”.*

Whereas bottom-up calculation is defined as follows:

*“A bottom-up calculation method means that energy savings obtained through the implementation of a **specific**<sup>6</sup> energy efficiency improvement measure are measured in kilowatt-hours (kWh), in Joules (J) or in kilogram oil equivalent (kgoe) and added to energy savings results from other specific energy efficiency improvement measures”.*

Top-down means therefore starting from global data (e.g. national statistics for energy consumption or sales of equipment), then going down to more disaggregated data when necessary (e.g. energy efficiency indicators) and correcting for non-policy effects such as autonomous savings to assess policy-induced energy savings<sup>7</sup>. In contrast to this, bottom-up methods start from data at the level of an EEI measure, mechanism or programme, (e.g. energy savings per participant and number of participants) and then aggregate results from all EEI measures and programmes reported by a Member State to assess its total energy savings in a specific field.

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<sup>6</sup> This bolding is used on purpose to highlight this word in this definition. Bottom-up looks at specific (or given) EEI measures, while top-down looks at the evolution of the energy consumption per given indicators (sector, end-use, etc.), but not considering given EEI measures. In concrete words, the results of a bottom-up evaluation is to say "this EEI measure was assessed to achieve xxx GWh/year of savings (+/- x%)", while a top-down evaluation is to say "the EE indicator for this end-use / sub-sector was assessed and shows that the unitary /overall consumption was improved by xx %, corresponding to xxx GWh/year saved after correction factors (+/- x%)"

<sup>7</sup> Top-down methods can not distinguish effects from several promotion measures targeting the same top-down indicator. Indeed they cannot directly establish the causality between the measures and their results.

In concrete terms, the difference between both approaches can be expressed in the way they calculate energy savings:

- top-down methods monitor the evolution of energy efficiency indicators, and then they calculate energy savings as:  
total energy savings = change in energy efficiency indicator  
\* total number of units of the indicator's driver
- bottom-up methods directly monitor the results at the level of an EEI measure (or a package of measures), then they calculate energy savings as:  
total energy savings = energy savings per end-use action  
\* number of end-use actions

This methodology deals with bottom-up calculation methods.

Bottom-up methods provide **quick feedback** and are requested to be increasingly used in ESD monitoring over time and experience gained. They also make possible to measure intermediate indicators on the success of a facilitating measure at some place in the cause-effect chain. These results provide valuable information on possibilities for the improvement of a facilitating measure.

We assume that the necessary condition for using bottom-up methods is that it is possible to account for the number of participants<sup>8</sup> (units of end-use EEI measures implemented) of the concerned facilitating measure or programme, or that energy savings can be evaluated at the level of an individual EEI measure (e.g. for a big technical end-use action supported by an energy audit programme or an energy service for a larger customer).

## II.2.2 Use and interest of bottom-up evaluations

Evaluation is first perceived as a process to **quantify the results** of what has been done. But bottom-up evaluations are more than that, especially because they can include different levels of evaluation efforts and analysis.

Bottom-up evaluation can:

- 1) **quantify** the results (i.e., the objective is an **impact** evaluation)
- 2) provide evidences of the **causality** between actions and results (i.e., the objective is to improve the **design** of the facilitating measure or package)
- 3) help understand **how and why** results are gained, and so highlight **success factors** (in order to improve both the design and the implementation **process** of the facilitating measure).

Bottom-up evaluation is not to be taken as a simple control. It is an **efficient tool to assist management and monitoring** of activities. As such, costs of bottom-up evaluations are not to be accounted for as pure administrative burden and costs. More generally, they are **not**

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<sup>8</sup> A participant may be accounted for either as an installed energy-efficient equipment (e.g. a CFL or an appliance), or as a participant site (dwelling, building, company ; e.g. a single family home being insulated or a company taking part in an energy audit programme), see also section IV.2

**additional costs**, as bottom-up evaluation should be integrated in the action process itself. Indeed, a proper use of bottom-up evaluation improves quality of activities, and enables their further improvement<sup>9</sup> (see also [Vine 2008]).

Moreover, bottom-up evaluations performed for ESD purposes may also be used for other purposes, such as climate change mitigation policies, if that link is made from the design phase of the evaluation.

The ESD approach is to encourage **gradual improvements of the reliability**<sup>10</sup> of results, through increasing the use of bottom-up evaluation methods (ESD article 15(1) and Annex IV (1.1.b)). This is necessary to ensure the credibility of reported results, and then of the usefulness of the ESD.

## II.3 Specifications included in the ESD

### II.3.1 Setting up a cost-effective evaluation system

The first requirement of the ESD related to evaluation is that its evaluation system has to be **cost-effective**. Costs of evaluation methods should be assessed, and minimised as much as possible, taking into account the related uncertainties:

- *“standardised methods which entail a **minimum of administrative burden and cost**” should be developed (ESD annex IV (1.1))*
- *“the acceptable level of uncertainty required in energy savings calculations is a function of the level of savings and the **cost-effectiveness of decreasing uncertainty**” (ESD annex IV (3))*

This methodology had thus to take into account that the aim is not to provide results with maximum accuracy, but to find a **compromise between evaluation costs and precision**. Simplifying assumptions may then be used when relevant. However a method can be cost-effective to use (requiring easy-to-collect data and using easy-to-perform calculation models) AND using a sophisticated treatment (based on reference data and underlying assumptions) ensuring a good accuracy level.

### II.3.2 Accounting rules already defined in the ESD

The main objective of the present methodology was to help developing harmonised and cost-effective bottom-up evaluation methods, which are to enable the MS to report EEI activities in a **common language** and with a **common and harmonised accounting system**. This methodology had therefore to propose the framework and rules of this accounting system, using ESD specifications.

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<sup>9</sup> For more details about reasons for evaluation, see the corresponding part within the European ex-post evaluation guidebook for DSM and energy services programmes [SRCI 2001 pp.8-18]

<sup>10</sup> Reliability means here both accuracy of reported results, and evidences of causality between actions and results.

1) **accounting units** : kWh of “*cumulative annual energy savings achieved throughout the nine-year application period of this Directive*” (ESD Annex I (1.c))

→ energy savings should be reported in kWh/year (or its multiples) applying **conversion factors** presented in ESD Annex II, “*unless the use of other conversion factors can be justified*” (ESD article 4(1)) (see also section VI.5).

→ energy savings should be first reported in annual values (see section IV.2), and not in lifetime-cumulated value. They should not be discounted either.

2) **results to be accounted for** : energy savings achieved “*by way of energy services and other EEI measures*” and “*measured as from 1 January 2008*” (ESD article 4 (1)), but “**early actions**”<sup>11</sup> with a lasting effect over 2008 may be accounted for, under certain conditions (ESD Annex I (3), see also part X-)

3) **main calculation rules** : energy savings are “*an amount of saved energy determined by measuring and/or estimating consumption before and after implementation of one or more energy efficiency improvement measures, whilst ensuring normalisation for external conditions that affect energy consumption*” (ESD article 3(d))

→ the **baseline** is to be defined as the situation before implementation of the evaluated EEI measure(s). This situation "before" may be expressed in **two ways**:

- "before" energy consumption, i.e. energy consumption with the replaced equipment or past organisation or behaviour (e.g. defined with past energy bills)
- "before" decision, i.e. energy consumption with the equipment/organisation/behaviour which is supposed to have been used if the EEI measure(s) would not have been implemented (e.g. defined through market modelling based on equipment sales data)

These two options correspond to two possible results, respectively: “all” savings or “additional” savings.

If the objective is to evaluate all energy savings, the guiding question will be:

*What would have happened if all equipment had stayed at the same energy efficiency level as before?* (“before-after” situation)

If the objective is to evaluate additional energy savings as an impact of (combinations of) individual facilitating measures, the guiding question will be:

*What would have happened in the absence of the EEI measure that is to be evaluated?* (“with and without” situation)

(For more details, see section VI.2)

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<sup>11</sup> “The term “early action” has been adopted from the climate protection debate where there are similar questions with regard to the reduction of greenhouse gases. Under the ESD it refers to measures taken between 1995 – in exceptional cases 1991 – and 2008, the start of the active period of the Directive and which have an effect during the active period, i.e. 2008-2016.” [Eichhammer 2006]

→ as highlighted in section II.1, when calculating energy savings, the corresponding difference between the before/after energy consumption has to be considered for the same normalised level of energy-related need. ESD Annex IV (1.2) proposes an indicative list of **normalisation factors** to take into account (see also section VI.3).

4) **main calculation rules** (2) : evaluation methods should be **harmonised** to ensure equality of treatment for all MS and EEI measure types (ESD article 15(3) and Annex IV(1 ; 4), but “*Member States that so wish may use further bottom-up measurements in addition to the part prescribed by the harmonised bottom-up model*” (ESD Annex IV (1.1))

→ A **harmonised accounting** system means that EEI measures are to be accounted the same way :

- **whatever the Member-State**, the reporting specifications provided by the Commission are respected (i.e. measures reported by one MS should not be favoured compared to similar measures reported by another MS, when they report the same level of information)
- **whatever the nature of the reported EEI measures**, the reporting specifications provided by the Commission are respected (i.e. measures of type "x" should not be favoured compared to measures of type "y")

→ However it should be taken into account that **resources and experience** of MS related to reporting EEI measures are spread **unequally among MS**. Experience should therefore be shared, and EU-widespread evaluation efforts should be encouraged, as well as efforts to update MS-specific data.

5) **other calculation rules** : “*corrections shall be made for double counting of energy savings*” and “*measures that have already resulted in multiplier energy savings effects should be taken into account*” (ESD Annex IV (5)) (see part VIII-)

In order to distinguish them from normalisation factors, these are called **gross-to-net correction factors** within EMEEES.

→ other **gross-to-net correction factors** that may be relevant for bottom-up evaluation methods are not explicitly mentioned in the ESD (especially free-rider and direct rebound effects are not referred to in the ESD). Advantages and drawbacks of (not) including other gross-to-net correction factors (especially free-riders), and general proposals how to include them are presented in section VIII.5. **It will then be up to the Commission (and/or to the Committee) to decide what to include, and how.**

### II.3.3 Evaluation recommendations suggested in the ESD

When developing an evaluation method, the following should be kept in mind:

1) evaluation methods should be designed with a view “*to ascertaining the impact of individual measures*” (ESD Annex IV (1.1))

- 2) evaluation methods should be designed “*to use, to the extent possible, data which are already routinely provided by Eurostat and/or the national statistical agencies*” (ESD Annex IV (1.1))
- 3) **existing experience** should be taken into account, to the extent possible, in evaluating EEI measures (ESD Annex IV (1.1.c)), especially information submitted by MS (ESD article 14(1))
- 4) bottom-up evaluation methodology should aim to propose “*standardised methods which entail a minimum of administrative burden and cost*” (ESD Annex IV (1.1))
- 5) a distinction is made “*between methods measuring energy savings and methods estimating energy savings, where the latter is the more common practice*” (ESD Annex IV (2)) (see also section VI-)
- 6) “*Member States may choose to use the method of quantified uncertainty*”, and “*the acceptable level of uncertainty required in energy savings calculations is a function of the level of savings and the cost-effectiveness of decreasing uncertainty*” (ESD Annex IV (3))
- 7) International Performance for Measurement & Verification Protocol [IPMVP 2002] and the European ex-post evaluation guidebook [SRCI 2001] are presented in ESD Annex IV as reference sources. This methodology therefore refers to these guidebooks when necessary.

## II.4 Two complementary evaluation fields

This methodology considers two main evaluation fields:

- 1) quantification of energy savings
- 2) causality between actions and results

The first point is to define rules for the accounting of energy savings. This objective is mainly related to two criteria defining an end-use action: the energy end use targeted<sup>12</sup> and the corresponding energy-efficient solution encouraged<sup>13</sup>. The end-use actions, in turn, have to be related to the effect of a facilitating measure.

The second point is to further investigate special issues, especially to evaluate both multiplier effect and double counting<sup>14</sup>. This part is more strongly related to the contextual factors<sup>15</sup> and multiple facilitating measures targeting a type of end-use measure, particularly different EEI policy instruments<sup>16</sup>. This may also be considered for providing examples of good practice. This last issue is not in the priority scope of this methodology, but the framework proposed in Annex I to present the results of an evaluation may be used to build experience feedback.

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<sup>12</sup> e.g. residential lighting, tertiary heating systems, see Table 1, ESD Annex III and WP3

<sup>13</sup> which may be technological, organisational, and/or behavioural (cf. ESD article 3(c)) : e.g. CFL, condensing boilers, see ESD Annex III and WP3

<sup>14</sup> and eventually free-rider effect

<sup>15</sup> e.g. energy prices, market barriers, cf. [Haug 1998 pp.3-6]

<sup>16</sup> e.g. regulation, information, economic incentives, cf. [Vreuls 2005a pp.14-19]

Within the scope of EMEEES, the priority objective is to develop evaluation methods to quantify energy savings. Other projects (e.g. AID-EE<sup>17</sup>) provide complementary tools and methods, especially for an in-depth analysis of programme theory, causality and success factors related to design and process evaluation (see for instance [Blumstein 2000, Joosen 2005]).

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<sup>17</sup> Intelligent Energy Europe project entitled "Active Implementation of the European Directive on Energy Efficiency", see [www.aid-ee.org](http://www.aid-ee.org)

### **III- Advised process to develop a harmonised bottom-up evaluation method**

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This part presents the first main result from task 4.1: the "recipe" of the "cook book", i.e. the advised process to develop a harmonised bottom-up evaluation method. The different phases are listed hereafter. Then details and additional explanations how to address corresponding issues are provided in Chapters VI- to IX-, completing the "cook book" with "cooking tips".

Templates for presenting an evaluation method are presented in Chapter V-, as a standard frame to collect and present results from task 4.2 and task 4.3.

Finally, a master template for presenting the results from an evaluation that is using a certain evaluation method is presented in Annex I, as a standard frame to collect results from evaluations, in order to prepare a NEEAP.

Our aim is to be as pragmatic as possible, and this especially means that we have to ensure this methodology and the future methods and templates are in line with MS expectations. Their appropriation of this material was one of the big challenges for the EMEEES project, and is the subject of WP9, where the EMEEES results were presented and discussed with as many stakeholders from as many MS as possible.

Moreover, all the results from task 4.1 (the "cook book" and the templates) were adjusted/improved through an iterative process, from EMEEES feedback (especially from partners applying it within tasks 4.2 and 4.3), from MS feedback (see EMEEES WP9), and from Commission and EDMC feedback (especially about what is expected for a concrete implementation of the ESD).

The initial advised process is presented in Figure 2 below:

- 1) preliminary work**
- 2) possible options for formulas (calculation / accounting)**
  - a. assessment**
  - b. choice**
- 3) data needs**
- 4) data collection options**
- 5) differences between MS**
- 6) final decision on levels of evaluation efforts**
- 7) summarising (key points of the evaluation methods)**

**Figure 2 - advised process to develop an harmonised bottom-up evaluation method**

Phases 2 to 5 form an **iterative process** enabling to complete phase 6.

Phases 1 to 4 (and within phase 4, the analysis of data collection options) correspond to the first phases of EMEEES task 4.2 works. Phases 4 (for the actual data collection) and 5 correspond to task 4.3 works. And phases 6 and 7 correspond to finalising task 4.2.

In practice, this process appears to be difficult to implement. It did provide a detailed view of all issues to be covered when developing a case application of a method, but according to the partners developing the case applications, it was not possible to address them all within the three weeks of time allocated to one case application within tasks 4.2 and 4.3. Moreover, it was not possible within the time constraints to make both, extended literature and experience review on the one hand, and developing a detailed method on the other hand. So each partner found a compromise between both tasks, especially by using its own experience and expertise.

Finally, the template (see chapter V-) was more useful than the detailed process presented here for guiding the development of an evaluation method. The template also provides the overview of issues to be covered, and a frame to order them. Then filling up the template should be done in a more pragmatic way than initially proposed (to be more cost-effective), especially by starting from its own experience and expertise, then looking for additional inputs only when needed, and confronting the results to key stakeholders in order to get a concrete feedback for finalising the method.

However, the sources given in Annex IV remain very useful to better target the literature review efforts (which are always needed to some extent).

Phase	Issues	Where to find information in this methodology
1) preliminary work	<ul style="list-style-type: none"> <li>▪ <b>listing available data and evaluation methods</b> + existing feedback → (data and methods from other Directives (e.g. EPBD, EU energy labels) + EMEEES WP2 results + volume II of [Vreuls 2005b] + other sources)</li>   <li>▪ <b>analysing this first material:</b> <ul style="list-style-type: none"> <li>- what data are available for which MS? what data could cost-effectively be collected for most of the MS?</li> <li>- what are evaluation methods currently used by MS? → advantages / drawbacks + consistency with ESD accounting rules</li> </ul> </li>   <li>▪ <b>technical analysis of the targeted energy end-use:</b> <ul style="list-style-type: none"> <li>- what are the related energy consumption data: measured? assessed? simulated?</li> <li>- what are the parameters which may affect energy consumption of this end-use (internal characteristics of equipments and external conditions)?</li> <li>- what would be the technical potential of energy savings (when available or easy to assess)?</li> <li>- what are the main differences between MS?</li> </ul> </li>   <li>▪ <b>market analysis of the targeted energy end-use/efficient solution:</b> <ul style="list-style-type: none"> <li>- what are the related stock/market data: stock data? sales data?</li> <li>- what are the market driving forces: summary of history and recent trends of concerned markets, barriers, energy prices, concurrent technologies/equipments</li> <li>- what are the main differences between MS?</li> </ul> </li>   <li>▪ <b>analysis of issues related to the facilitating measures used:</b> <ul style="list-style-type: none"> <li>- how can the number of implemented actions be accounted for? (see part VII-)</li> <li>- should multiplier effects be considered? (see section VIII.4)</li> </ul> </li> </ul>	Annex IV

	<ul style="list-style-type: none"> <li>- may facilitating measures have an influence on the baseline? (to be related with the analysis of market driving forces)</li> <li>- may facilitating measures create particular reasons for free-rider effects?</li> </ul>	
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<p><b>2) possible options for formulas (calculation / accounting):</b></p> <p><b>a. assessment (starting the process)</b></p> <p><b>b. choice (iterating)</b></p>	<ul style="list-style-type: none"> <li>▪ general formula for calculating <b>unitary annual gross energy savings</b></li> </ul>	Step 1 of the calculation process (section VI.1 and VI.4)
	<ul style="list-style-type: none"> <li>▪ <b>baseline</b></li> </ul>	Step 1 of the calculation process (section VI.2)
	<ul style="list-style-type: none"> <li>▪ listing relevant <b>parameters</b> to be included in case of broken down formula</li> </ul>	Step 1 of the calculation process (section VI.1)
	<ul style="list-style-type: none"> <li>▪ listing <b>normalisation factors</b> to be included in the formula</li> </ul>	Step 1 of the calculation process (section VI.3 and VI.6)
	<ul style="list-style-type: none"> <li>▪ considering how to deal with <b>uncertainties</b> for unitary annual gross energy savings</li> </ul>	Section IV.1.1
	<ul style="list-style-type: none"> <li>▪ considering if <b>conversion factors</b> are needed</li> </ul>	Step 1 of the calculation process (section VI.5)
	<ul style="list-style-type: none"> <li>▪ general formula for <b>accounting for number of implemented end-use actions</b></li> </ul>	Step 2 of the calculation process (part VII-)
	<ul style="list-style-type: none"> <li>▪ considering how to deal with <b>uncertainties</b> for annual gross energy savings</li> </ul>	Section IV.1.1
	<ul style="list-style-type: none"> <li>▪ considering risks of <b>double counting</b></li> </ul>	Step 3 of the calculation process (section VIII.2 and VIII.3)
	<ul style="list-style-type: none"> <li>▪ considering possibilities of <b>multiplier effects</b></li> </ul>	Step 3 of the calculation process (section VIII.4)
	<ul style="list-style-type: none"> <li>▪ considering other eventual <b>gross-to-net correction factors</b>, e.g., the free-rider effect</li> </ul>	Step 3 of the calculation process (section VIII.5)
	<ul style="list-style-type: none"> <li>▪ considering how to deal with <b>uncertainties</b> for annual ESD energy savings</li> </ul>	Section IV.1.1
	<ul style="list-style-type: none"> <li>▪ considering <b>saving lifetime within ESD period</b></li> </ul>	Step 4 of the calculation process (part IX-)
	<ul style="list-style-type: none"> <li>▪ considering special requirements for <b>early actions</b></li> </ul>	Part X-
<ul style="list-style-type: none"> <li>▪ considering whether conversion guidelines are needed to express energy savings from White Certificates schemes as ESD energy savings</li> </ul>	This will be addressed in specific case studies in WP 2 and WP8	

<b>3) data needs</b>	<ul style="list-style-type: none"> <li>▪ listing the data needed according to options considered during phase 2 (for each issue raised during phase 2)</li> </ul>	Same locations as for corresponding phase 2 issues
<b>4) data collection</b>	<ul style="list-style-type: none"> <li>▪ collecting data listed during phase 3, when available, or deeming default values, in order to define level 1 values</li> </ul>	for explanations about what are the levels of evaluation efforts, see IV.1
	<ul style="list-style-type: none"> <li>▪ considering data collection techniques to be used to define level 2 and/or 3 values, and defining how they can be harmonised in order to make results comparable and consistent</li> </ul>	Annex III
<b>5) differences between MS</b>	<ul style="list-style-type: none"> <li>▪ feedback from MS on data availability and current evaluation system</li> </ul>	
	<ul style="list-style-type: none"> <li>▪ assessment of different alternatives (considering available data, experience feedback and eventual differences between MS), especially in terms of evaluation costs → then go to phase 2 again if needed</li> </ul>	
<b>6) final decision on levels of evaluation efforts</b>	<ul style="list-style-type: none"> <li>▪ specifying three levels of evaluation efforts for each issue raised during phase 2, taking into account results of phases 3, 4 and 5 (after an iterative process)</li> </ul>	same locations as for corresponding phase 2 issues
	<ul style="list-style-type: none"> <li>▪ specifying requirements for the levels 2 and 3</li> </ul>	same locations as for corresponding phase 2 issues
<b>7) summarising (key points of the evaluation methods)</b>	<ul style="list-style-type: none"> <li>▪ listing key points of the evaluation methods, to highlight main issues to be addressed</li> </ul>	Section V.1
	<ul style="list-style-type: none"> <li>▪ completing templates to present the finalised evaluation method</li> </ul>	Part V-
	<ul style="list-style-type: none"> <li>▪ completing advised templates to collect data and report results while performing an evaluation using the method developed</li> </ul>	Annex I

Table 3 - advised phases to develop a bottom-up evaluation method and related issues

## IV- General approach for calculating energy savings

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This part presents the main principles of our methodology:

- a **progressive approach** based on **three levels of evaluation efforts**, where the MS have to comply with **minimum requirements** but are free (and induced) to go beyond these requirements, according to their own evaluation practice and objectives (section IV.1)
- addressing the quantification of energy savings by **breaking down the whole calculation process into four main steps**, in order to deal with the different issues raised one after the other, **making the calculation work easier to prepare** (section IV.2)

Then all the evaluation issues to be covered while developing a method are listed and organised in the frame proposed to present the evaluation methods set up using this methodology (see part V-). And the following parts (VI- to X-) provide explanations and/or advice for completing this frame.

### IV.1 Three levels of evaluation efforts

#### IV.1.1 Defining three levels of evaluation efforts to take account of data collection issues

ESD Annex IV highlights that **evaluation costs** are mostly due to **data collection issues**, which may be **different from one MS to another**. As the aim of the ESD concerning evaluation is to set up a cost-effective and harmonised evaluation system, the present methodology considers concrete possibilities of evaluation taking into account the related data collection issues.

Therefore, building an evaluation method will require to analyse what are the data needed, and considering their availability. This availability can be expressed through three cases:

- 1) data **already available** and/or "*already routinely provided*" (and for as many MS as possible)
- 2) data which could be available through "**well-known**"<sup>18</sup> data collection techniques
- 3) data which would require "**specific or unknown**"<sup>19</sup> data collection techniques

These cases define categories of data collection techniques. Annex III presents examples of data collection techniques, which may be considered defining evaluation methods.

Once data collection techniques are chosen, the resulting data used for calculating energy savings can also be qualified in three categories according to their origin:

- 1) EU-wide reference values

---

<sup>18</sup> "well-known" means here that these techniques were already successfully used in the past or currently (but only by some MS), that they could be used in all MS, and that their related costs could be easily assessed.

<sup>19</sup> "specific" means here that these collection techniques have to be adapted for each MS or even for each EEI programme. "unknown" means that these collection techniques are not currently used and/or were not experimented in the past, and/or that their related costs could not be easily assessed.

- 2) MS-specific (national) values (representative of a given MS)
- 3) measure-specific values (representative of a given EEI measure)

Then, three levels of evaluation efforts could be defined, in relation to these three categories of data. This approach with three levels of evaluation efforts is similar to these developed in many recent evaluation guidebooks<sup>20</sup>. This methodology adapts this approach to fit ESD needs. The relation between data collection techniques, main data used to assess results, and levels of evaluation efforts is illustrated in Figure 3 below.

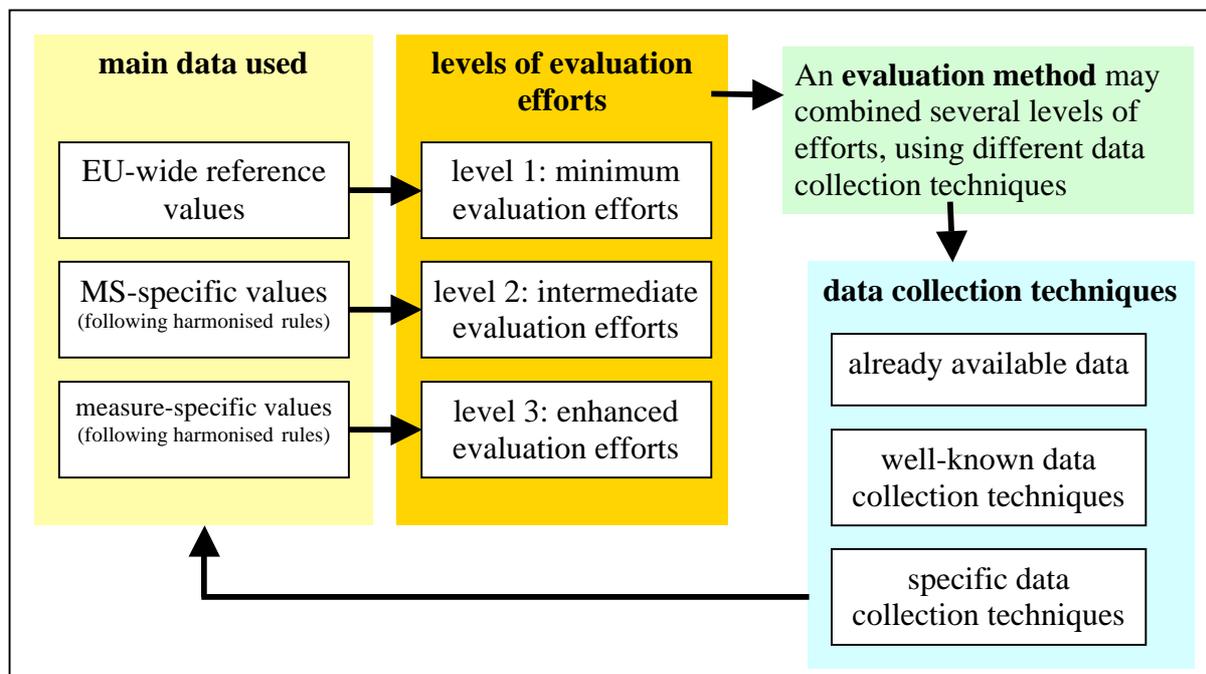


Figure 3 - level of evaluation efforts related to data collection techniques

Calculating energy savings requires a calculation formula or model based on several assumptions (e.g. defining a baseline), and using several parameters (e.g. duration of use, average load). Each of these parameters or assumptions may be defined according to the three levels of efforts. So **an evaluation method may combine different levels of efforts** within its calculation model (e.g. one parameter being level 1 and another being level 2, etc.).

One of the main tasks for developing an evaluation method will be to define the level 1 data needed and to specify requirements for level 2 and level 3 efforts. These common basic values and requirements aim at ensuring the quality and harmonisation of the evaluations and then of the reported energy savings figures (see also Table 5 below).

<b>Level 1: harmonised or default values</b>	<p>Level 1 data are to be the same for all MS, should be validated by the Commission, and then will be available for all MS. Such values have to be defined for as many parameters/assumptions as possible. These level 1 data may be of two types:</p> <ul style="list-style-type: none"> <li>- <b>harmonised values:</b> values really representative of all MS (e.g. some</li> </ul>
--	---

<sup>20</sup> For instance, the Danish evaluation guidebook for energy saving actions [SRCI 2003], the IEA evaluation guidebook for evaluating energy efficiency policy measures & DSM programmes [Vreuls 2005a pp.43-47], the 2006 IPCC guidelines for national greenhouses gas inventories [IPCC 2006 pp.1.7-1.8].

	<p>saving lifetimes, see Chapter IX-)</p> <ul style="list-style-type: none"> <li>- <b>default values:</b> values to be used when level 2 or 3 not possible/cost-effective, set at a conservative level to avoid any overestimation and to encourage level 2 and 3 efforts</li> </ul> <p>Main data sources for level 1 values are existing studies and statistics (see Annex IV). Moreover, default values may result from a <b>compromise</b> between members of the Committee, with final decision up to the Commission. Discussions to specify values may be fed by arguments from relevant stakeholders (e.g. manufacturers and consumers).</p> <p><b>Three cases</b> may occur according to available data:</p> <ul style="list-style-type: none"> <li>- European average value available: the corresponding default value may be based on this average value, affected by a security factor (e.g. 10%, 20%, 30%? + same % for all methods or % according to reliability of available data? In the development of concrete case applications within EMEEES task 4.2, 20% was used. This did not in all cases lead to conservative figures, as the pilot tests in WP 8 revealed, but the reason is rather a too wide range of end uses covered by one default value)</li> <li>- only a few data available: the corresponding default value may be based on the lowest<sup>21</sup> values, eventually affected by a security factor</li> <li>- no measured data available: the corresponding default value may be based on experts' words, and then the security factor has to be higher than these applied for both other cases (e.g., 75 % as used in the case application on energy audits).</li> </ul> <p><b>Harmonised or default values have to be defined for all required parameters for each new method. If this is not possible, it will have to be justified, and a method proposed for generating the data needed to define a value in the future.</b></p>
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<p><b>Level 2: MS-specific values</b></p>	<p>Level 2 and 3 values are values reported by the MS themselves. Therefore, in order to keep evaluations harmonised, these values have to be defined according to harmonised requirements and rules. Level 2 and 3 values may be either required by the Commission (e.g. if no level 1 value is possible) or voluntarily reported by MS, especially when level 1 values are default values, likely to lead to an underestimation of energy savings.</p> <p>MS-specific values have to be based on data representative at national scale. Corresponding possible data sources are national statistics, surveys, samples (then samples requirements are needed), registries.</p> <p>MS reporting national values should provide explanations/evidences for these values. <b>Such requirements have to be defined in the evaluation methods.</b></p>
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<sup>21</sup> Lowest means here leading to lower results in terms of energy savings, but may be highest values of an intermediate parameter if energy savings increase when this parameter decreases.

<b>Level 3: measure-specific values</b>	<p>The same first comment as for level 2 values applies.</p> <p>Measure-specific values are defined from data specific to the evaluated EEI measure. Corresponding possible data sources are monitoring systems, registries, surveys, measurements (then measurements requirements are needed).</p> <p>Besides this, the same requirements as for MS-specific values apply.</p>
---	---

**Table 4 – three levels of values resulting from three levels of evaluations efforts**

The three levels of evaluation efforts can also be related to the treatment of uncertainties:

<b>Level 1</b>	range of magnitude assessed with lowest and highest values available among MS
<b>Level 2</b>	sensitivity analysis: definition of both pessimistic and optimistic scenarios, according to variation ranges for each calculation parameter
<b>Level 3</b>	quantified uncertainties (confidence levels and intervals)

**Table 5 – three levels for treatment of uncertainties**

Selecting the most relevant evaluation effort depends on evaluation conditions such as data required for calculating energy savings and the accepted threshold for results uncertainties<sup>22</sup> (see more explanations in section IV.1.2 below). Besides, defining three levels of evaluation efforts is considered for each step of the calculation process (see the presentation of this process in the section IV.2, and then each step is detailed from Chapter VI- to IX-).

#### IV.1.2 How to choose the level of efforts

The main reason for defining three levels of evaluation efforts is to fit to the objective of “*cost-effectiveness of decreasing uncertainty*” (ESD Annex IV).

The idea is then to reach the best compromise between evaluation costs and accuracy, which mainly depends on what are the available and/or easy-to-access data. The calculation process (and formula) is thus broken down in steps and parameters (see sections IV.2 and VI.1), so that values can be defined for these parameters either on EU, MS or measure level, corresponding to three levels of evaluation efforts (see Figure 3).

Evaluation methods have to specify the details of these levels, for the particular EEI measure they address. General specifications for each key evaluation issue are proposed in Chapters VI- to IX-.

The Commission should then define whether a particular minimum level of efforts should be required. Main criteria for this choice are:

- what is the expected level of uncertainties for each level?
- is there a minimum required level of uncertainties so that energy savings can be accounted for?

<sup>22</sup> It is assumed that level 3 is more accurate than level 2, being itself more accurate than level 1.

- what is the limit threshold (in GWh or in % of global target) above which level 2 or 3 are required?

Level 1 values will be defined most of the time as default values, supposed to avoid overestimating the savings. So if MS develop level 2 or 3 values, these are expected to lead to higher energy savings. The three levels approach is indeed to induce a progressive improvement of the values used by the MS, rewarding their evaluation efforts.

At the same time, level 1 values and requirements for level 2 and level 3 are meant to ensure a minimum harmonisation and quality level of the evaluations and then of the energy savings figures.

Moreover, this methodology proposes to tackle cost-effectiveness of decreasing uncertainties by using formulas which include the factors affecting energy consumption (e.g. size of a fridge). It should then be specified to target in priority the most influencing parameters, for instance requiring level 3 values, while other parameters may be defined using level 1 or 2 values.

**Anyway, the proposed levels of efforts have not to be seen as three totally parallel alternatives. The approach is to combine the three levels, according to necessities and possibilities for each evaluation issue.** For instance, unitary gross annual energy consumption may be level 3 and saving lifetime level 1, especially if major uncertainties come from assessments of annual energy consumption.

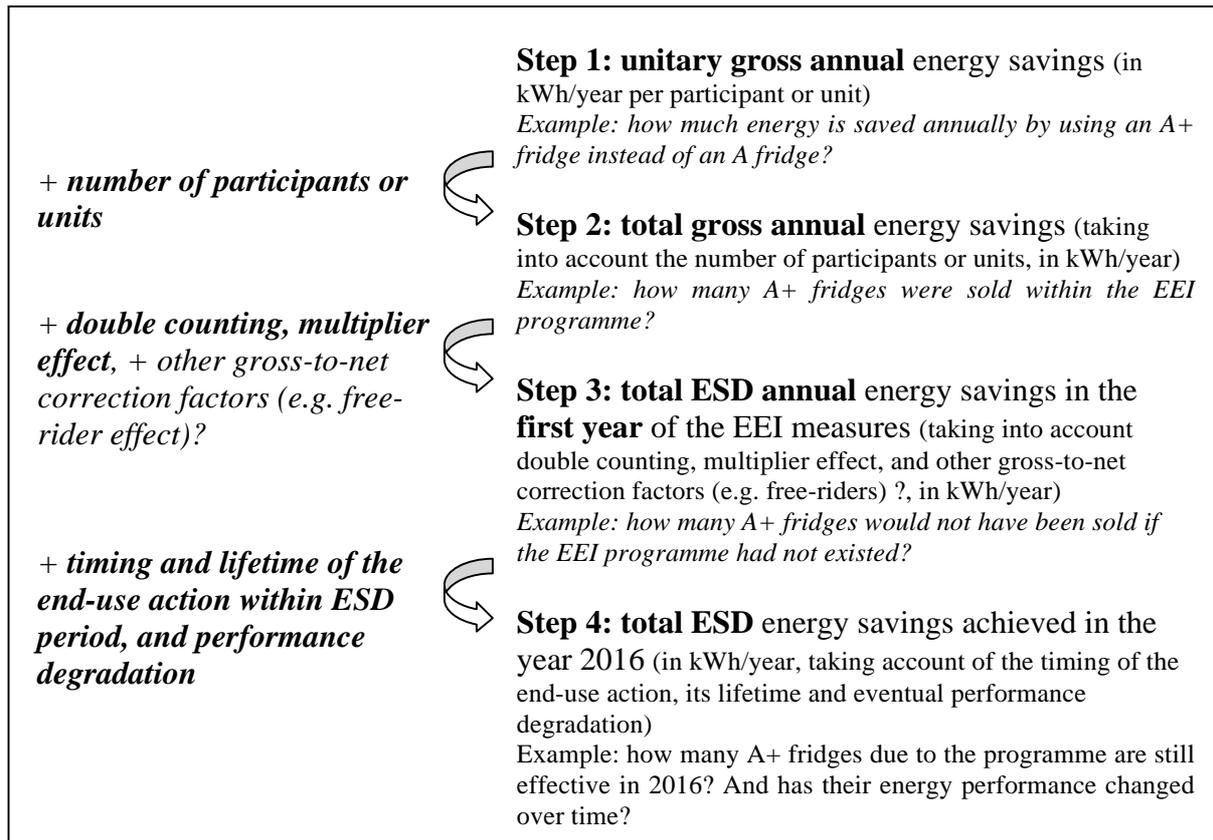
Finally, the Commission (and/or ESD art. 16 Committee) should decide whether the MS remain free to choose the evaluation efforts they want to apply or whether they should comply with given requirements. Here we recommend combining both views, by specifying minimum requirements related to the kind of measures and the part of the target the measures represent<sup>23</sup>, as well as for the reporting. Then MS are free to go beyond the minimum requirements to claim for higher energy savings. Regarding this, the Commission should consider how to provide support for MS which would have less experience in evaluating facilitating measures and particularly EEI programmes, and how to favour transfer of evaluation know-how between MS. This is particularly important to ensure that in the harmonised evaluation system, no MS is left behind.

## IV.2 A four steps calculation process

The calculation process may be divided in four steps:

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<sup>23</sup> We consider it is necessary to apply high-level requirements for EEI measures which would represent more than a certain threshold of the global target (for instance 10%). This threshold should be specified by the Commission and/or the ESD art.16 Committee.



**Figure 4 - a four steps calculation process**

It should be reminded that before going any further in evaluating an EEI measure, it should first be checked whether these measures can be accounted for the achievement of the ESD target (see the conditions on the sector targeted and the timing of the measure in the section I.3.2.1)

**Unitary** energy savings means energy savings resulting from a unitary end-use action. The unit of an end-use action may be:

- either a unit of energy-efficient equipment (e.g. a CFL or an appliance)
- or a participant or participating site (dwelling, building, company; e.g. a single family home being insulated or a company benefitting from an energy audit programme)

**Gross** energy savings refer to the point of view of final users, which means energy savings as observed by the final users taking advantage of an EEI measure. These energy savings take account of normalisation factors as defined in ESD calculation methods, as they affect the energy consumption, and so the amount of energy savings as perceived by the end-users.

**ESD** energy savings refer to the point of view of the implementation of the ESD as surveyed by the European Commission, which means taking account of gross-to-net correction factors. Two gross-to-net correction factors are explicitly mentioned in the ESD: double counting and the multiplier effect. Other considered gross-to-net correction factors are introduced here with a question mark to highlight that so far they are not mentioned explicitly in ESD. However it was decided to include them in the analysis done for the development of a concrete method (especially the free-rider effect), as the aim of EMEEES is to give to the Commission and ESD art.16 Committee a view of the issues to be addressed, as complete and pragmatic as possible (see also sections VIII.1 and VIII.5).

This methodology follows the principle of being as thorough as possible in the analysis, and as pragmatic as possible in the proposal for the concrete methods as the result of the analysis. It clearly remains up to the Commission and/or ESD art.16 Committee to decide, which correction factors should be applied in the ESD accountability for any of the methods developed for the harmonised monitoring system.

Each step is further explained and detailed in Chapters VI- to IX-:

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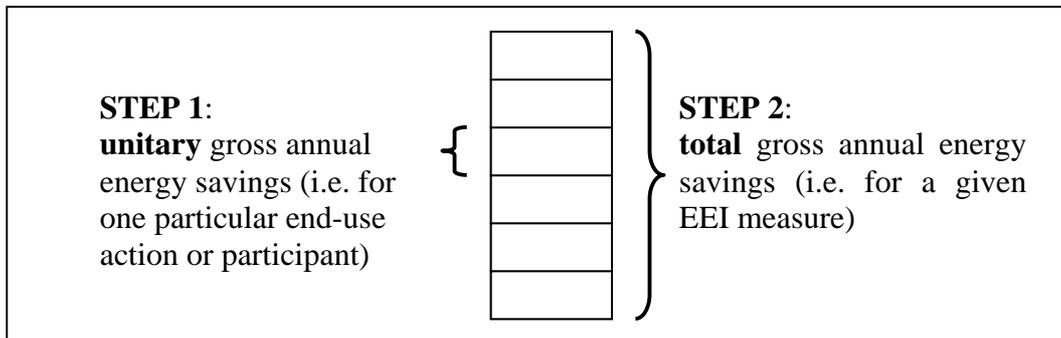
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Figure 5, Figure 5, and Figure 7 hereafter represent what are the energy savings for each step.



**Figure 5 – representing unitary and total gross annual energy savings**

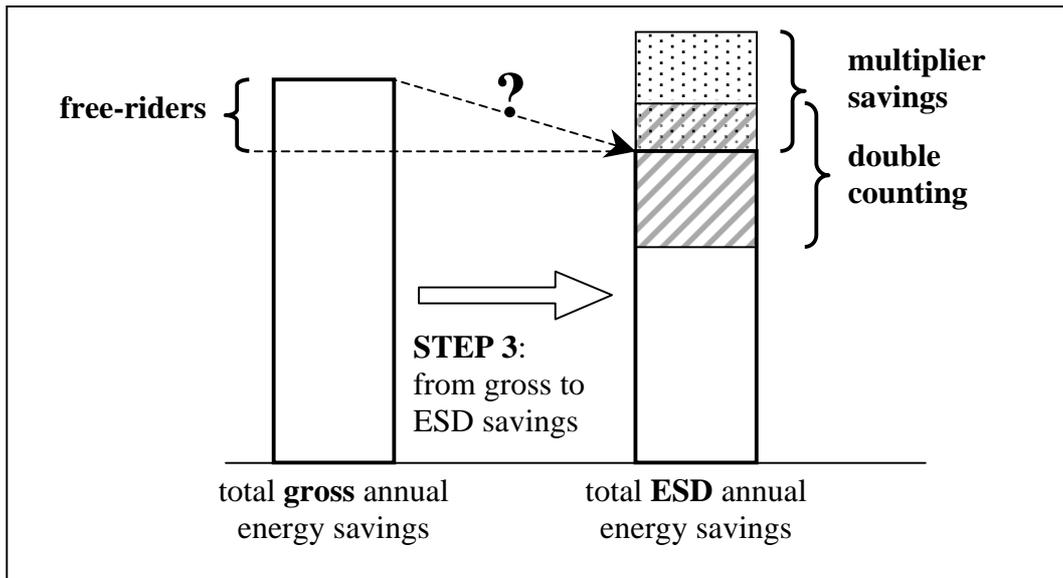


Figure 6 – representing gross and ESD energy savings

The free-rider effect was included in Figure 6 with a question mark, as it is not explicitly mentioned in ESD. The Commission and/or the Art. 16 Committee should specify whether to take it into account (see also section VIII.5).

Also in Figure 6, there is an overlap between the double counting and the multiplier savings, because double counting may also apply for multiplier savings.

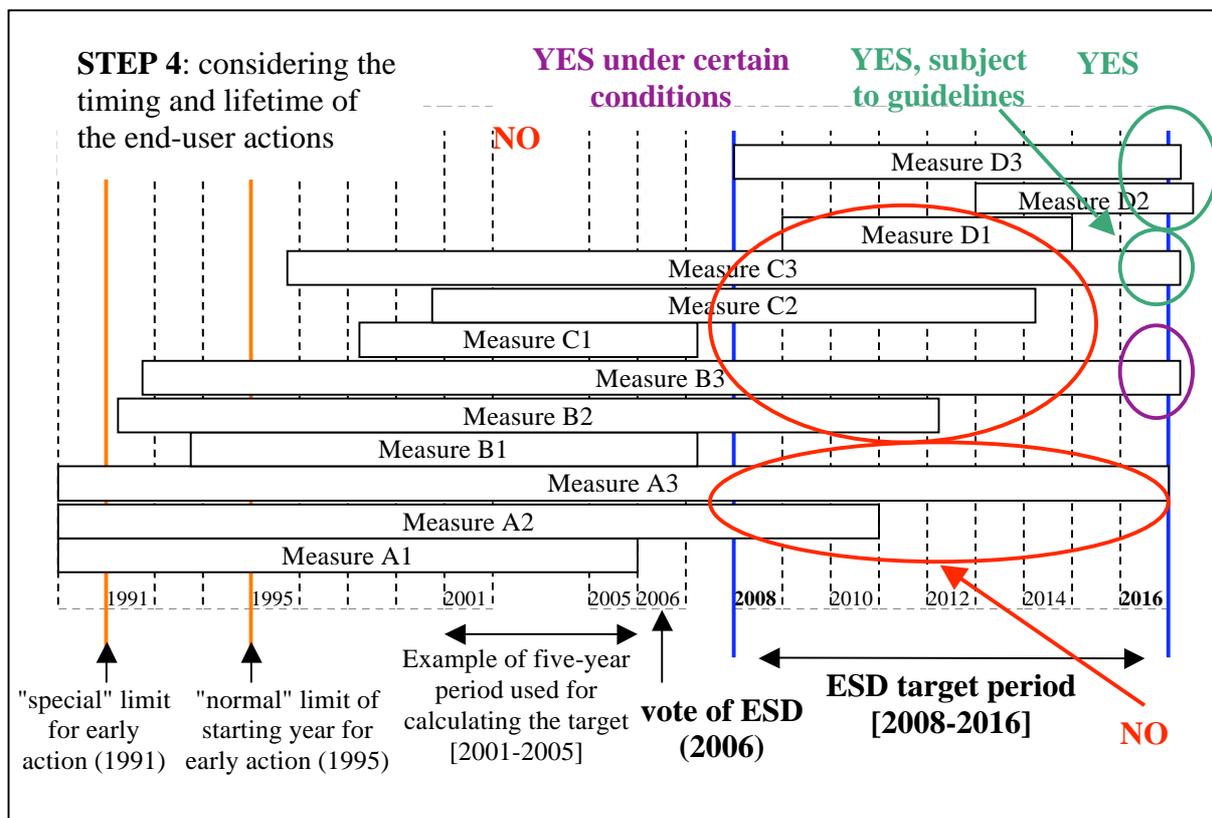


Figure 7 – considering the timing of the EEI measures and their results

Figure 7 highlights that there should be a preliminary step before going further in the evaluation of any EEI measure to be reported for ESD accounting. Indeed it should be checked if the measure complies a priori with the timing requirements:

1. the end-use actions are to **be still effective in 2016**: this could be checked with the default or harmonised values of saving lifetimes already available (see also part IX-)
2. the end-use actions were implemented **from 2008 on**, or from 1995 on (and under special conditions from 1991 on) (see also part X- about **early actions**)

Table 6 below summarises the comments about the measures represented in Figure 7.

measures	energy savings accounted for	comments
A1	NO	measures initiated before 1991
A2		
A3		
B1	NO	"special" early measure initiated after 1991 but not achieving savings after 2008
B2	NO	"special" early measure initiated after 1991, but not achieving savings in 2016
B3	YES, under certain conditions	"special" early measure initiated after 1991, achieving savings in 2016
C1	NO	early measure initiated after 1995 but not achieving savings after 2008
C2	NO	early measure initiated after 1995, but not achieving savings in 2016
C3	YES, subject to guidelines provided by the Commission	early measure initiated after 1995, achieving savings in 2016
D1	NO	measure initiated from 2008, but not achieving savings in 2016
D2	YES	measure initiated from 2008, achieving savings in 2016
D3	YES	measure initiated from 2008, achieving savings in 2016

**Table 6 – considering the timing of the measures represented in Figure 7**

Even if the results which finally matter are these achieved in 2016, it may also be necessary to consider the results achieved in a particular year of the ESD period (2008-2016), especially because “each Member State shall establish an **intermediate national indicative energy savings target** for the third year of application of this Directive, and provide an overview of its strategy for the achievement of the intermediate and overall targets.” (ESD article 4(2)).

To keep Figure 7 simple, the EEI measures were represented as achieving the same amount of energy savings during their whole lifetime. In practice, the energy savings may decrease over time, due to performance degradation (see also part IX-).

## V- General frame for presenting a harmonised bottom-up evaluation method

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This part proposes a general frame for presenting the bottom-up evaluation methods developed within EMEEES tasks 4.2 and 4.3. This frame mainly aims at listing the issues to be covered while setting up a method, and at organising them in a standard way to ensure consistency between methods.

For each point, reference is made to the section where explanations and/or advice are provided.

### V.1 Summary

#### V.1.1 Title of the method

#### V.1.2 Type of EEI activities covered

End-use action	
▪ Sector	
▪ Energy end-use	
▪ Efficient solution	
Facilitating measure	
▪ Types of Facilitating measures	

(See section I.3.2.1)

#### V.1.3 Detailed definition of EEI activities covered

Detailed explicit definitions of the EEI measures covered (if the information that can be presented in the above table is not considered sufficient or clear enough).

#### V.1.4 General specifications

- conditions for energy savings to be eligible (e.g. compliance with a quality charter or minimum level of energy performance)
- conditions requiring level 2 and 3 efforts for a particular point or for the whole evaluation (e.g. special conditions on a parameter responsible of major uncertainties)

#### V.1.5 Formula for unitary gross annual energy savings

(see VI.1)

**V.1.6 Indicative default value for annual unitary energy savings** (when relevant)

(deemed savings or range of magnitude [min; max], in kWh/year/action)

**V.1.7 Formula for total ESD annual energy savings**

(see VIII.1)

**V.1.8 Indicative default value for energy savings lifetime**

(see IX.)

**V.1.9 Main data to collect (for level 2 and 3 evaluation efforts)**

Data to be collected	Examples of corresponding data sources
Data 1	(statistics listed in Odyssee, equipments sales data,
Data 2	surveys, etc.)
etc.	

**V.2 Step 1: unitary gross annual energy savings**

**V.2.1 Step 1.1: general formula / calculation model** (for unitary gross annual energy savings)

Detailed Equation 1 or Equation 2, including list of normalisation factors to take into account.

(See section VI.1)

**V.2.2 Step 1.2: baseline**

- before/after or current market inefficient?

level 1	default baseline: <i>(when possible)</i>
level 2	guidelines: <i>(how to define a MS-specific baseline)</i> data required:
level 3	guidelines: <i>(how to define a measure-specific baseline)</i> data required:

(See section VI.2)

**V.2.3 Step 1.3: requirements for normalisation factors**

Reference to appendix for normalisation factors already addressed in existing methods.

▪ (new) normalisation factor 1	
level 1	default coefficient: <i>(when possible)</i>
level 2	guidelines: <i>(how to include the normalisation factor in calculation model or how to calculate a level 2 coefficient of normalisation)</i> data required:
level 3	guidelines: data required:

▪ (new) normalisation factor 2	
level 1	default coefficient:
level 2	guidelines: data required:
level 3	guidelines: data required:

(See section VI.3)

#### V.2.4 Step 1.4 Specifying the calculation method and its three related levels

level 1	(only if unit = equipment: mix of deemed and ex-post ; deemed savings)
level 2	(direct measurement ; billing analysis ; mix of deemed and ex-post ; deemed savings)
level 3	(direct measurement ; billing analysis ; enhanced engineering estimates ; mix of deemed and ex-post ; deemed savings)

(See section VI.4)

#### V.2.5 Conversion factors (when relevant)

(See section VI.5)

#### V.2.6 Considering the direct rebound effect

This section only applies for lighting, cars, and for measures related to the internal temperature of dwellings.

(See section VI.6)

#### V.2.7 From EMEEES tasks 4.2 to 4.3: defining values and requirements

(See section IV.1.1 about the three levels of values)

##### V.2.7.1 Default values for energy consumption and/or related parameters

This part depends on whether Equation 1 or Equation 2 is used:

- for both cases : reminder of what are the parameters, which can affect the evaluated energy consumption
- for Equation 1 : if possible at all: indicative benchmarks for the corresponding energy end-use or end-user category (energy consumption “before and “after” the EEI measure and/or energy savings per participant: European average, min and max)
- for Equation 2: default values for each parameter included in the calculation model + min and max (default range of variations)

Benchmarks and default values may be either directly values for the corresponding parameters/coefficients, or values of energy consumption related to parameters.

*Example:*

For cold appliances, the baseline, compared to which the energy saved by an energy-efficient appliance shall be calculated, can be defined as a value of the energy efficiency index from the EU energy label for cold appliances:

Cold appliances	
Class	Energy efficiency index
A++	< 30%
A+	30% - 42%
A	42% - 55%
B	55% - 75%
C	75% - 90%
D	90% - 100%
E	100% - 110%
F	110% - 125%
G	> 125%

The baseline could either be an average EEI on the market (e.g., 53%), or in case of a rebate programme for A++ appliances, the average EEI of the appliances of classes A+ to D on the market (E to F were already phased out anyway by the minimum energy performance standard). Then the average annual energy consumption of the A++ appliances and the rest of the market need to be calculated. The difference of both will be the unitary gross annual energy savings for this type of end-use action.

#### V.2.7.2 Requirements to define level 2 and level 3 values

Conditions for which level 2 or 3 values are required (e.g. special thresholds).

Reference to appendix for general requirements when necessary (e.g. for sampling, measurement, etc.).

Other specific requirements (e.g. specific data, skills, etc. required), detailed by parameters when necessary.

## **V.3 Step 2: total gross annual energy savings**

### **V.3.1 Step 2.1: formula for summing up the number of actions**

- unit = specific type of end-user EEI action or participant?

(See section VII.1)

### **V.3.2 Step 2.2: requirements and methods for accounting for the number of actions**

The number of actions always has to be defined for the evaluated EEI measure (level 3 effort).  
The method(s) proposed for monitoring the number of actions shall be described here.

(See sections VII.2 and VII.3)

## **V.4 Step 3: total ESD annual energy savings**

### **V.4.1 Step 3.1: formula for ESD savings**

See section VIII.1.

### **V.4.2 Step 3.2: requirements for double counting**

See section VIII.2.

### **V.4.3 Step 3.3: requirements for technical interactions**

See section VIII.3.

### **V.4.4 Step 3.4: requirements for multiplier energy savings**

See section VIII.4.

### **V.4.5 Step 3.5: Requirements for the free-rider effect**

See section VIII.5.

## V.5 Step 4: total ESD energy savings for year “i”

### V.5.1 Requirements for the energy saving lifetime

See chapter IX- and Annex VI (this will be further completed, using CWA results)

## V.6 Special requirements for ‘early action’

See chapter X-.

## V.7 Reminder to treat uncertainties

Any value/result should be presented with at least a range of magnitude (min-max).

For each parameter included in the calculation model, it should be considered if uncertainties can be addressed through:

- level 1 effort: range of magnitude (min-max)
- level 2 effort: sensitivity analysis (pessimistic/optimistic scenarios)
- level 3 effort: quantified uncertainties (confidence intervals)

The final result should then be associated to a global uncertainty:

- either level 1 (range of magnitude), if all parameters have a level 1 uncertainty
- or level 3 (quantified uncertainties), if all parameters have a level 3 uncertainty
- or level 2 (sensitivity analysis) in all other cases

Moreover, the qualification of data sources used in Odyssee project could be used when relevant. This qualification is presented in the following table.

Category of source	Details
A	Official statistics: official statistics/surveys (national statistical office, Eurostat/AIE, Ministries statistics), model estimations used as official statistics, data “stamped” by Ministries
B	Surveys/ modelling estimates: consulting, research centres, universities, industrial associations
C	Estimations made by national teams

Quality grades for data
1 Good: low uncertainty
2 Medium: medium uncertainty
3 Poor: large uncertainty

The idea here is to consider what would be possible. Then, going further in tasks 4.2 and 4.3, it will be clarified what is pragmatic or "realistic". Anyway, EMEEES results will only be indicative. Then the Art.16 Committee and/or the Commission will decide what should be recommended and/or required, and what remains only advice.

## **V.8 Appendix I: justifications and sources**

Following the same frame as the description of the method, and providing justifications and sources for each choice and default value.

## **V.9 Other appendix**

Reference to existing requirements from other methods (or general requirements for all methods).

## VI- Step 1: unitary gross annual energy savings

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Reminder of the four steps calculation process (see section IV.2):

**Preparatory step:** checking whether the evaluated EEI measures can be accounted for the achievement of the ESD target (see the **conditions** on the sector targeted and the timing of the measure in the section I.3.2.1)

⇒ **Step 1: unitary gross annual energy savings** (in kWh/year/participant or unit)

**Step 2: total gross annual energy savings** (in kWh/year)

**Step 3: total ESD annual energy savings** in the first year (in kWh/year)

**Step 4: total ESD annual energy savings achieved in 2016** (in kWh)

### ► Contents of step 1:

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Step 1 focuses on unitary gross annual energy savings. Its objective is therefore to define calculation methods, which serve to calculate the unitary gross annual energy savings and are mainly related to the type of end-use actions considered.

A calculation method is actually composed of three main elements:

- a calculation model of formula
- data collection techniques (used to collect the data needed to feed the calculation model)
- a set of reference or default deemed values (to be used when ex-post data cannot be collected or are not cost-effective to collect)

## VI.1 Step 1.1: formula for unitary gross annual energy savings: two approaches according to data availability

Two main approaches may be used to calculate energy savings, depending on whether energy consumption data are directly available. This view refers to the distinction made within ESD Annex IV (2), “*between methods measuring energy savings and methods estimating energy savings.*”

- 1) when energy consumption data are **directly available**, at least for a sample of participants (therefore always corresponding to a level 3 of evaluation efforts), the general calculation formula is:

$$\text{unitary gross annual energy savings} = ([\text{annual energy consumption}]_0 - [\text{annual energy consumption}]_1) \text{ +/- normalisation factors}$$

Equation 1

Annual energy consumptions for situations before (0) and after (1) implementation of the end-use action are directly known:

- either from energy bills or meter reading
- or from energy end-use measurement

- 2) when energy consumption data are **not directly available**, the formula is broken down in **intermediate parameters** (for which data are easier to access/assess) to calculate energy consumption.

For instance, energy consumptions may be broken down in two terms, load and duration of use:

$$\text{unitary gross annual energy savings} = ([P*ALF*D]_0 - [P*ALF*D]_1) \text{ +/- normalisation factors}$$

Equation 2

where:

- 0 and 1 : situation respectively before and after implementation of an end-use action
- P : average nameplate power
- ALF : average load factor
- D : average annual duration of use

Concerning normalisation factors, in case some are necessary, they may be applied in practice at the level of the parameter they actually affect (more than at the level of the whole equation).

According to the type of end-use action, energy consumption may be broken down in other sets of parameters (e.g. average consumption per cycle and number of cycles for washing machines). And as for energy consumption, these parameters may be related to additional parameters (e.g. number of persons per dwelling for the number of cycles). Each of these parameters may be defined either at level 1, 2 or 3 of evaluation efforts (see section IV.1).

The evaluation method has to specify this formula, setting a “definitive” list of parameters to be taken into account. Definitive means here that the parameters to be considered have to be the same for all MS, in order the evaluation method to be harmonised. However, the evaluation method may be reviewed by the Commission, especially if new elements of decision are available or if feedback from MS provides relevant arguments for changes. But if changes occur, they then apply for all MS.

The ESD definition of energy savings (ESD article 3(d)) is “*an amount of saved energy determined by measuring and/or estimating consumption before and after implementation of one or more energy efficiency improvement measures, whilst ensuring normalisation for external conditions that affect energy consumption.*”

Consequently, whatever the kind of formula (general or broken down), two main issues are to be considered:

- how to define the before and after situations (baseline, see section VI.2 below)
- what are the normalisation factors to be taken into account, so that before and after situations can be compared under normalised (similar) conditions (see section VI.3)

## VI.2 Step 1.2 baseline issues

### VI.2.1 Step 1.2.a: “all” or “additional” savings

The ESD definition of energy savings states the baseline is the situation before implementing an EEI measure. This “before” situation may be interpreted:

- either as “**before**” **annual energy consumption**, i.e. energy consumption of the equipment or site in the year before the implementation of the EEI measure
- or as “**before**” **decision**, i.e. whether implementing an EEI action would have occurred or not if the EEI measure had not existed (and so the “before situation” is the corresponding energy consumption with the equipment / organisation / behaviour which is assumed to have been used without the EEI measure)

As explained in section II.3.2, these two options correspond respectively to “all” and “additional” savings.

If the objective is to evaluate all energy savings, the guiding question will be:

*What would have happened if all equipment had stayed at the same energy efficiency level as before? (“before-after” situation)*

In this case, there are two options for the situation before the EEI measure:

A. There is a real situation ‘before’, and this can be taken and the energy use can be measured or estimated; e.g. for the renovation of a building;

B. There is no situation before, so one has to create a reference situation (e.g., for a new building).

If the objective is to evaluate additional energy savings as an impact of (combinations of) individual measures, the guiding question will be:

*What would have happened in the absence of the EEI measure that is to be evaluated? (“with and without” situation)*

In this case, one always has to create a reference situation.

Moreover, three general cases can be distinguished for the reference situation (see more details in section VI.2.2):

- Case 1: replacement of existing equipment
  - o Baseline = Before action situation (for all energy savings)
  - o Baseline = Without measure situation (for additional savings)
- Case 2: energy efficiency retrofit (add-on energy efficiency investment or management, without replacement of existing equipment or building)
  - o Baseline = Before action situation (both for all and additional energy savings)
- Case 3: new building or appliance: the before situation does not exist and a reference has to be created (for all as well as for additional savings).
  - o Baseline = A reference situation (both for all and additional energy savings)

There are several options to create a reference situation (when it can not be measured or directly monitored):

1. The average annual energy consumption of the existing stock;
2. The average annual energy consumption of the not energy-efficient equipment on the existing market;
3. The legal minimum energy performance;
4. The average annual energy consumption of the Best Available Technology (BAT) (only for technology procurement and similar measures that aim to bring technologies better than BAT to the market).

The EMEEES case applications showed that existing stock and existing market are often used as the reference situation for level 2 evaluations.

Table 7 presents, which additional factors need to be taken into account for the calculation in either case (“all” and “additional”) for the EMEEES bottom-up methods. In the second column, we included ‘before EEI measure’, as we assume that a cost-effective bottom-up data collection will in most cases be done in relation with an EEI measure. The calculation could also be done for all changes that can be measured and monitored.

**Table 7 - Choices for calculating energy savings and EMEEES bottom-up methods.**

<b>EMEEES method</b>	<b>Bottom-up</b>	<b>Choices for calculating all energy savings (before-after situation)</b>	<b>Choices for calculating additional energy savings only (with-without situation)</b>
1) direct measurement		Baseline = the situation before the EEI measure; taking account of multiplier effects, but not correcting for free-rider and rebound effects	Baseline depending on the end-use action as described above and below (in theory; in practice, often the situation before the EEI measure is taken); taking account of multiplier, and correcting for free-rider effects and rebound effects if these exist
2) billing analysis		May be possible if unitary	Use control group to

<b>EMEEES method</b>	<b>Bottom-up</b>	<b>Choices for calculating all energy savings (before-after situation)</b>	<b>Choices for calculating additional energy savings only (with-without situation)</b>
		energy savings are large and lead to absolute reduction of energy consumption of the participant group. Then, savings are estimated as being just the absolute reduction of energy consumption of the participant group (options 2 a or b, cf. Table 8).	calculate baseline development of energy consumption for comparison with actual development of participant group (option 2 c, cf. Table 8); or perform econometric or discrete choice modelling (option 2 d, cf. Table 8)
3) enhanced engineering estimate		Baseline = the situation before the EEI measure; taking account of multiplier effects, but not correcting for free-rider and rebound effects	Baseline depending on the end-use action as described above and below (in theory; in practice, often the situation before the EEI measure is taken); taking account of multiplier, and correcting for free-rider and rebound effects if these exist
4) mix of ex-ante and ex-post		Baseline = the situation before the EEI measure; taking account of multiplier effects, but not correcting for free-rider and rebound effects	Baseline depending on the end-use action as described above and below ; taking account of multiplier, and correcting for free-rider and rebound effects if these exist
5) deemed savings		Baseline = the situation before the EEI measure; taking account of multiplier effects, but not correcting for free-rider and rebound effects	Baseline depending on the end-use action as described above and below ; taking account of multiplier, and correcting for free-rider and rebound effects if these exist

### VI.2.2 Three main cases when defining baselines

This section provides more details about the three cases defined above. The definition of these three main cases was a result of the feedback loop. The general principles for baselines were not defined in a so clear and concrete way initially. This result was possible thanks to the feedback from the case applications (EMEEES task 4.2) and the discussions in the national EMEEES workshops (EMEEES WP9) and EDMC meetings.

## → Case 1: replacement

Case 1 corresponds to an equipment (e.g. appliances, lighting) replaced by a more energy-efficient one. The “all” savings baseline is therefore the energy consumption of the replaced equipment (when known, i.e. for level 3 evaluations) or the average consumption of the stock (for level 1 or 2 evaluations). To account for “additional” savings, it is assumed that the equipment would have been replaced anyway (normal turnover). The proposed baseline is then the energy consumption of the equipment which would have been bought without the measure, assumed to be the average of the “inefficient” market<sup>24</sup>. Both baselines are summarised in Figure 8.

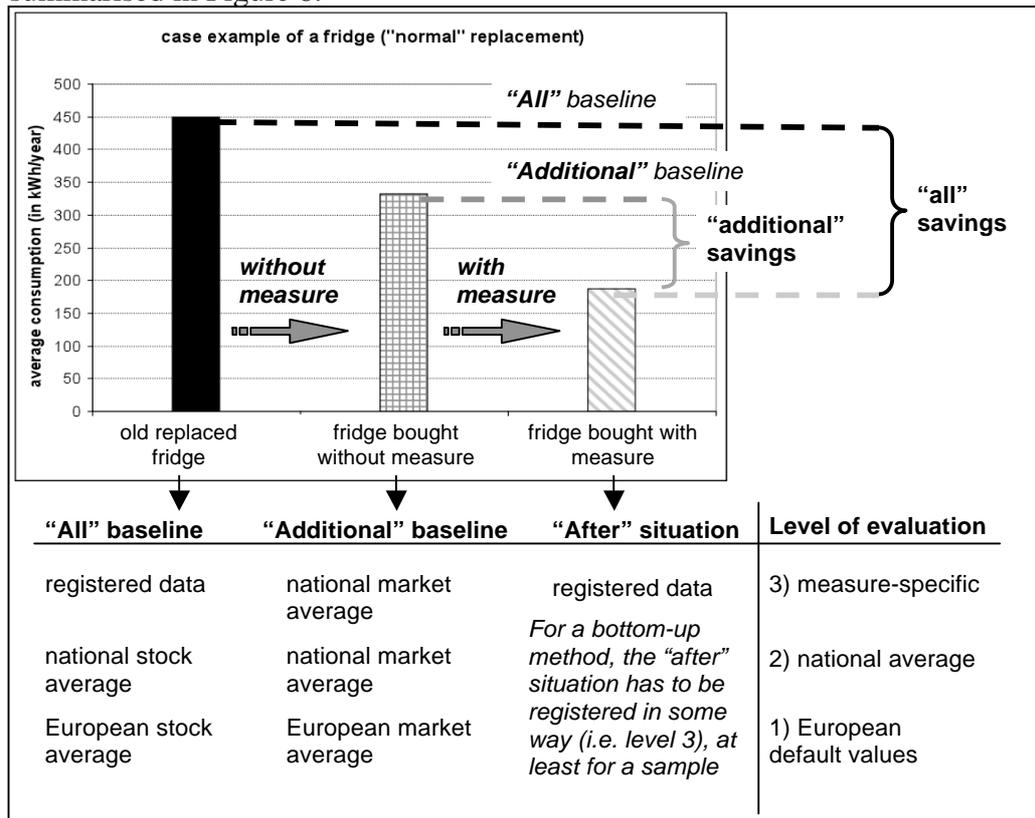


Figure 8 - Proposed baselines for case 1 (replacement).

Moreover, it may occur that the replacement is not normal but anticipated. For such situations, “all” and “additional” baselines will be the same, if a level 3 evaluation can prove that the replacement was anticipated due to the evaluated measure (e.g. an improved energy management).

## → Case 2: retrofit

Case 2 corresponds to a retrofit energy efficiency investment or action made without replacing existing equipment or buildings. Retrofitting may be technical (e.g. wall insulation, variable speed drives), organisational (e.g. improved energy management) or behavioural (e.g. eco-driving) changes. Here the proposed baseline is the same for both, “all” and “additional” savings, because it would have prevailed also without the evaluated measure. The baseline is therefore the energy consumption before the action, either defined through registered data (level 3), national statistics (level 2) or European default values (level 1).

<sup>24</sup> The “inefficient” market is here the market less the efficient models promoted by the measure. Consequently the share of these efficient models which would have been bought anyway represents the free-rider effect.

**→ Case 3: new building or equipment**

For case 3, no real “before” situation exists. It is therefore necessary to define a “virtual” baseline. Due to very different action lifetimes, the cases of buildings and equipments have to be distinguished. The project treated the case of new buildings<sup>25</sup>. The proposed baseline is the energy consumption level required in the first (but not earlier than 1991<sup>26</sup>) building code in force in each country. It is assumed that this first building code reflects a state of market conformity and therefore no savings can be attributed to this. It is also assumed that every increase in the energy efficiency of new buildings above the baseline is due to energy efficiency measures<sup>27</sup>. So both baselines, “all” and “additional” are the same in this case.

**VI.2.3 Updating baselines**

So far we considered the baseline for a given year (e.g. 2008). But actions are implemented in different years. Shall the baseline be the same for actions started for example in 2008 and in 2012? This issue applies for level 1 and 2 evaluations to specify how frequently shall be updated the European default values and national statistics. It does not apply for level 3 evaluations where data are registered when actions are done.

The update frequency is then a trade-off between taking account of turnovers, stock or market changes speed on the one hand, and limiting monitoring costs on the other hand. Harmonised rules for each baseline case are currently under discussion in the EDMC meetings.

**VI.2.4 Step 1.2.b: specifying three levels of efforts for defining the baseline**

Before specifying the three levels of efforts, any new evaluation method has to indicate what is the alternative for the baseline (as presented in section VI.2.1) to be used for the given type of measure treated.

**→ level 1: baseline based on European references, statistics or default values**

Level 1 baselines are defined in priority using European references, such as European Directives for energy labels, energy performance of buildings, etc.

Level 1 baselines have to take account of European averages (when available), in order to define a realistic but conservative baseline, which can apply for all MS. In restricted cases (e.g., for comparing building codes), the baseline could also be defined by an extrapolation of the past trend of the average of the “worst practice” thirteen Member States, meaning the thirteen EU Member States with the weakest requirements, i.e., the highest allowed kWh/m<sup>2</sup> per year<sup>28</sup>.

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<sup>25</sup> New equipments (e.g. brown goods) were not considered a priority and may be addressed in a latter phase of ESD implementation.

<sup>26</sup> 1991 is the limit of implementation year for “early” actions which may be reported for the ESD if they are still effective in 2016 (ESD Annex I).

<sup>27</sup> See for example (Nässén et al., 2008).

<sup>28</sup> This is to deal with the cases where there is not an EU-wide existing and accepted reference. This last comment is just indicative, and will be further discussed in task 4.2 when necessary

All methods developed within tasks 4.2 and 4.3 have to include with priority a level 1 unitary gross annual energy saving compared to the baseline; or, if that is not feasible, a level 1 baseline, unless this appears not to be feasible either. In this latter case, MS will be required to define a level 2 unitary gross annual energy saving compared to the national baseline, or a level 2 baseline when reporting such measures.

→ **level 2:** baseline based on national statistics or samples

When a MS is required to or wishes to use its own baseline, it has to use the alternative for the baseline indicated in the corresponding evaluation method or to argue for its choice if the reported measure is not addressed yet by an existing evaluation method.

Then MS have to report what national data or other evidences they use to define their baseline. The evaluation method has to specify the corresponding requirements, especially what data are needed and what conditions have to be fulfilled, so that the level 2 baseline can be considered both harmonised and more accurate than the level 1 baseline.

→ **level 3:** baseline based on measure-specific data and/or samples

When a MS is required to or wishes to use a level 3 baseline, it has to use the alternative method for defining the baseline indicated in the corresponding evaluation method or to argue for its choice, if the reported measure is not addressed yet by an existing evaluation method.

Then MS have to report what measure-specific data or other evidences they use to define level 3 baselines. The evaluation method has to specify the corresponding requirements, especially what data are needed and what conditions have to be fulfilled, so that level 3 baseline can be considered both harmonised and more accurate than level 2 and/or level 1 baseline.

### **VI.3 Step 1.3: normalisation factors**

Calculation methods have to define, which normalisation factors have to be taken into account among these listed in ESD Annex IV(1.2):

- (a) weather conditions, such as degree days;
- (b) occupancy levels;
- (c) opening or operation hours for non-domestic buildings;
- (d) installed equipment intensity (plant throughput); product mix;
- (e) plant throughput, level of production, volume or added value, including changes in GDP level;
- (f) schedules for installation and vehicles;
- (g) relationship with other units

Selecting normalisation factors should be based on reviewing available knowledge and experience feedback about the energy end-use targeted and the corresponding efficient solution. Physical reasons and/or measured data should be used as evidences to discuss whether a normalisation factor is to be considered. Examples of information sources which may be used for that are presented in Annex IV.

When the same normalisation factors are used within several calculation methods, **it has to be ensured normalisation factors are applied the same way whatever the methods**. So for any new method, it should be checked whether the corresponding normalisation factors were already addressed in an existing method. This also confirms that new methods will be easier to develop once methods addressing similar issues are set up.

Normalisation methods have also to be the same for bottom-up and for top-down methods.

Calculation methods have then to define how to apply the selected factors. Especially, it has to be highlighted whether additional data are required, and how to collect them. If these data appear not to be available for all MS, three levels of efforts should be proposed (default EU values – rarely possible; national values; measure-specific values):

<b>Level 1</b>	According to the normalisation factors, level 1 may not be possible (e.g. for weather conditions). When possible, level 1 corresponds to default coefficients based on existing studies or experts' words. It may include a security factor to avoid overestimations.
<b>Level 2</b>	Normalisations applied using national data (e.g. average national heating degree days).
<b>Level 3</b>	Normalisations applied using measure-specific data (e.g. local heating degree days or level of production of a single big customer)

#### **VI.4 Step 1.4: categories of calculation methods according to main data sources**

ESD annex IV (2) makes a distinction “*between methods measuring energy savings and methods estimating energy savings*”.

Main data sources are then listed:

- for methods based on measurements (Annex IV (2.1)):
  - bills from distribution companies or retailers
  - energy sales data
  - equipment and appliance sales data
  - end-use load data
- for methods based on estimates (Annex IV (2.1)):
  - o simple engineering estimated data (without on-field inspection)
  - o enhanced engineering estimated data (with on-field inspection)

Categories of calculation methods may be defined in relation to these data sources. Table 8 below describes for each main category, what is the preferred formula (either Equation 1, or Equation 2 or both), and whether methods consider participants or equipments as unit of action. Table 8 gives also details about what are possible options of additional treatment, and then special analysis and/or tools required.

Besides, Table 8 refers to [IPMVP 2002] when a category is similar to a M&V option proposed by IPMVP, as experts may be already accustomed to use IPMVP options<sup>29</sup>.

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<sup>29</sup> and as IPVMP is one of the references quoted in ESD Annex IV.

→ methods mainly based on measurements	Category of method	Main input data (cf. Annex IV(2))	Type of formula	Options	additional analysis / tools required	Characterisation of costs and data collection
	<b>1) direct measurement</b>	end-use load data	Equation 1 <i>unit = participant</i> [≈ IPMVP option B]	a) without any normalisation		can be costly; usually restricted to large buildings or sites
				b) with normalisations	analysis of required normalisation factors	
	<b>2) billing analysis</b>	energy bills or energy sales data	Equation 1 <i>unit = participant</i> [≈ IPMVP option C]	a) without any normalisation	to be allowed only if savings > 10 %	can be very costly to collect and analyse, particularly d); may be the only way of evaluation for information campaigns
b) with normalisations				analysis of required normalisation factors		
c) with control group comparison				forming control groups		
d) other billing analysis				econometric or discrete choice modelling		
<b>3) enhanced engineering estimates</b> (e.g. calibrated simulation)	energy bills and/or end-use metering and/or equipment/building data from inspection	Equation 1 or 2 <i>unit = participant or equipment</i> [≈ IPMVP option D]	variable level of details	simulation tool calibrated with billing or metering data	can be costly; however, if an energy audit is done anyway, small extra cost of monitoring results	

methods mainly based on estimates ↙	<b>4) mixed deemed and ex-post estimate</b>	engineering estimates and measure-specific data (e.g., from equipment and appliance sales data, inspection of samples, monitoring of equipment purchased by participants)	Equation 1 or 2 <i>unit = equipment</i> [≈ <i>IPMVP option D</i> ]	combinations of reference values and measure-specific values	analysis of parameters to be included in calculations ; definition of reference ex-ante values for some of these parameters	costs depend on level of accuracy and gross-to-net correction required; monitoring usually straightforward
	<b>5) deemed savings</b>	engineering estimates or sample measurements (e.g., from equipment and appliance sales data, inspection of samples before implementation of the facilitating measure)	Equation 1 or 2 <i>unit = equipment</i> [≈ <i>white certificates</i> <sup>30</sup> ]	method 5) is actually an option of method 4) (all ex-ante)	analysis of parameters to be included in calculations ; definition of reference ex-ante values for all of these parameters	costs can be quite low, monitoring of number of measures and savings per measure may be combined with "anyway" contacts

Table 8 - categories of calculation methods for unitary gross annual energy savings

<sup>30</sup> for standardised actions

Categories of methods 1 to 4 require collecting data<sup>31</sup> at the participant level. Evaluation methods have then to specify whether data should be collected for **all** participants or for **samples**. In the latter case, unitary energy savings are average values<sup>32</sup>, assumed to be either representative of the whole participants, or conservative when representativeness can not be ensured, in order to avoid overestimations (see also section VI.4.2, about the related evaluation efforts).

Deemed savings (category 5) are totally based on values fixed ex-ante and always are average values. Thus as for ex-post values, the ex-ante ones have to be either representative or conservative.

Category 2-a) (billing analysis without normalisation) can only be considered when the evaluated energy savings represent more than a certain threshold of the energy bill (usually 10%, as stated in IPMVP).

The issue of the evaluation costs should be especially looked at when developing a method. Moreover, it should be highlighted that evaluation costs are not always additional. First because evaluation can partly be based on the regular monitoring of the projects, and second because it is a major way to ensure the quality of the project and thus its cost-effectiveness. This is to emphasise that evaluation is not to be perceived as a control with a net cost, but as a tool for continuous improvement, and therefore sustainability.

#### VI.4.1 Step 1.4.a: how calculation methods are usually chosen

The main issues to be taken into account choosing a calculation method<sup>33</sup> are:

- what are the available or easy-to-access data?
- what would be the possibilities and costs of collecting additional data?
- what would be the possibilities and costs of performing additional analysis?
- “*cost-effectiveness of decreasing uncertainty*” (ESD Annex IV (3))

These issues mainly depend on two criteria, energy end-use targeted and corresponding efficient solution encouraged, except for particular cases (when no efficient solution is specified) where it depends also on the type of facilitating measure.

Considering data availability, it should be tried to use as much as possible **statistics or indicators already defined at EU-level** (e.g. EU energy labels, energy performance certificates resulting from EPBD). Besides, **data availability should be considered in practice** and not in theory, especially some market data (e.g. equipment sales data) may be difficult to collect because “*they may be considered proprietary information*” [SRCI 2001 p.70]. Likewise, individual energy bills may be difficult to collect, due to separation between energy distributors and retailers, or due to **confidentiality** and/or **privacy conditions**.

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<sup>31</sup> either directly energy consumption data, or data about intermediate parameters related to energy consumption

<sup>32</sup> indeed, it can be often assumed for measures with large numbers of participants, that, even if variations can occur from one participant to another, these variations set off due to the number of participants and so average values are relevant.

<sup>33</sup> Examples of decision tree may be found in [IPCC 2006 p.1.9, TecMarket Works 2004 p.101].

Moreover, choosing calculation methods is also to be linked with the three levels of evaluation efforts. Above criteria should then be considered for each level of effort.

The iterative process to choose and define the calculation method is presented in chapter III-.

It has also to be reminded that ESD Annex IV gives priority for “*standardised methods which entail a minimum of administrative burden and cost*”.

This part will be further completed, especially when an insight of what are the available data will be given by WP 2, and using WP3 results (one of the WP3 objectives is to consider what method should be used for what type of EEI measures).

#### VI.4.2 Step 1.4.b: specifying 3 levels of evaluation efforts for calculation methods

Category of method	Level of effort	Details
1) direct measurement	level 1	can not be applied at level 1 (EU default values)
	level 2	samples representative of national averages + see IPMVP option B
	level 3	see IPMVP option B
2) billing analysis	level 1	can not be applied at level 1 (EU default values)
	level 2	samples representative of national averages + see IPMVP option C
	level 3	samples representative of measure participants + see IPMVP option C
3) calibrated simulation	level 1	can only be applied at level 3 (measure-specific)
	level 2	
	level 3	see IPMVP option D
4) mix of ex-ante and ex-post	level 1	same ex-ante values for all MS
	level 2	MS-specific ex-ante or ex-post values
	level 3	measure-specific values (for ex-post values)
5) deemed savings	level 1	same ex-ante values for all MS
	level 2	MS-specific ex-ante values
	level 3	No level 3, as deemed savings are all ex-ante

**Table 9 - considering 3 levels of evaluation efforts for calculation methods**

As certain categories of calculation methods can not be defined for the three levels of efforts, an evaluation method can be composed of different categories of calculation methods according to the level of evaluation effort.

Besides, evaluation methods have to define requirements for (if necessary):

- measurement issues (see for instance guidelines in [TecMarket Works 2006 pp.49-64, TecMarket Works 2004 chapter 7 - pp.182-198])
- sampling issues (see for instance guidelines in [TecMarket Works 2006 pp.163-176, TecMarket Works 2004 chapter 13 - pp.315-384])
- modelling issues (e.g. for billing analysis, see for instance guidelines in [TecMarket Works 2004 chapter 6 - pp.101-120])

- skills required (see for instance [TecMarket Works 2006 pp.45,63,171, TecMarket Works 2004 p.95,148])
- list of normalisation factors to take into account (see section VI.3)

Setting up a new method, it should be considered whether such requirements were already defined for existing methods.

## **VI.5 Step 1.5: conversion factors**

When the evaluated energy savings are not directly in kWh, conversion factors have to be used to express these savings in kWh.

ESD Annex II provides a conversion table for usual fuels concerned by ESD. These values are harmonised values to be used by all MS as level 1 effort values.

ESD article 4(1) states that these “*conversion factors set out in Annex II shall apply unless the use of other conversion factors can be justified*”.

MS may then use level 2 or 3 effort values:

- level 2 : national conversion factors
- level 3 : specific conversion factors in case EEI measures are implemented in plants or buildings supplied by local energy production

(for detailed guidelines about conversion factors, see [IPCC 2006 pp.1.7-1.8])

Using level 3 values will probably remain rare (e.g. for big individual EEI measures including CHP). Using level 2 values may be more frequent, especially for electricity.

If a MS uses other values than these of ESD Annex II, it should ensure its own values are used in the same way for calculating both its indicative target and its reported results. Especially, if level 3 values are used, then the energy consumptions of the related sectors have to be disaggregated enough so that these special conversion factors are taken into account while calculating the indicative target.

Moreover, once a MS defines a level 2 conversion factor, it is irreversible to ensure consistence during the ESD implementation period with the MS target, unless the target will also be recalculated.

## **VI.6 Step 1.6: (not) taking account of the rebound effect ?**

The rebound (or takeback) effect is usually defined as “*a change in energy using behaviour that yields an increased level of service and that occurs as a result of taking an energy efficiency action*” [TecMarket Works 2004 p.242].

The rebound effect is not explicitly mentioned in ESD. But it is not explicitly asked not to address it either. Indeed, the list of normalisation factors of ESD Annex IV is so far only

indicative. Our aim is to consider the issues, which appear to be relevant when looking at existing literature and experience on evaluating EEI measures.

In this methodology, we will only consider (when relevant) rebound effect that directly affects energy consumption of an end-user after (s)he implemented an end-use action. This rebound effect results in using an equipment longer (higher duration of use) or in increasing the level of the corresponding energy-related need (higher "equivalent" load<sup>34</sup>, e.g. higher internal temperature).

Changes due to this rebound effect would be included in gross annual energy savings as they affect the unitary annual energy savings, as perceived by the end-users.

Within EMEEES, the rebound effect will in any case be considered for lighting, for changes of internal temperature of dwellings, and for cars. This was agreed by the Commission. However, the Commission also asks for each other method to be developed to check the available literature on this issue, whether the direct rebound effect has been shown to be relevant or not. The final decision on the inclusion of the direct rebound effect for a method remains up to the Commission and the Art. 16 Committee.

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<sup>34</sup> "equivalent" load means here that efficient equipments provide the same energy service than inefficient ones, but with lower energy consumption

## VII- Step 2: total gross annual energy savings

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Reminder of the four steps calculation process (see section IV.2):

**Preliminary step:** checking whether the evaluated EEI measures can be accounted for the achievement of the ESD target (see the **conditions** on the sector targeted and the timing of the measure in the section I.3.2.1)

**Step 1: unitary gross annual** energy savings (in kWh/year/participant or unit)

⇒ **Step 2: total gross annual** energy savings (in kWh/year)

**Step 3: total ESD annual** energy savings in the first year (in kWh/year)

**Step 4: total ESD annual** energy savings achieved in 2016 (in kWh)

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Step 2 focuses on total gross annual energy savings. Its objective is therefore to define accounting methods, which serve to aggregate the unitary gross annual energy savings to total gross annual energy savings. Accounting methods are mainly related to the type of facilitating measures considered.

An accounting method is mainly composed of an accounting system (e.g. registries or databases) and of requirements for ex-post verifications (e.g. for on-site inspections).

### VII.1 Step 2.1: what is an elementary unit of action?

As defined in section IV.2, the unit of action may be either a participant or an equipment. This distinction is made because summing up energy savings is usually different, depending on whether sums are made for energy savings from similar units of equipment or from individual participants.

Formula for units of equipment<sup>35</sup>:

$$\text{total energy savings} = \text{average energy savings per equipment} * \text{number of units of equipment}$$

Equation 3

Formula for participants<sup>36</sup>:

$$\text{total energy savings} = \sum_{i=1}^n [\text{energysavings of participant } i]$$

Equation 4

The number of participants or installed equipments may be:

- either directly accounted for (e.g. number of vouchers used or energy audits)
- or assessed by means of statistics (e.g. through equipment sales data) or surveys

## VII.2 Step 2.2: defining methods for accounting for the number of actions

### VII.2.1 Accounting methods are mainly related to facilitating measures

Methods for accounting for the number of actions are mainly related to **facilitating measures**, as the latter specify the way participants can actually take part in an EEI measure. Therefore, for a given facilitating measure, the same requirements should apply for all MS.

"Same requirements" does not mean that the facilitating measures are to be applied the same way, neither monitored exactly the same way. It just means that the reported results should be based on the same information level, and if possible with a minimum level of quality / reliability.

Facilitating measures at first place refer to those given in ESD definitions (article 3). Furthermore, there is the category of EEI mechanisms. Some facilitating measures and mechanisms are then described in further ESD articles 6 to 13. We propose here a taxonomy of facilitating measures and mechanisms based on ESD terms (in *italic*) and on the taxonomy defined in the IEA guidebook [Vreuls 2005a p.16]:

<sup>35</sup> e.g. accounting for energy savings within white certificates or tax rebates schemes

<sup>36</sup> e.g. accounting for energy savings within energy audit programmes

<b>Category</b>	<b>Subcategories</b>
1 <i>Regulation</i>	<i>Standards and norms:</i> 1.1 Building Codes and Enforcement 1.2 Minimum Equipment Energy Performance Standards
2 Information and legislative-informative measures (e.g. mandatory labelling)	2.1 <i>Focused information campaigns</i> 2.2 <i>Energy labelling schemes</i> 2.3 Information Centres 2.4 <i>Energy Audits</i> 2.5 <i>Training and education</i> 2.6 <i>Demonstration*</i> 2.7 <i>Exemplary role of the public sector</i> 2.8 <i>Metering and informative billing*</i>
3 <i>Financial instruments</i>	3.1 <i>Subsidies (Grants)</i> 3.2 <i>Tax rebates and other taxes reducing energy end-use consumption</i> 3.3 <i>Loans (soft and/or subsidised)</i>
4 <i>Voluntary agreements and Co-operative instruments</i>	4.1 Industrial Companies 4.2 Commercial or Institutional Organisations 4.3 <i>energy efficiency public procurement</i> 4.4 Bulk Purchasing 4.5 Technology procurement
5 <i>Energy services for energy savings</i>	5.1 <i>Guarantee of energy savings contracts</i> 5.2 Third-party Financing 5.3 <i>Energy performance contracting</i> 5.4 <i>Energy outsourcing</i>
6 <i>EEI mechanisms</i> and other combinations of previous (sub)categories	6.1 Public service obligation for energy companies on energy savings including “ <i>White certificates</i> ” 6.2 <i>Voluntary agreements</i> with energy production, transmission and distribution companies 6.3 <i>Energy efficiency funds</i> and trusts

\* Energy savings can be allocated to these subcategories only if a direct or multiplier effect can be proven. Otherwise they must be evaluated as part of a package. Terms in *italic* are these used in the ESD.

**Table 10 - proposed taxonomy for instruments (fit to ESD terms)**

(for more details about how this taxonomy was defined, see Annex II)

This taxonomy is just a proposal in order to list the methods to set up for accounting for number of actions. It should be reviewed by the Commission and/or the art.16 Committee to know whether such a taxonomy can be used.

Anyway, MS may use other instruments and therefore set up the corresponding evaluation methods. In this case, they have to ensure their proposal is accepted by the Commission, and the resulting methods have to comply with ESD requirements and with this methodology (if confirmed by the Commission). Especially, the methods should propose requirements to be fulfilled by all MS, so that once a new instrument is addressed, the same method is used by all, in order to ensure a harmonised evaluation system.

The idea here is not to ask to MS, which have already their own evaluation system for already many years to change it. The evaluation methods are to be taken as guidelines to perform evaluations for MS, which may look for advice about this, and as requirements for the way to recalculate – if necessary – and report the results in a harmonised way.

If each MS reports the results the way it is used to, and not complying with any requirement, it will be :

- 1) impossible for the Commission to assess all the NEEAPs
- 2) impossible to compare results between MS

In the ESD, it is repeated many times that the idea is to use harmonised methods. So each MS can use the monitoring systems they want. But at the end, they should provide a minimum set of harmonised information (data, explanations about calculations, etc.). And that is what is meant by requirements.

The IEA guidebooks provide useful advice for developing methods specific to given instruments (or facilitating measures in the terminology used here):

- building codes [Vreuls 2005a pp.53-63]
- minimum equipment energy performance standards [Vreuls 2005a pp.63-71]
- energy labelling and information centres [Vreuls 2005a pp.77-85]
- energy audits, education and training [Vreuls 2005a pp. 86-95]
- price-reducing policy measures [Vreuls 2005a pp.101-108]
- taxation systems [Vreuls 2005a pp.108-112]
- financial arrangements [Vreuls 2005a pp.112-117]
- bulk purchasing and technology procurement [Vreuls 2005a pp.117-120]

### **VII.2.2 In practice, measures are not individual but form packages**

EEI programmes often use several facilitating measures targeting the same energy end-use. The IEA guidebooks also provide advice for such combinations [Vreuls 2005a pp.137-152].

In this case, EEI measures **must** not be evaluated individually, but must be grouped in consistent packages. It is then necessary to apply **guidelines to avoid double counting** (see section VIII.2 for more details about double counting).

### **VII.3 Step 2.3: accounting for the number of actions is always level 3**

The number of implemented actions is always a specific result of the evaluated EEI measure. So defining an accounting method will result in specifying level 3 requirements. These requirements are particularly important when the number of participants/equipments can not be accounted for directly<sup>37</sup>.

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<sup>37</sup> e.g. for a subsidies scheme, direct accounting is possible with vouchers. But when the subsidies are given to retailers, then the number of equipments sold due to the subsidies may not be accounted directly.

Examples of accounting methods are:

- direct accounting methods (recommended):
  - o collection of vouchers, invoices or similar accounting evidences
  - o registry/databases to collect details about participants
  - o other monitoring/tracking systems
- indirect accounting methods:
  - o assessment from equipment sales data (may include the use of control groups)
  - o surveys among the whole population targeted to assess the participant rate
  - o surveys among the participants to assess the portion/number of implemented end-users measures

The accounting method may be completed by ex-post verifications such as controls of registered evidences, or on-site inspections to control that end-use actions are actually in place and operational (as specified initially).

## VIII- Step 3: total ESD annual energy savings in first year

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Reminder of the four steps calculation process (see section IV.2):

**Preliminary step:** checking whether the evaluated EEI measures can be accounted for the achievement of the ESD target (see the **conditions** on the sector targeted and the timing of the measure in section I.3.2.1)

**Step 1: unitary gross annual** energy savings (in kWh/year/participant or unit)

**Step 2: total gross annual** energy savings (in kWh/year)

 **Step 3: total ESD annual** energy savings in the first year (in kWh/year)

**Step 4: total ESD annual** energy savings achieved in 2016 (in kWh)

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Step 3 focuses on total ESD annual energy savings. Its objective is therefore to consider the **gross-to-net correction factors** needed to distinguish ESD savings from gross savings.

### VIII.1 Step 3.1: formula for ESD energy savings

ESD Annex IV (5) states that further “*corrections shall be made for **double counting** of energy savings*” and for “***multiplier energy savings effects***”. No other gross-to-net correction factors are explicitly mentioned in ESD. However, such factors as the free-rider effect are frequently used to distinguish "additional" or “net” from “all” energy savings<sup>38</sup>. The European Commission has asked the EMEEES team for assessing the possibilities to evaluate free riders. However, it will be up to the Commission, with the assistance of the Art. 16 Committee, to finally decide on inclusion of free-rider effects. Therefore, the basic formula for ESD energy savings<sup>39</sup> is:

$  \begin{aligned}  \text{ESD energy savings} &= \text{total gross energy savings} * \text{double counting factor} \\  &+ \text{multiplier energy savings} \\  &- \text{free-rider savings?}  \end{aligned}  $
--

Equation 5

where:

- **double counting factor** is a coefficient between 0 and 1, taking account of whether energy savings have to be shared between several EEI measures or programmes (see section VIII.2)
- **multiplier energy savings** are additional energy savings, as indirect results of an EEI measure or programme, when “*the market will implement a measure automatically without any further involvement from the authorities or agencies (...) or any private-sector energy services provider*” (ESD Annex IV (5)) (see section VIII.4)
- **free-rider energy savings** are the amount of energy saved by free riders. Free riders are participants or consumers who would have implemented the end-use action also in absence of the facilitating measure(s) being evaluated (cf. section VIII.5).

The free-rider effect is a major factor to take into account while evaluating EEI measures. Neither the term "additional" nor "free-rider" are in the text of ESD yet. That's why it is highlighted by the question mark in the formula. But ESD article 1 states that the purpose of the Directive is to “enhance the cost-effective improvement of energy end-use efficiency in the Member States by ... (2) creating the conditions for the development and promotion of a market for energy services and for the delivery of other energy efficiency improvement measures to final consumers”. This implies an active role of someone who is not the final consumer him-/herself. Therefore we decided to include the free-rider effect in the issues to be discussed, and this was agreed by the Commission.

The ESD should be interpreted in a wider sense than just sticking to its exact wording. More generally, there would be no need and use to measure and/or assess the effect of an energy

<sup>38</sup> **net energy savings** refer to savings from the point of view of society, i.e. only accounting for "additional" savings ("additional" meaning these savings would have not occurred without involvement from the authorities or public agencies or any private-sector energy services provider).

<sup>39</sup> **ESD energy savings** refer to energy savings as accounted for within ESD. ESD energy savings account for end-user energy savings, taking into account at least two additional gross-to-net correction factors, double counting and multiplier effect, and possibly also the free-rider effect, depending on the decision by the European Commission.

service or a public policy, if it was to look at all energy savings results, including those not due to this service or policy. In one way or another, additionality should be addressed. It should also be further investigated, whether it can be assumed that free-rider effects and multiplier effects set off each other.

This methodology is just a proposal. It clearly remains up to the Commission and/or ESD art. 16 Committee to decide at the end, whether it should be applied in the ESD accountability. As arguments for this decision, advantages and drawbacks of (not) taking account of free-riders are presented in the section VIII.5.1.

A more specific equation for net energy savings could be deduced from [SRCI 2001 p.65]:

<p><i>total net energy savings</i></p> <p>= <i>average energy savings per equipment (or participant)</i></p> <p>* <i>number of equipment (or participants)</i></p> <p>* <i>(1 - free-rider (?)+ multiplier)</i></p> <p>* <i>double-counting factor</i></p>
--

**Equation 6**

where:

free-rider: share of free-riders between 0 and 1 (see above comment and section VIII.5.2)

multiplier: equivalent to spill-over effect,  $\geq 0$  (see section VIII.4)

double counting factor: coefficient between 0 and 1 (see section VIII.2)

### **VIII.2 Step 3.2: double counting (when facilitating measures may overlap)**

The ideal case for evaluation would be that a given energy end-use is targeted through a given EEI measure using one given facilitating measure. But, as highlighted in section VII.2.2, most of the time, several instruments are used to target the same end-use, and so measures may not be considered individually but must be grouped in consistent packages.

For the monitoring of energy savings under the ESD, it is not relevant which facilitating measure caused the energy savings. The easiest way to avoid the double-counting issue is, therefore, to evaluate the consistent package of measures aiming at promotion of a specific end-use action from the outset.

Therefore, double counting will have to be addressed, if several facilitating measures may overlap that aim to promote the same end-use action(s), and if they are evaluated separately. Furthermore, double counting can be divided in two cases:

- overlap of national EEI activities
- overlap of national and local or EU (or special) EEI activities

## VIII.2.1 Double counting when national EEI activities may overlap

### VIII.2.1.1 Recommendations for addressing double counting

In case of overlap, the decision to allocate the corresponding energy savings to one or another EEI measure is up to the Member-States. They just have to explain how they deal with it in order to avoid double counting.

The easiest way will be to group facilitating measures targeting the same type of end-use action in a single package, reporting one global result by end-use action, assessed using a unique way to account for number of participants. In that case, it should be tried when possible to use a direct tracking of participants and even end-use actions if possible (see section VIII.2.1.3 below).

Another way may be to associate each targeted end-use with a particular facilitating measure or programme, allocating the corresponding energy savings only to this measure.

For Member-States which would like to share energy savings between overlapping measures, in order to better know what are the contributions of each measure to their target, proposals of sharing rules are presented in Annex IV.

Finally, three levels of efforts may also be proposed to address double counting:

<b>Level 1</b>	reporting one single facilitating measure per end-use action (if possible at all)
<b>Level 2</b>	forming consistent packages of facilitating measures per end-use action
<b>Level 3</b>	sharing results according to priority rules (see annex IV)

### VIII.2.1.2 Matrix of reported measures to list risks of overlaps (i.e. when several measures target the same energy end-use)

In order to know when MS should provide details about how they dealt with double counting, it is useful to map the risks/possibilities of overlaps. They should therefore list what end-use actions are targeted by their facilitating measures. Then a matrix crossing end-use actions and facilitating measures will highlight the risk of overlap.

	facilitating measure 1	facilitating measure 2	facilitating measure 3	facilitating measure 4	etc...	Risk of overlap ?
end-use action 1		X				
end-use action 2	X	X				X
end-use action 3			X			
end-use action 4	X			X		X
etc...						

Table 11 - example of matrix to list risks of overlaps

## VIII.2.1.3 Tracking overlaps

Two main cases may occur quantifying overlaps:

- either participants or units of equipment are **clearly identified** (so it is possible to know if one particular unit or participant may be accounted for several measures) → then no particular problem (it will then be recommended to MS or other providers of facilitating measures to design their monitoring and evaluation system in order to fit to this case)
- or participants or equipments are **not clearly identified**:
  - either a unique way for assessing the number of actions is chosen (and the different EEI measures are considered as a single package)
    - number of actions accounted by a single system for the whole package
  - or the number of actions is assessed for each measure and a share of overlap between measures has to be assessed to deduct doubles
    - number of actions =

$$\sum_i (\text{actions of measure } i) - \sum_{i,j} (\text{overlapping actions accounted for measures } i \text{ and } j)$$

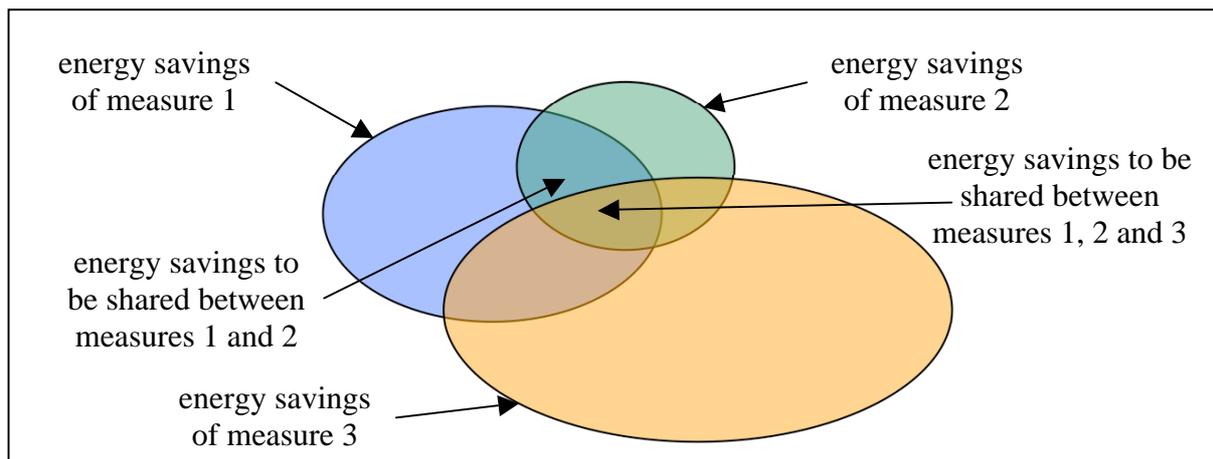


Figure 9 - representing overlaps of EEI measures

*Example where participants are clearly identified thanks to direct tracking of double-counting (based on experiences, e.g., in Finland):*

- *measure 1: energy audit in industry → registry (database) of companies, sites, and end-use actions proposed with estimated savings and investment*
- *measure 2: voluntary agreement and tax rebate or direct subsidy or soft loan for implementation of end-use actions → registry (database) of companies, sites, and end-use actions implemented with financial incentive*
- *measure 3: energy performance contracting → registry (database) of companies, sites, and actions implemented by contractors*

*Then double counting is avoided by comparing these three databases (or even integrate databases for measures 1 and 2).*

*Whenever possible, this approach of direct tracking through registering participants in databases is recommended (proposal agreed by the Commission), as it enables both an easy monitoring of double counting, and sampling to perform ex-post verifications.*

### **VIII.2.2 Double counting when local or EU (or special) and national EEI activities may overlap**

Overlaps may occur between national and local or EU (or special) EEI activities (e.g. between a national energy audit programme for industries and a local pilot operation in a particular industrial plant started after an audit, or between a rebate programme and the EU energy label targeting the same equipment).

In the case of a local or special operation, the local (or special) operation will often be evaluated at the operation level (level 3 of evaluation efforts). The corresponding results should then be allocated in priority, and the corresponding participants or equipments should be deducted of results accounted for other overlapping measures.

It should be also controlled, whether a local or special result may affect the national result for the same kind of measure (especially when the sum of average unitary energy savings is used, and this average encompasses local or special measures).

Regarding EU measures, the national activity and the EU measures should either be evaluated as a package, or the result of the EU measure be taken as the baseline for the national measure (cf. baseline considerations above).

### **VIII.3 Step 3.3: technical interaction (when efficient solutions may overlap)**

Just as double counting may occur when several facilitating measures target the same end-use action, technical interaction may occur when a single or several EEI activities encourage several efficient solutions at once (e.g. better insulation and a better heating system).

#### **VIII.3.1 (not) taking account of technical interaction**

The ESD clearly states that double counting has to be avoided. However, the ESD definition of double counting does not include technical interaction (which is actually not referred to within the Directive).

Indeed, contrary to double counting, technical interaction may not be perceived as a negative factor. The ESD aims to encourage energy efficiency efforts. When two efficient solutions overlap, the resulting energy savings may be smaller (or bigger) than the sum of both individual solutions. However, both efficient solutions are really implemented.

Moreover, taking account of technical interaction may create a barrier to global energy efficiency approaches because it reduces the incentive for the MS to promote both solutions (e.g. tackling both insulation and heating issues), and therefore may be inconsistent with the aims of other Directives going in this direction, such as EPBD. However, the EPBD does not out the effect of technical interaction by focussing on the overall energy performance of the building.

This is why some existing systems for encouraging energy efficiency do not take account of technical interaction, or even consider to give a bonus for global approaches (e.g., in the French white certificates scheme).

Finally, as agreed by the Commission, technical interaction was to be analysed while developing a method within EMEEES task 4.2, keeping in mind that global approaches (e.g. improving the whole energy performance of a building) should not be penalised but encouraged. Commission representatives even interpreted technical interaction to be part of the double-counting problem.

The final decision on the inclusion of technical interaction will be left to the Commission and the Art. 16 ESD Committee.

### **VIII.3.2 Proposal for taking account of technical interaction**

If it is decided to consider technical interaction issues, the following approach is proposed (similar to the one proposed for double counting).

#### *VIII.3.2.1 Step 3.3.a: assessing the risks of technical interaction*

Risks of technical interaction may be analysed first, to keep only cases where technical interaction can occur in practice (e.g. technical interaction is likely between thermal insulation and the heating system, but unlikely between fridge and CFL). Indeed technical interaction will probably have to be considered only in a limited number of cases, especially these related to the energy performance of buildings. The major risk for technical interaction is actually when several end-use actions target the same energy end-use. This can easily be tracked by listing the different categories of reported end-use actions, and grouping them by end-use targeted.

For the case of possible interaction between end-uses, a general matrix could be defined to list the risks a priori.

	energy end-use 1	energy end-use 2	energy end-use 3	energy end-use 4	energy end-use 5	energy end-use 6	energy end-use 7
energy end-use 1		-	-	-	-	-	+
energy end-use 2			+	-	-	+	-
energy end-use 3				-	-	-	-
energy end-use 4					+	-	-
energy end-use 5						-	+
energy end-use 6							-
energy end-use 7							

**Table 12 - example of matrix to assess risks of technical interaction between energy end uses**

#### VIII.3.2.2 Step 3.3.b: tracking risks of technical interaction

Once "real" risks of technical interactions are stressed, technical interactions may be tracked when an household / building / company can take advantage of several EEI actions (within one or several EEI measures).

For tracking risks of technical interactions within a single EEI measure, the operators and/or evaluators of this measure could monitor, which actions are implemented by which participants.

In case of technical interactions due to several measures, it could be required to have a central database/registry, listing participants and actions implemented (as for tracking double counting).

Another alternative could be to use samples to define average ratios of interactions (e.g. x% of participants installing better insulation have also changed their heating device, and the energy savings from changing the heating device should therefore be reduced by y%).

#### VIII.3.2.3 Step 3.3.c: evaluating effects of technical interactions

Once effective technical interactions are detected, their effects may be evaluated according to the three level of efforts:

- level 1: default value for percentage of decrease/increase when summing several efficient solutions together (pessimistic value based on existing studies)
- level 2: national value (argued with evidences valid for a particular MS)
- level 3: measure-specific value (argued with evidences from this particular measure)

## VIII.4 Step 3.4: multiplier effect

### VIII.4.1 Multiplier and spill-over effect: the same or different?

In ESD (Annex IV(5)), **multiplier effect** means that “*the market will implement a measure automatically without any further involvement from the authorities or agencies referred to in Article 4(4) or any private-sector energy services provider*”.

**Spill-over effect** is usually defined as “*energy impacts caused by the programme other than those resulting from participants making the specific improvements targeted by the programme*”, i.e. “*the programme is responsible for impacts outside of the formal programme participation process*” [SRCI 2001 pp.69-70]. In practice, spill-over effect can be illustrated by three cases:

- “*participants are sometimes influenced by the programme to make EE improvements not directly targeted by the programme, perhaps due to an increased awareness of the benefits of energy efficiency in general*” → **participant spill-over**
- “*consumers make the efficiency improvements promoted by the programme because of the programme, but do not bother to officially participate or let the programme sponsor know they are making these improvements*” → **non-participant spill-over**
- “*trade allies<sup>40</sup> are influenced by the programme to change what they recommend to their customers or change the types of equipment they stock because of the programme. Some portion of the consumers with which they interact are affected by these actions to improve their energy efficiency but may never even know of the programme*” → **trade allies spill-over<sup>41</sup>**

The ESD definition of multiplier effect emphasises that it is a market transformation effect, so it may be compared to trade allies spill-over. To clarify this point, the Commission has to decide what is to be considered as multiplier effect, especially whether multiplier effect applies only to the same outputs as those promoted by the EEI measure or whether other outputs may be accounted for (e.g. in case of a campaign to promote A+ cold appliances, should only the sales of A+ cold appliances be considered, or could increased sales of A+ wet appliances also be accounted for under certain conditions ?).

A first discussion with the Commission has led to the preliminary agreement to interpret the ESD in the sense that **future multiplier effects** should be included in any case. And while developing a bottom-up method within EMEEES task 4.2, it should be analysed, whether the three types of spill-over effects are relevant and how they can be evaluated. The final decision on the inclusion of spill-over effects remains up to the Commission and Art.16 Committee.

### VIII.4.2 Step 3.4.a: conditions for the multiplier effect to be eligible

The basic condition for the multiplier effect to be eligible is that a clear causality can be argued between multiplier energy savings and the reported EEI measures.

<sup>40</sup> Manufacturers, wholesalers, retailers, etc.

<sup>41</sup> In practice, trade allies spill-over encompasses a major part of non-participant spill-over, as the latter (non-participant) most often result from the former (trade allies).

This condition may be expressed more concretely through two recommendations:

- **clear assumptions in the programme theory** showing the programme was designed to have a multiplier potential: this recommendation is to avoid MS claiming multiplier energy savings afterwards, for instance taking advantage of contextual factors. Moreover, it could be a way to encourage MS to design EEI programmes with multiplier potential. This recommendation to use programme theory to the extent possible, when assessing whether the three types of spill-over and future multiplier effects are relevant, was agreed by the Commission.
- **performing an ex-post evaluation** to control these assumptions are reliable and to assess a posteriori the share of multiplier savings, using one or several following analysis [SRCI 2001 p.70]:
  - sales data analysis (market modelling)
  - surveys among representative samples of (non-)participants
  - surveys with trade allies and/or other relevant stakeholders

This latter recommendation is clearly stated in ESD, and should then be considered as a requirement<sup>42</sup>.

The evaluation of multiplier effect should also be encouraged ex-ante, when MS report in their NEEAP the forecasted EEI measures. Assessing whether a multiplier effect may happen as soon as possible in the life of a facilitating measure<sup>43</sup> makes the ex-post evaluation of multiplier savings easier.

The ex-post requirement applies when MS report in their NEEAP the EEI measures already implemented. But the NEEAP are also used to assess whether the strategy adopted by the MS will lead to reach the target in 2016 (cf. ESD article 4(2)). So if it is part of the MS strategy to design measures with an expected multiplier effect, it should be presented as soon as possible so that the final ex-post evaluation could be prepared cost-effectively.

The EMEEES partners involved in task 4.2 should also consider whether additional conditions for the accounting of multiplier savings should be recommended and/or required.

Furthermore, ESD Annex IV(5) states “*a measure with multiplier potential would in most cases be more cost-effective than measures that need to be repeated on a regular basis*”. EEI measures with clear lasting multiplier effect could then be encouraged with a bonus rate on the ESD energy savings accounted for it. For instance, new efficient luminaires could be favoured in comparison to efficient lightbulbs alone.

### VIII.4.3 Step 3.4.b: accounting for the multiplier effect means evaluating market transformation

In the United States, EEI programmes are often divided in two categories, according to their strategies: resource acquisition and market transformation [Blumstein 2005, Broc 2006 pp.21-

<sup>42</sup> “*Member States shall estimate the energy savings potential of such measures including their multiplier effects and verify the total effects in an ex-post evaluation using indicators when appropriate*” ESD Annex IV(5)

<sup>43</sup> The best will be when designing the measure.

25]. *Resource acquisition* refers to programmes with short-term goals, while *market transformation* is related to longer term<sup>44</sup> objectives.

This classification fits with ESD definition of multiplier energy savings, which can therefore be considered as the results of market transformations. Thus, accounting for multiplier savings is similar to evaluating market transformation. Moreover, ESD Annex IV(5) states “*Member States shall estimate the energy savings potential of such measures including their multiplier effects and verify the total effects in an ex-post evaluation*”, so multiplier energy savings have to be evaluated with level 3 efforts.

Guidelines for market transformation evaluation may be found in [SRCI 2001 pp.76-79, TecMarket Works 2006 pp.143-162, Vreuls 2005a pp.145-151, TecMarket Works 2004 pp.245-268].

Moreover two special issues related to multiplier effects have to be highlighted:

- multiplier energy savings often occur after a delay, compared to energy savings directly due to the EEI measure: it could be asked to plan ex-post evaluations to monitor the multiplier effect over time, and especially in 2016 (as it is the control year for ESD)
- **it should be investigated whether the multiplier effect may have a link with the free-rider effect, and especially whether it can be assumed that they set off each other** (for instance, can it be considered that the free-rider effect for current EEI measures might result from multiplier effects of past EEI measures?)

### VIII.5 Step 3.5: considering the free-rider effect

Whether taking account of the free-rider effect or not was discussed in section VIII.1, and final decision is up to the Commission and the Art 16 ESD Committee. We propose here three possible alternatives to account for free-riders, to provide additional elements for Commission decision.

The free-rider effect is usually defined as the “*portion of gross programme impacts that would have occurred even if there had been no programme. A free-rider is a customer who would have adopted the actions recommended by the programme even without the programme and who participates directly in the programme.*” [SRCI 2001 p.66].

Several reasons may explain the free-rider effect, especially gross-to-net correction factors usually considered in top-down approach: autonomous effect, energy price effect, natural change effect... A way to address the free-rider effect could then be to list what could be reasons for free-riders, and thus avoid for double counting gross-to-net correction factors.

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<sup>44</sup> Long term does not mean here that the facilitating measure has to be in place for many years. Long term refers to the target of the facilitating measure: lasting (= long term) effect, and not immediate effect as for resource acquisition. See [Blumstein 2005] about that. Long term effects may be gained through facilitating measures implemented only a few years. Indeed it is often the objective of these measures, and that is what the ESD wants to encourage when speaking about multiplier effects (see ESD Annex IV(5)).

Moreover, the free-rider effect can occur in three ways [SRCI 2001 pp.66-67]:

- *“**pure or full free-ridership** exists when all of the gross impact related to an installation or some other unit of programme implementation would have occurred exactly as it did in the programme, even if the programme had not existed”*
- *“**partial free-ridership** exists when only some portion of the gross impact would have occurred in the absence of the programme”* (e.g. buying an A++ appliance instead of an A+, while A is the baseline of non-efficient models)
- *“**deferred free-ridership** is more complex. It exists when some portion of the gross impact would have occurred in the absence of the programme, but would have occurred at a later date”*

While developing a bottom-up method within task 4.2, it should be analysed, whether the three types of free-rider effects are relevant and how they can be evaluated. This principle was agreed by the Commission. The final decision on inclusion of free-rider effects remains up to the Commission and the Art.16 Committee.

### VIII.5.1 Advantages, drawbacks and possible alternatives for (not) taking account of free-rider effect

We consider here advantages and drawbacks (not) taking account of free-riders. Possible alternatives to account for free-riders are then presented in section VIII.5.2.

#### → taking account of free-riders

- **advantages:**
  - + **ensuring "additionality" at the level of an individual EEI measure or programme:** taking account of free-riders for a particular measure or programme will enable to better know the specific additional effect of this measure or programme
  - + **encouraging to target hard-to-reach deposits:** taking account of free-riders may drive MS to target their actions where the risk of incurring a free-rider effect is assumed to be lower, thus enhancing policy effectiveness
  - + **getting closer to implementing the additional cost-effective potential** for energy end-use efficiency, which is bigger than 1 % per year, because more EEI measures have to be implemented to reach the ESD target than if the free-rider effect is not taken into account
- **drawbacks:**
  - **difficult to evaluate:** as highlighted above, evaluating free-riders raises two issues (what is a concrete definition of free-riders ? how to account objectively for these free-riders ?), which are particularly **difficult to address in an harmonised way** among MS<sup>45</sup> and which may turn out to be **expensive** in terms of related evaluation and administration costs
  - **risk of double counting free-riders:** if the baseline is defined through stock/market modelling, there is a risk to double count free-riders, first reducing

<sup>45</sup> MS may have distinct perception of what are free-riders, and also different resources to evaluate free-rider effect, as it is often resource consuming.

average unitary energy savings, and second reducing the number of accounted actions (see also section VIII.5.2)

- **high risk of arbitrary results:** free-rider effect may be tackled unexpensively through default net-to-gross ratios, but existing experience in this field (e.g. in California or in other US states) shows standardised ratios may result from arbitrary decisions and are not reliable [TecMarket Works 2004 p.134]. Defining net-to-gross ratios for each EEI measure may be expensive, and has to address several biases, such as self-selection and social desirability (see also section VIII.5.2).

→ **not taking account of free-riders directly but maybe including them in the baseline**

▪ **advantages:**

- + **ESD energy savings easier to account:** not taking account of free-riders removes one issue to address while accounting for energy savings, and therefore it makes the accounting easier
- + **indirectly taking account of early actions:** the free-rider effect will be bigger if the background for EEI measures is more favourable, this background usually resulting from early actions. Indeed, this is **consistent with the ESD approach to encourage EEI measures with multiplier potential**<sup>46</sup>, as the free-rider effect of today may be considered as a form of multiplier effect of earlier measures
- + **additionality of energy savings can be directly included in the baseline:** if the baseline is defined through stock/market modelling, then the business-as-usual (or autonomous) evolution of equipments (or buildings) energy performance can be directly included in the baseline (see also section VIII.5.2)

▪ **drawbacks:**

- **“self-fraud”:** counting BAU developments as a success of policy will result in falling short of reaching real 9 % energy savings in the 9<sup>th</sup> year **from facilitating measures**. This will also mean that the full cost-effective additional potential of energy end-use efficiency compared to BAU, which is bigger than 1 % per year, is not harnessed.
- **encouraging to target easy-to-access deposits:** not taking account of free-riders may drive MS to target their actions where the background is more favourable. But it may also be a policy objective to first exhaust these easy-to-access deposits, ensuring a positive launch to prepare stakeholders to further target hard-to-reach deposits
- **risk of double counting early actions results:** if the free-rider effect of today is considered as a multiplier effect of early actions, there may be a risk of double counting early actions results. But this can be avoided with stricter conditions on early actions (see part X-)

In summary, choosing (not) taking account of free-riders depends on policy objectives of public authorities, and then should result from a compromise between trying to give the most accurate view of additional energy savings, and setting up a cost-effective and harmonised system to account for energy savings. It also has to be **evaluated in connection with the**

<sup>46</sup> as these measures “*would in most cases be more cost-effective than measures that need to be repeated on a regular basis*” (ESD Annex IV(5))

**bottom-up evaluation method used, and the selection of the baseline according to that method.**

### **VIII.5.2 Proposed options to take account of free-riders**

In this section, three potential options to deal with the free-rider effect are presented.

**Each concrete method case application developed in EMEES task 4.2 was to propose a clear way how to deal with free-rider effects (e.g., at which level: EU-wide, national or specific), which may be chosen from the following three options or yet different. Furthermore, treating these effects at national or measure-specific level will need guidance on how to calculate them in a harmonised way.**

#### *VIII.5.2.1 Step 3.5 – option 1: assuming free-riders are included in the baseline*

Free-riders can be included in the baseline when it is defined through stock/market modelling (this is actually similar to excluding the autonomous development in Top-down methods).

Links with the 3 levels of evaluation efforts:

- level 1 : same default baseline values for all MS, based on available data around MS (average values if data available for enough MS; it has to be assessed for each method, how many means “enough”)
- level 2 : baseline based on national statistics of stock or market
- level 3 : baseline based on available data for the specific targeted area or public

This option avoids double counting of gross-to-net correction factors, and enables an objective and harmonised treatment of these factors. No survey of participants is needed (avoiding especially self-selection and social desirability bias). Evaluation is based on outputs statistics such as equipments and appliances sales data or energy performance certificates for buildings. It usually needs a control group or area to evaluate the “autonomous” baseline.

However, this alternative can not take into account sudden changes, as present reference values forming the baseline will be deduced from a modelling of past values (e.g. linear regression). This issue can be addressed by checking whether contextual factors may lead to sudden changes.

#### *VIII.5.2.2 Step 3.5 – option 2: defining net-to-gross ratios (NTGR)*

This alternative is used by the US EPA [Vine 1999 p.58].

Links with the 3 levels of evaluation efforts:

- level 1: same default NTGR for all MS, but should be neither too low to induce MS to make level 2 evaluation efforts, neither too high, avoiding to penalise MS with not enough resources and/or experience to define their own NTGR (e.g. new MS). There is a risk that these default values will be somewhat arbitrary, although based on surveys of samples, market or stock modelling, or sales data, and the level of energy efficiency eligible for the facilitating measure compared to the market average of the not eligible models.

- level 2 : national NTGR, but it may be very difficult to find a way to ensure harmonised evaluation of NTGR from one MS to another
- level 3 : measure-specific NTGR based on specific surveys/studies, but it may be very difficult to find a way to ensure harmonised evaluation of NTGR from one facilitating measure to another

For level 2 and 3 values may be assessed either [Vine 1999 pp.56-57]:

- by **participant surveys**, asking what they would have done in the absence of the project, but “*two problems arise in using this approach: (1) very inaccurate levels of free ridership may be estimated, due to questionnaire wording and (2) there is no estimate of the level of inaccuracy, for adjusting confidence levels*”
- by **discrete choice modelling**<sup>47</sup> to “*estimate the effect of the program on customers tendency to implement measures*”

A more sophisticated approach to define level 2 and 3 values may be found in the Californian Protocol [TecMarket Works 2006 pp.36-40], defining three further levels of rigor:

<b>Rigor level</b>	<b>Alternative methods required</b>
Basic	1. participant self-report
Standard (one out of these three options to choose)	1. participant and non-participant analysis of utility consumption data that addresses the issue of self-selection. 2. enhanced self-report method using other data sources relevant to the decision to install/adopt. These could include, for example, record/business policy and paper review, examination of other similar decisions, interviews with multiple actors at end-user, interviews with midstream and upstream market actors, review of typically built buildings by builders and/or stocking practices. 3. econometric or discrete choice <sup>47</sup> modelling with participant and non-participant comparison addressing the issue of self-selection.
Enhanced	1. “Triangulation” using more than one of the methods in the Standard Rigor Level. This must include analysis and justification for the method for deriving the triangulation estimate from the estimates obtained.

**Table 13 - methods proposed in the 2006 Californian Protocol for evaluating free-rider effect**

### VIII.5.2.3 Step 3.5 – option 3: choosing a progressive approach

For a first period: a general default value of NTGR to be defined for each concrete method by the Commission OR no NTGR but baselines defined through stock/market modelling, depending on the EEI measure that is the subject of the method in question.

During the first period: possibilities for MS to propose methods to define MS values of NTGR, taking into account that these methods should be applicable for all MS (the Commission could then choose to allocate bonus for MS proposing relevant methods, or to prepare call for tenders for such studies).

<sup>47</sup> The discrete choice is the customer yes/no decision whether to implement a measure. The discrete choice model is estimated to determine the effect of various characteristics, including project participation, on the tendency to implement the measures.

For further periods: according to experience gained for all MS, new proposal for (not) taking account of free-riders.

Whatever the option considered, it should also be further investigated whether it could be assumed that free-rider effects and multiplier effects set off each other.

## **IX- Step 4: total ESD annual energy savings achieved in 2016**

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Reminder of the four steps calculation process (see section IV.2):

**Preliminary step:** checking whether the evaluated EEI measures can be accounted for the achievement of the ESD target (see the **conditions** on the sector targeted and the timing of the measure in section I.3.2.1)

**Step 1: unitary gross annual** energy savings (in kWh/year/participant or unit)

**Step 2: total gross annual** energy savings (in kWh/year)

**Step 3: total ESD annual** energy savings in the first year (in kWh/year)

 **Step 4: total ESD annual** energy savings achieved in 2016 (in kWh)

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Step 4 focuses first on checking whether the evaluated end-use actions are still effective in 2016, and second on considering whether the performances of the end-use actions change over time, compared to the corresponding standard solution.

### **IX.1 Considering the timing of the end-use actions**

ESD Annex I(1) states that “*the national indicative energy savings target shall:*

*(b) be measured after the ninth year of application of this Directive;*

*(c) be the result of cumulative annual energy savings achieved throughout the nine-year application period of this Directive.”*

It was clarified with the Commission that when accounting energy savings for the ESD target, **only the annual energy savings achieved and still existing in 2016 matter.**

The first consequence of this interpretation is that there should be a **preliminary step** before going further in the evaluation of any EEI measure to be reported for ESD accounting. Indeed it should be checked whether the measure complies a priori with the **timing requirements**:

1. the end-use actions are to be **still effective in 2016**: this could be checked with the default or harmonised values of **saving lifetimes** already available (see also section IX.2.2)
2. the end-use actions were **implemented from 2008 on**, or from 1995 on (and under special conditions from 1991 on) (see also part X- about **early actions**)

With this interpretation there is a certain risk that it may tempt Member States to start their measures as late as possible<sup>48</sup>. To avoid this, ESD article 4(2) mentions that “*each Member State shall establish an **intermediate national indicative energy savings target** for the third year of application of this Directive, and provide an overview of its **strategy** for the achievement of the intermediate and overall targets. This intermediate target shall be realistic and consistent with the overall national indicative energy savings target referred to in paragraph 1. The Commission shall give an opinion on whether the intermediate national indicative target appears realistic and consistent with the overall target.*”

Then it may also be necessary for the MS to consider the results achieved in a particular year of the ESD period (2008-2016) to support the presentation of their strategy.

## **IX.2 Overview on the CWA27 results on saving lifetime**

### **IX.2.1 Presentation of the CWA**

A CWA (CEN<sup>49</sup> Workshop Agreement) is the result of a CEN Workshop, which is a flexible working platform open to the participation of any company or organisation, inside or outside Europe, for rapid elaboration of consensus documents.

The CWA27 is entitled “*Saving lifetimes of Energy Efficiency Improvement Measures in bottom-up calculations*”. The final CWA document has been agreed and should be available soon [the reference of this document and where to find it should be added here when available].

Its **scope** is defined as follows:

“*This CEN Workshop Agreement specifies a **list of values of average saving lifetimes**<sup>50</sup>, and/or an agreed methodology to establish these saving lifetimes, for commonly implemented*

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<sup>48</sup> First, because the later the measure is started, the more chance for the measure to be "alive" in 2016. Second, because if only what happens in 2016 matters, it could be a reason to put this issue later on the agenda (e.g. because the mandate of the current governments will be over before 2016).

<sup>49</sup> CEN = Comité Européen de Normalisation (European Committee for Standardisation)

<sup>50</sup> The term "saving lifetime" was used in the CWA27, as to avoid confusion with the lifetime of products, used by manufacturers in e.g. a guaranty on duration of the product.

*types of EEI measures. These saving lifetimes can be used in bottom-up calculations of energy savings, (to be) realised as result of policies and actions, as part of the ESD.*

*This Workshop Agreement provides saving lifetimes in relation to the ESD, and does not supersede saving lifetimes used in Member States for other purposes. The Workshop Agreement recognizes that there is variation in the saving lifetimes of EEI measures across Member States”.*

The CWA uses specific definitions:

- **saving period:** *“number of years after implementation of the measure, for which the measure is performing and there is a verifiable effect on energy consumption”*
- **saving lifetime:** *“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 EEI measures or measure types”*
- **harmonized saving lifetime**<sup>51</sup>: *“saving lifetime, agreed on in this CWA for specified EEI measures, used throughout the EU in bottom-up calculations of energy savings for the ESD”*
- **default saving lifetime**<sup>52</sup>: *“conservative (lowest) estimate of a saving lifetime, valid throughout the EU for those EEI measure types where no harmonized saving lifetime is available”*

The CWA also highlights that the saving lifetime can diverge from the saving period due to **correction factors** (see also section IX.3).

## **IX.2.2 Main results: default and harmonised values for saving lifetime**

The main result of the CWA27 is a **list of default and harmonised values for the saving lifetime** (see Annex VI). This was achieved by executing a **survey of presently applied lifetimes** in different EU countries.

*“In practice the lifetimes of individual EEI measures of the same type will show a (wide) range of values. However, in the CWA document it has been assumed that **average values** can be used for the large number of EEI measures in the bottom-up calculation of total energy savings.”*

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<sup>51</sup> This harmonised saving lifetime constitutes an average value for all EEI measures to be classified under a defined measure type. It does not supersede EEI measure lifetimes used in Member States for other purposes.

<sup>52</sup> Member States can choose to determine the saving lifetime instead of using the default value. And this default lifetime does not supersede lifetimes used in Member States for other purposes

### IX.2.2.1 First priority: defining harmonised lifetimes

*“Harmonized saving lifetime figures constitute an **average saving lifetime** for a given EEI measure type across all EU Member States, to be used in the context of the ESD.”*

*“The survey generally offered up to five figures per EEI measure type. These results have been discussed at the CWA meetings and complemented with saving lifetime values supplied by experts. For EEI measure types with **sufficient matching between the available values** an average saving lifetime value was agreed.*

*For EEI measure types with relatively long saving lifetimes harmonized saving lifetimes are the standard [see section IX.2.2.4].*

*In defining the harmonised saving lifetimes all factors directly influencing the saving period [see section IX.4.1] have been (implicitly) taken into account.*

***It has to be stressed that only limited evidence on actual saving lifetimes is available. Therefore, with increasing evidence over time, the list of EEI measure types with harmonised saving lifetimes [see Annex VI], and the values of saving lifetimes, can be adapted at a revision of CWA27.”***

### IX.2.2.2 Second option: defining calculated lifetimes

When it was not possible to agree on a harmonised lifetime for a given type of EEI measure, it was then tried to define a calculated value.

*“Calculated saving lifetime figures result from a prescribed process taking into account all relevant factors that might influence saving lifetimes of specific EEI measure types”.*

For **technical end-use actions**, the calculated value is based on technical standards or on information provided by the manufacturers. Then an analysis aims at defining whether factors may affect this **design lifetime**<sup>53</sup> (see also section IX.3).

For **behavioural and organisational end-use actions**, *“there is often a close relationship between the saving lifetime and the facilitating measure to stimulate implementation of these measures. In these cases, the calculated saving lifetime is directly linked to the duration of the facilitating measure”.*

*“In some cases there are **alternative methods** to determine the saving lifetime for EEI measures in **specific countries** (e.g. a survey on EEI measures that are still present in the year of monitoring). If factors are present that influence the saving period, their effect will be visible in the results of the survey (e.g. less old boilers than could be expected according to the design lifetime). Such a survey may replace the calculation method. However, this is less*

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<sup>53</sup> Design lifetime: *“intended lifespan, in terms of functioning time, number of functioning cycles, etc., foreseen by the manufacturer when designing the product, provided that it is used and maintained by the user as intended by the manufacturer. This definition regards technical EEI measures where lifetime is determined by technical properties of the system. The design lifetime must not be confused with the guarantee period of products, which is a commercial and marketing aspect.”*

*probable for ex-ante evaluations than in ex-post evaluations where actual developments can be observed”.*

#### *IX.2.2.3 Third option: defining default lifetimes*

*“Default saving lifetime values, based on a conservative estimate of actual lifetimes, are used when neither a harmonised lifetime nor a calculated saving lifetime is available. Because it is not known beforehand for which cases lifetimes are calculated, the CWA document has specified default saving lifetimes for all EEI measure types presented in ESD Annex A for which no harmonized saving lifetime could be agreed. In this way MS can always choose to either calculate saving lifetimes or rely on default/harmonised saving lifetimes.*

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

*The default values of Annex VI are partly based on available lifetime figures that diverged too much between the countries as to have harmonised lifetimes. If no such data was available the default values have been based on expert opinions.”*

#### *IX.2.2.4 Other conclusion: three lifetime groups related to ESD timing*

*“ESD regards EEI measures that will be implemented from 2008 on (new measures) and "early action" measures from 1995 on, or under special conditions from 1991 on [see part X-].”*

As highlighted in section IX.1, only the energy savings achieved in 2016 matter for the ESD accounting. Therefore, *“EEI 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 regard to the consequences of saving lifetimes for ESD-evaluation methods, three groups are distinguished: shorter than 10 years, from 10 to 25 years and longer than 25 years [see Table 14 below]. With regard to the contribution to the ESD-target a distinction is made between new measures and early action measures”.*

Lifetime group	Measure category related to contribution to the ESD target		Recommended method for specifying saving lifetime
	Early actions	New measures	
< 10 years	No	Part	All methods
10-25 years	Part	Full	Harmonised (for new measure)
> 25 years	Full	Full	Harmonised

Table 14 - considering three lifetime groups related to the ESD timing

### IX.2.3 Links with the EMEEES project

The CWA27 document is a first basis for addressing lifetime issues related to the implementation of ESD. It should, therefore, be used within the EMEEES project. However, the objective and timing of both works are different<sup>54</sup>.

Therefore, the EMEEES project will **use the CWA27 results**, but will have to **update the values** presented in the Annex VI when necessary, and to complete the approach for **specifying requirements for new values**. Especially, lifetime issues are to be included consistently in the whole methodology. As soon as the European Commission will have updated the list of lifetimes presented in Annex IV of the ESD based on CWA 27 results, this must also be taken into account.

Consequently, the different methods proposed in the CWA can be linked to the three levels of evaluation efforts used in this methodology:

Level 1	harmonised (when possible) or default values
Level 2	calculated values, based on national data
Level 3	calculated values, based on measure-specific data

Table 15 – links between the three levels of evaluation efforts and the methods proposed in the CWA27

Moreover, one important challenge will be to address the treatment of behavioural and organisational end-use actions, for which the CWA does not propose any concrete method, mainly because there is not enough experience feedback about this among the MS.

<sup>54</sup> The CWA27 was to assist the Commission in establishing a list of preliminary saving lifetimes to be used by the MS in their first NEEAP. The EMEEES project is to assist the Commission and the art.16 Committee in refining and completing the ESD Annex IV about calculation methods for 2008 (cf. ESD article 15(2)).

## IX.3 Main issues related to step 4: measure retention and performance degradation

### IX.3.1 Introducing the persistence of the savings

Once an end-use action is implemented, the resulting energy savings may change over time. The **evolution of energy savings over time** refers to the so-called **persistence** of an end-use action, which can be expressed through two components:

1) *measure “retention: the degree to which measures are retained in use after they are installed”* [TecMarket Works 2006 p.239], in other words: is the end-use action still effective, i.e. in place and operable? (see also section IX.3.2)

2) *“performance degradation<sup>55</sup>: any over time savings degradation (or increases compared to standard efficiency operation) that includes both (1) technical operational characteristics of the measures, including operating conditions and product design, and (2) human interaction components and behavioural measures”* [TecMarket Works 2006 p.235] (see also section IX.3.3)

Until the early 1990's in the United States of America, *“persistence was assumed to be relatively constant, and most analyses of persistence relied on engineering estimates of measure lifetime. For example, most planners assumed that knowing the physical life of an installed measure was sufficient to determine persistence, i.e. first-year savings continued for the life of the measure. This assumption has been challenged as the issues of persistence have gained more prominence in the evaluation of energy efficiency programmes. In fact, the limited empirical research conducted so far raises questions about the validity of using manufacturer's claims for physical measure lives as a basis for projecting persistence”* [Vine 1992 p.1073].

Indeed, Vine [1992 p.1074] listed the main **factors which may affect the lifetime** of an end-use action: *“technical lifetime<sup>56</sup>, measure installation, measure performance or efficiency decay, measure operation (behaviour), measure maintenance, repair, commissioning, measure failure, measure removal, changes in the building stock (renovations, remodels, alterations, additions), occupancy changes (turnover in occupants; changes in occupancy hours and number of occupants).”*

Then he considered three definitions for the measure lifetime, which express the possible differences between ideal, normalised and real field conditions:

- *“test measure life reflects how long a measure can be operated until it breaks down irreparably if installed, operated and maintained according to **manufacturer's specifications for best performance**. This lifetime is often based on manufacturer's test (laboratory) data and ignores the effects of repeated cycling, improper maintenance and other factors influencing the measure persistence”*

<sup>55</sup> In the CWA27, the performance degradation is called deterioration effect. Here we used "performance degradation" as it is more commonly used in the existing literature.

<sup>56</sup> The "technical lifetime" of Vine is equivalent to the "design lifetime" of the CWA.

- *“operational measure life is how long equipment is expected to save energy under **typical field conditions**, if the equipment is not removed. The key factors affecting operational life are the quality of installation, occupant use, and level of maintenance”*
- *“effective measure life considers not only field conditions, but also the impact of obsolescence, building remodeling, renovation, demolition, and occupancy changes.”*

While the paper of Vine gives the theoretical basis for addressing the persistence issues, many persistence studies were performed in the early 1990's. A summary of this first round of US research about persistence can be found in [WOLFE 1995].

During this period, it was required in certain regions (e.g. in California) that a persistence study was performed for every energy efficiency programmes (e.g. in the 4<sup>th</sup> and 9<sup>th</sup> years after the EEI programme started). However, one of the main conclusions of these experiences is that **systematically requiring persistence studies is very expensive and does not necessarily provide the expected results.**

Consequently it was decided to better group and organise the persistence studies, so that they are more cost-effective and their results have a better quality. In California, this system relies now on **three categories of evaluation studies**: retention studies, EUL (Effective Useful Lifetime) analysis studies, and performance degradation studies. These three categories are presented in the two next sections, based on the experience in the USA (especially California).

### IX.3.2 Retention of the end-use actions

The retention of an end-use action mainly depends on the following factors: technical (or design) lifetime, measure installation, measure failure, measure removal, obsolescence<sup>57</sup>, changes in the building stock (renovations, remodels, alterations, additions).

The CWA document includes two other aspects:

- *“**economic lifetime**: 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. For example, smaller CHP units are sometimes switched off because the ratio between fuel prices (costs) and electricity prices (benefits) has become too unfavourable”*
- *“**behavioural/social lifetime**: electronic appliances are frequently replaced before the end of their technical lifetime due to behavioural or social reasons (e.g. because audio or video systems with new features enter the market)”*

These issues are the object of the retention studies:

- **retention studies** *“collect data to determine the proportion of measures that are in place and operational. The primary evaluation components of a measure retention study are research design, survey-site visit instrument design, establishing the definition of an operable status condition, identifying how this condition will be measured, and establishing the data collection and analysis approach”* [TecMarket Works 2006 p.111]

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<sup>57</sup> e.g. when a component cannot be found on the market (for technical or economic reasons) as spare part of a product that shall be maintained or repaired

However, by definition, the final lifetime of an end-use action can only be checked when the action "dies", which in certain case may require to wait for many years before getting this final result. That's why the concept of **EUL (Effective Useful Lifetime)** was developed: "*an estimate of the median number of years that the measures installed under a program are still in place and operable*" [TecMarket Works 2006 p.224]. The EUL issues are addressed by EUL analysis studies:

- **EUL analysis studies** : their objective "*is to estimate the ex-post EUL, defined as the estimate of the median number of years that the measures installed under the program are still in place, operable, and providing savings (...) the evaluator should propose a method for estimating a survival function and a survival rate of measures installed over time using standard techniques*" [TecMarket Works 2006 p.120]

Skumatz [2005] analysed 94 retention studies to bring out the best practices and errors to avoid for each step of a retention study. Their synthesis provides recommendations for future studies, and enabled to update a list of reference values of EUL per end-use action now used for the evaluations of energy efficiency programmes in California<sup>58</sup>.

The results defined ex-post did not differ significantly from the deemed ex-ante values used before, the retention rate<sup>59</sup> being very high. But the main conclusion of Skumatz et al. is that the retention studies have to be planned on **longer periods**, and taking into account that the size of the samples has to be larger in order to get more examples of failures or removals, and then get a better understanding of it. Otherwise, the ex-post verifications do not increase really the accuracy of the reference values.

Besides, Skumatz et al. also highlighted that for special types of end-use action, **some ex-post verification remains necessary**.

### IX.3.3 Performance degradation of the energy savings

Performance degradation studies "*produce a factor that is a multiplier used to account for both time-related and use-related change in the energy savings of a high efficiency measure or practice relative to a standard efficiency measure or practice.*" [TecMarket Works 2006 p.116]

Proctor Engineering Group [1999] made a synthesis of the performance degradation studies performed in California in the 1990's. Their main result is a list of reference values for **TDF (Technical Degradation Factors)** for the most usual end-use actions. This TDF is defined as "*a scalar to account for time and use related change in the energy savings of a high efficiency measure or practice relative to a standard efficiency measure or practice.*" In practice, "*the TDFs are a series of yearly numbers which when multiplied by the first year savings yield an estimate of the energy savings in years subsequent to the first year*".

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<sup>58</sup> this list is available at <http://eega.cpuc.ca.gov/deer/home.asp>

<sup>59</sup> retention rate: percentage of end-user actions still effective after a given number of years

The authors highlighted that, as for the calculation of energy savings, the persistence of these energy savings also has to be considered in comparison to a baseline, i.e. the research question of a persistence study is: *“how will DSM program savings be affected over time by changes in the technical performance of efficient measures compared to the technical performance of the standard measures they replace?”*.

Consequently a TDF may be lower or higher than 1. Lower when the energy-efficient action is more affected over time than the standard one, and higher in the opposite case. This means that **energy savings may decrease, remain the same, or even increase over time, compared to the standard situation.**

The authors also concluded that **reference values can be defined**, avoiding to verify persistence ex-post for each programme. They recommended to gather the performance degradation studies and to plan them in order to **update** the values, with a frequency according to the type of end-use action. The more variations are observed in TDF values from one study to another, the more frequent should be the study.

The results provided by Proctor Engineering Group give a first insight about where could be the need for persistence studies. For instance, most of the 25 end-use actions considered in their study have a constant FTD of 1, showing these actions are not affected over time. In comparison, two of these actions, dimmable daylighting controls and process adjustable speed drives, have their FTD significantly decreasing over time (until respectively 0,2 and 0,47 in the 20<sup>th</sup> year). These types of actions should then be treated with a special attention.

## **IX.4 Final proposals to address lifetime and persistence issues**

Based on the Californian experience described in the above section IX.3, we recommend to address **separately** the **lifetime** (or retention) and **persistence** (or performance degradation) issues.

### **IX.4.1 Step 4.1: defining saving lifetimes per type of end-use action (for ESD purpose)**

The first question to answer in step 4 is **whether the end-use action is still effective in 2016.**

This question should be first treated ex-ante as a **preliminary step** to the evaluation, considering **reference values** as these defined in the CWA27 (see Annex VI). As soon as the European Commission will have updated the list of lifetimes presented in Annex IV of the ESD based on CWA 27 results, this must also be taken into account.

Then the evaluation method should specify whether it is relevant to require an **update** of the CWA27 values and/or to require any **ex-post verifications**.

The aim of step 4.1 is to define saving lifetimes per type of end-use action. These values should **include the factors which could affect the retention rate** of the end-use actions<sup>60</sup>:

- rate of effective installation

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<sup>60</sup> We propose here a synthesis of the factors introduced by [Vine 1992] and these of the CWA27 document.

- risk of failures
- changes in the building stock (renovations, remodels, alterations, additions)
- occupancy changes: turnover in occupants, changes in occupancy hours and number of occupants
- conditions of commissioning, operation (behaviour) and maintenance
- reasons for removal: economical (because the efficient solution is not considered cost-effective anymore) or social (because the efficient solution is not considered "attractive" anymore, e.g. due to new products on the market)
- rate of effective application (for organisational and behavioural actions)

Addressing issues related to saving lifetimes, it should be first considered in which of the three groups introduced in Table 14 the type of end-use action belongs to:

- for saving lifetimes accepted to be **longer than 25 years**, there is a priori **no need for additional discussions**, and there should therefore be no differences between MS
- for saving lifetimes from **10 to 25 years**, additional discussions could be needed **only in the case of early actions**, and there could be some differences between MS in special cases
- for saving lifetime **shorter than 10 years**, the factors listed above should be considered, differences between MS are likely, and therefore either the Commission should coordinate an evaluation effort on this issue, or the MS should be incited to define their own values

This analysis highlights that the needs for additional discussions will be mostly targeted on the end-used actions with a saving lifetime deemed to be shorter than 10 years.

The second point to consider in step 4.1 is whether the type of end-use action appears to be **reversible**. The end-use actions are again assorted in **three categories**:

- not removable (e.g. cavity wall insulation)
- easily removable (e.g. CFL)
- reversible (e.g. organisational and behavioural actions)

This distinction could be an easy way to make a pre-selection of the factors to consider:

<b>Category of end-use action</b> <b>Factors to consider</b>	Not removable	Easily removable	Reversible
- rate of effective installation	X	X	X
- risk of failures	X	X	X
- changes in the building stock	X	X	X
- occupancy changes	X	X	X
- conditions of commissioning, operation (behaviour) and maintenance		X	X
- reasons for removal		X	X
- rate of effective application			X

**Table 16 - factors to consider according to the reversibility of the end-use action**

Based on these considerations and as a conclusion for step 4.1:

- 1) (EMEEES task 4.2) it should be checked whether **additional discussions** to what was adopted in the CWA27 are necessary (according to Table 14)

- 2) (EMEEES task 4.2) if additional discussions are required, the **factors** should be selected, which may affect the saving lifetime of the end-use action (according to Table 16)
- 3) (EMEEES task 4.3) after a **review** of the available information, it should be specified what **kind of value** can be defined:
  - a **harmonised** value (see also section IX.2.2.1), in case the influence of the correction factors is well-known and the variations among MS are limited (+/- a given percentage to be specified by the Commission or the art.16 Committee)
  - a **default** value (see also section IX.2.2.3), in other cases

Whatever the available information, at least a default value based on expert statements should be defined.

- 4) (EMEEES task 4.2) Level 2 and 3 values are always possible when the level 1 value defined is less than 10 years (or less than 25 years for early actions). In that case, **requirements** should be specified to ensure MS use harmonised methods to define their values. These requirements should at least include:
  - the list of factors to be considered
  - the list of minimum information to provide (about the values and the way they are defined)
- 5) (EMEEES task 4.3) the experts who develop a method should consider the reliability of the level 1 value they adopt, and when necessary, they should propose to update the value and/or to ask for specific studies coordinated by the Commission (especially retention studies should be asked when energy savings are claimed for organisational and/or behavioural actions alone)

If it is decided to perform specific studies to improve the quality of the saving lifetime value, it should be reminded that the aim is first to understand what is influencing this value, and how it can be controlled.

Indeed, most of the time, a more reliable value will be possible only if it is associated with a condition on the product or on the implementation of the action<sup>61</sup>. For instance, the saving lifetime for CFLs could be improved by specifying conditions on the quality of the CFLs.

#### **IX.4.2 Step 4.2: performance degradation of the energy savings**

The first point to be dealt with in step 4.2 is to list the factors, which may affect the performance of the end-use action, in comparison to the "regular" performance degradation for the corresponding standard solution.

The usual factors to be considered are:

- performance or energy efficiency decay

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<sup>61</sup> This approach is similar to a quality control. If a minimum quality is ensured for the implementation of the end-user action, its results are supposed to be more reliable.

- conditions of operation (behaviour) and maintenance<sup>62</sup>
- changes in usage patterns

Specific factors may be added according to the type of end-use action.

Based on the factors selected and on the review on available information (EMEEES task 4.2), the experts who develop an evaluation method should then:

- (EMEEES task 4.2) clarify what should be the standard solution the end-use action is to be compared to
- (EMEEES task 4.3) propose a default value for TDFs (Technical Degradation Factors) for a 9-year period (i.e. 9 annual TDFs that are lower than, equal to, or higher than 1): this value should be "realistically" conservative<sup>63</sup>
- (EMEEES task 4.2) specify requirements for defining level 2 and 3 values, including at least:
  - the list of factors to be considered
  - the list of minimum information to provide (about the values and the way they are defined)
- (EMEEES task 4.3) propose specific studies if they are likely to improve the TDF values (such studies should especially be considered for organisational and behavioural actions)

As for saving lifetimes, when it is decided to perform specific studies to improve the quality of the TDFs, it should be recalled that the aim is first to understand what is influencing the performance of the end-use action, and how it can be controlled.

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<sup>62</sup> This factor may affect both the saving lifetime and the performance over time

<sup>63</sup> Values much smaller than 1 should be argued and based on concrete evidences.

## **X- Special ESD issue: accounting for ‘early action’**

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ESD Annex I(3):

*“Energy savings in a particular year following the entry into force of this Directive that result from energy efficiency improvement measures initiated in a previous year not earlier than 1995 and that have a lasting effect may be taken into account in the calculation of the annual energy savings. In certain cases, where circumstances can justify it, measures initiated before 1995 but not earlier than 1991 may be taken into account. **Measures of a technological nature should either have been updated to take account of technological progress, or be assessed in relation to the benchmark for such measures.** The Commission shall provide guidelines on how the effect of all such energy efficiency improving measures should be measured or estimated, based, wherever possible, on existing Community legislation, such as Directive 2004/8/EC of the European Parliament and of the Council of 11 February 2004 on the promotion of cogeneration based on a useful heat demand in the internal energy market and Directive 2002/91/EC.”*

So according to this ESD statement, there is a need for special accounting rules concerning the so-called early action(s).

### **X.1 Conditions for early actions to be eligible**

A basic question that needs to be clarified by the European Commission with the help of the Committee according to Art.16 of the ESD is the nature of early actions:

- Are they **early facilitating measures**, and only those energy savings that result from end-use actions that are implemented during 2008-2016 as a result of these facilitating measures are eligible? The fact that energy savings are related to a “before” and “after” situation may point to this interpretation, as does the formulation in ESD Annex I given above. Examples for this interpretation are building codes and energy taxes initiated between 1995 and 2008 and still in place in 2008 and later years until up to 2016.
- Or are they **early energy savings** in 2008 (and later years until up to 2016) from **end-use actions** initiated between 1995 and 2008, with the end-use actions having a lasting effect in 2008 and later years until up to 2016, and eligible for counting towards the target? The formulation in ESD Annex I given above can also be read in this sense. These energy savings would then have to be calculated compared to the “before” situation for the respective end-use actions in a year to be defined between 2008 and 2016 (cf. next section).

If the second interpretation is valid, the first necessary condition for an early action to be eligible will be that its **saving lifetime** enables to consider it has lasting effect in 2016. For instance, an end-use action with a saving lifetime of 10 years started in 2005 will not be effective in 2016 and therefore will not be accounted for (see sections IX.1 and IX.4.1, and Annex VI).

It needs clarification by the Commission and the Art. 16 ESD Committee, which of the two definitions is valid. A working clarification has been made that early energy savings can only be counted, if the energy efficiency level achieved by the end-use actions taken (and creating the energy savings) is still better than the baseline energy efficiency level (in the following abbreviated as „baseline“) in 2008 for the same types of end-use actions; and only the energy savings relative to the baseline in 2008 can be counted. I.e., the energy saving will be treated, as if it had been achieved in 2008.

## X.2 Special accounting rules for early actions

**How to deal with early actions, according to the types of facilitating measures, needed to be treated in task 4.2 for each method, especially considering cases such as building regulations or energy taxation, which may probably represent early actions claimed for by many MS.**

As emphasised in ESD Annex I(3), “*measures of a technological nature should either have been updated to take account of technological progress, or be assessed in relation to the benchmark for such measure. The Commission shall provide guidelines on how the effect of all such energy efficiency improving measures should be measured or estimated, based, wherever possible, on existing Community legislations*”. This backs the working clarification mentioned above that, **if early energy savings are allowed, the situation "before" should be assessed taking into account what is the present standard (baseline) level of energy performance in 2008** (whatever the starting year of the early end-use action). The annual energy savings from new end-use actions taken after 1 January 2008 as a result of early facilitating measures should be measured against the baseline in each year between 2008 and 2016. And to define this present standard level, references stated in EU Directives (e.g. about energy labels and EcoDesign standards) should be used as much as possible.

*Example: if a building has been constructed in 2005 according to the new building code of 2001, and the energy performance level is, say, 70 kWh/m<sup>2</sup> per year, whereas the EU-wide baseline for building codes for 2008 for the respective climate zone is 90 kWh/m<sup>2</sup> per year, an energy saving of 20 kWh/m<sup>2</sup> per year can be counted (early energy savings).*

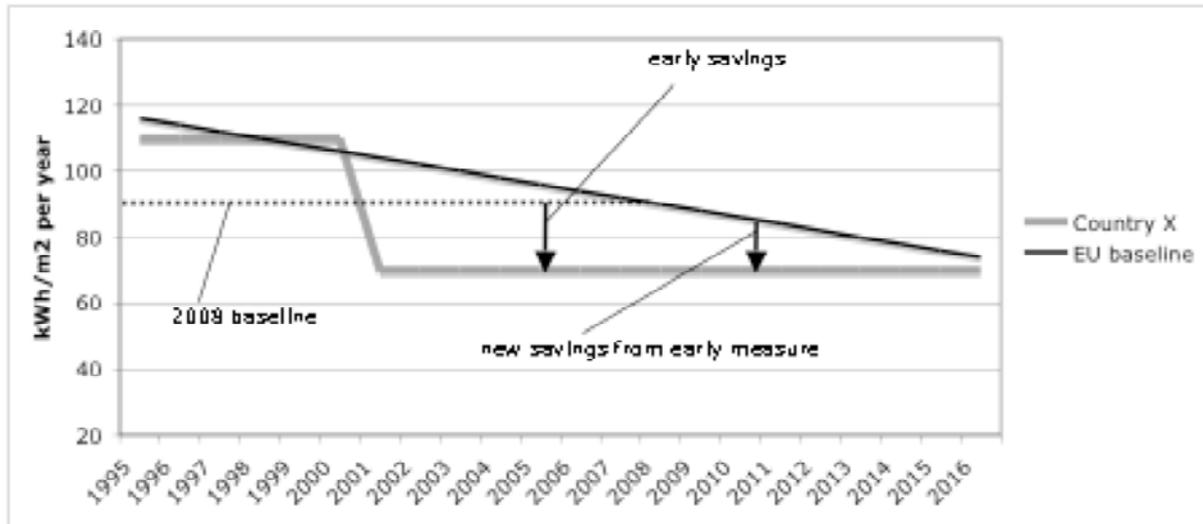
*If the building code from 2001 continues to be in effect after 2008, and the EU-wide baseline for building codes is still above 70 kWh/m<sup>2</sup> per year in, say, 2010, for the new buildings constructed in 2010 an energy saving equivalent to the difference between the baseline and the 70 kWh/m<sup>2</sup> per year can be counted towards the target (the building code from 2001 is then an early facilitating measure).*

The EU-wide baseline for building codes could be defined as the average of the thirteen EU Member States with the weakest requirements, i.e., the highest allowed kWh/m<sup>2</sup> per year, in 2008, and then extrapolating the past trend for this number into the future.

*On the other hand, if a rebate programme in a Member State in 1999 encouraged the purchase of A label appliances, and in 2008 A label is the market average in that Member State, no energy savings can be counted for.*

The following figure illustrates the example of the building code from 2001 and the energy savings attributable to a building constructed in 2005 (yielding early energy savings), and one

constructed in 2010 (yielding new energy savings from the early facilitating measure, i.e. the 2001 building code). It shows that the „value“ of that building code for ESD compliance is reduced over time, as the baseline efficiency level improves. This is justified, as it provides an incentive to adapt the building code to technical progress and achieve higher energy savings.



**Figure 10 - Energy savings from an early building code relative to the EU-wide baseline**

When interpreting Figure 10, it should be noted that the accumulated annual energy savings in 2016 are given by the summation over the years between 2001 and 2016 of the product

(energy savings in kWh/m<sup>2</sup> per year for year *i* (from the figure) ) \* total number of m<sup>2</sup> in dwellings built in year *i* in the country.

It is not that they almost vanish by 2016 as the figure might suggest. What almost vanishes are the new savings that can be claimed for new buildings constructed in 2016, unless the level of the national building code is updated after 2008 to reflect technical progress!

While addressing the accounting of early actions, two special issues should also be kept in mind:

- past EEI measures (implemented before 2008) may be a reason for free-riders for EEI measures implemented within the ESD period, in other words, multiplier effects of past measures may be equivalent to free-rider effects of new measures
- likewise, past EEI measures may have raised the 2008 baseline energy efficiency level<sup>64</sup>, so it should be considered how to deal with cases where a successful past measure has significantly improved the standard situation in a given MS (compared to others), leading to a reduction of the energy savings accounted for the ESD target in comparison to other MS (for this particular end-use)

<sup>64</sup> E.g. the effect of strengthened standards is the difference in savings between old and new standards.

For this latter point, it should also be reminded, that if a MS had implemented such successful measures in the past, then its ESD target has been reduced approximately in the same proportion as its energy savings will be reduced (as the target is a percentage of the energy consumption).

## XI- General conclusions

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### ► About the general approach

The rich consortium of the EMEEES project and the dissemination & exchanges activities offered a **unique platform to put experiences in common**. At the same time, one of the main conclusions from the debates about key evaluation issues (e.g., setting baselines) is that it is often difficult to let own experiences, standpoints or habits aside in order to agree on common rules. One will always better accept them when they are in line with the rules one is used to. Likewise, when coming from different horizons, it is first needed to **adopt a common language**, in order to avoid misunderstandings.

It was then necessary to find a framework which enables clarifying what the issues were, defining common minimum requirements while letting some freedom to Member States for the choice of their evaluation strategies. Nine national workshops covering 21 Member-States were organised to discuss the results of the EMEEES project with concerned stakeholders (ministries, national agencies, energy suppliers, etc.). The main principles of the bottom-up methodology were also presented at EDMC meetings.

It stands out from these exchanges that **the proposed approach based on the four steps calculation process and three levels of evaluation was recognised as a relevant solution**. It was especially acknowledged that this approach provides a structure enabling to address evaluation issues in a systematic (and not case by case) way. It was also useful to clarify what the issues were to non-expert people.

The **three levels approach** proved to be a clear guidance for priority setting in the energy savings calculation. But it appeared to be difficult to produce EU default values for level 1 evaluations. Nevertheless the vast majority of the case applications provided some default values (not always for unitary savings, but also for key parameters). More and better default values should become available as Member States will start reporting for the ESD and from ongoing projects and evaluations.

Also the dynamic approach (for the main areas at least a level 2, and for the key areas increasing level 3) is already visible in several case applications, where a level 2a and 2b is presented. Likewise, when Member States report their savings (probably mainly at level 2), this will generate information to improve formulas and default values, and for experience sharing on evaluation practices.

The three levels approach will also ease the comparison of reported energy savings from Member-States.

The **four steps calculation process** turned up to be a useful frame for the documentation of the energy savings (how they were calculated). In order to avoid administrative burden, this frame may not be used for all reported measures, but more at a general level for the main facilitating measures of the NEEAP, when describing their monitoring & evaluation system.

However, a common general structure for documentation of savings (see the proposed one in Annex I) would provide a quality assurance (on data, sources, etc.) that would enable the

Commission to well compare data provided by the Member-States. This frame addresses issues that do not necessarily need to be harmonised at an EU level, but that are relevant when evaluating savings. By pinpointing the main evaluation issues, the aim is to induce better evaluation designs and practices.

In parallel, for certain specific issues (free-rider and multiplier effects, rebound effects, technical interactions), there is still some knowledge or experience missing and the (few) corresponding suggested default values are likely to be provisional ones.

### ► About setting baselines

The most debated issue was definitely how to set baselines. Here discussions were not only technical but also (and often above all) political, as the rules for baselines can change significantly the height of the ESD target. So instead of looking at what technical methods should be used for setting baselines, the debates often focused on whether the energy savings calculated should be additional or all energy savings.

Indeed, it is one of the advantages of the bottom-up evaluations to look at the link/causality between the results (energy savings) and the actions (EEI measures). One option to quit passions out of the debates could be to consider two functions for the evaluation (which are actually its basic functions as defined in evaluation theories):

1. reporting energy savings = evaluating how much savings have been achieved, either whatever the cause (then looking for “all” savings) or only those due to the combination of facilitating measures (“additional” savings), as preferred by a Member State, but in any case stated which one is reported
2. evaluating cost-effectiveness of the facilitating measures = looking at how much savings were likely to be really linked with the evaluated facilitating measures

The first function is the one required for any measure reported for ESD purpose. The second one could be required for the 4 or 5 main facilitating measures of each NEEAP.

It is likely that evaluating “additional” savings with bottom-up methods is more expensive than evaluating “all” savings because of the need to also evaluate free-rider effects for “additional” savings, but it also brings information with a much higher added value. It seems quite inconsistent that Member States all claim for (sometimes very) ambitious NEEAPs, that they want the EU to be the shining star of energy efficiency in the world, and that they refuse to look at what is actually achieved by the money they put in energy efficiency. The exemplary role of Member States should also include that they know the results of their actions, in order to better detect success factors, best practices, etc.

This is an essential question, as one of the ESD’s objectives is to encourage the dissemination of best practices, and the experience sharing. This is not possible, just by looking at “all” savings.

Anyway, whatever the results to evaluate (“all” or “additional”), the final proposal to consider three main baseline cases (replacement, retrofit and new) appeared to be a pragmatic compromise between distinguishing really different situations and limiting the number of cases to keep the rules simple.

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### ► About developing case applications

It is not an easy work to develop case applications, and as experts in each specific field were involved in this task, there is a tendency to increase the level of details. Especially for the discussion within the EMEEES project team and the peer review, the size of a case application increased every time. On average the case applications hold 40-60 pages. During the national and other dissemination workshops of the project, it was obvious that there were two main groups: experts who always want more elements and details on the one hand, and policy makers and other stakeholders who want more general and simplified rules.

### ► General experience feedback

Options proposed by EMEEES for each evaluation issue were not always agreed upon (in the different dissemination activities). But EMEEES results were appreciated as a good starting point, especially for the debates within the EDMC.

The outcomes from the pilot testing (EMEEES WP8) of the evaluation methods usefully complete the work presented here, especially on practical issues such as feasibility of data collection and evaluation costs.

### ► What's next?

At the end of 2008, the Energy Demand Management Committee started a discussion on common principles for methods to measure energy savings for ESD reporting purposes. The resulting guidelines should be available by December 2009. For the bottom-up calculations, the three levels approach and the three main cases for baselines were included in the document proposed by the Commission. The check-list also proposed by EMEEES (see Annex I) could be a good starting point for additional guidance.

The very significant (in size and in quality) materials produced by EMEEES lead however to a double face analysis:

- on the one hand, it is a very useful basis for the continuation of the ESD implementation;
- on the other hand, the gained experiences also show that it would be a nightmare if on EU level for the vast majority of policies, measures and actions such case applications should be developed, approved and be used by the Member-States: this would need a project team working for several years, a lot of experts devoting their time on discussion and long decision making process in the EDMC, and thousands of pages with instructions to be maintained and updated.

One of the implicit objective of EMEEES WP4 was to test to what extent it was possible to develop concrete evaluation methods ('case applications') for well-specified cases. The answer is then that it is possible to develop such methods using the available material (evaluation methodologies, detailed studies on specific technologies, etc.). This has provided new concrete materials to illustrate the debates about key evaluation issues (so far there were many methodological documents, but very few concrete case applications available). Options proposed by EMEEES for each evaluation issue were not always agreed upon (in the different

dissemination activities). But EMEEES results were appreciated as a good starting point, especially for the debates within the EDMC.

This was a useful and necessary step in the quest of developing a harmonised evaluation system. But it is not anymore the direction to follow.

Of course, not all issues were solved within this project, and additional discussions and work will be needed. But the following conclusions can already be drawn:

- harmonisation rules should be focused on general principles (e.g. rules for defining baselines) and on a common reporting template: several key elements are already under discussion in the EDMC for the definition of common principles.
- concrete evaluation methods are useful to provide a technical support to Member-States and to show the applicability of the general principles, but it would not be relevant to develop methods for all possible sectors (i.e. all sectors, technologies, etc.) as it would be a resource consuming and endless process;
- consequently, Member States should be free to use their own methods, as long as they use the harmonised reporting template;
- results and conclusions from the performed evaluations should be used over time to define quality criteria for both, the evaluation methods and the energy efficiency measures.

Additions to the key guidelines discussed by the EDMC could be developed, using the EMEEES case applications, dealing with measurements and energy savings calculations, and with reporting. To help the improvements in calculations and reporting over time, guidance and tools could be developed dealing with e.g., EU default values and benchmarks, preferred EU formulas, quality criteria for data. The case applications could be used as examples (good practices).

Setting up an evaluation system is indeed a formative and continuous process (see the Californian experience related in [Vine et al., 2006]. This is especially true when the system has to be harmonised between several countries.

Other recent experiences could be looked at in the US: the development of a common protocol in the Northeast States [Michals and Titus 2006], and at the national level [NAPEE 2007, Schiller 2007]. These experiences were too recent to be used in the EMEEES project. They are based mainly on the same methodological sources, adapted to the different contexts. What will be interesting and valuable is to see how the corresponding protocols will be implemented, to have a new hands-on experience feedback. The main conclusion from these recent experiences (and also from the experience gained through EMEEES) is that a key solution for a cost-effective evaluation system is to group evaluation studies as far as possible. This will be especially relevant for countries with limited budgets for evaluation.

Finally, it appears from the EMEEES dissemination activities (in particular from the final EMEEES conference in Brussels in October 2008) that training activities would be a key success factor when looking for improvements of evaluation practices among all Member States. Such support is needed to encourage experience sharing for both evaluation and implementing EEI measures.

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## Annex I: general frame for presenting the results of an evaluation

### ► First proposal

A first template was partly based on the one proposed within EMEEES Work Package 7, and partly based on the template for an evaluation method proposed in Chapter V-. It is presented hereafter.

<b>Description of the EEI measure evaluated</b>	
<b>Title of the EEI measure</b>	
<b>Facilitating measures (or instruments)</b>	<i>See Table 10</i>
<b>Regional application (or target area)</b>	<i>( whole country or specific areas ?)</i>
<b>Target group and share of energy consumption</b>	<i>Energy consumption sub-segment/sector which is addressed by the EEI measure + share of final energy consumption of this target group compared to the total energy consumption addressed by the ESD in the respective Member State</i>
<b>Energy carrier and conversion factor applied</b>	
<b>End-use action(s) (or efficient solution(s)) targeted</b>	<i>See Table 1</i>
<b>Planned / implemented actions</b>	<i>Detailed qualitative description of the single elements of the EEI measures and of the way in which the EEI measure leads to energy savings at the final energy consumer (“effectiveness model”); the description should not exceed 2000 characters (if necessary more detailed information can be included in an Annex).</i>
<b>Links with other EEI measures</b>	<i>(especially if other measures target the same (sub)sector and/or efficient solution) risks of overlap (and double counting) ? synergies ?</i>
<b>Barriers addressed</b>	<i>Explanations about what barriers the measure is supposed to address and how</i>
<b>Status of implementation and exact timeframe</b>	<i>Concerning their status of implementation, the EEI measures should be categorised as follows: EEI measure implemented as described no earlier than 1995 (1991) and still effective in 2010 and 2016 respectively; no major adaptations planned – “Early Actions” EEI measure implemented as described no earlier than 1995 (1991) and still effective in 2010 and 2016 respectively, major adaptations as described – “Early Actions” new EEI measure, process of implementation started</i>

	<i>new EEI measure, process of implementation not started yet</i> <i>What is the exact date of start and end of the EEI measures?</i> <i>What is the exact date of start and end of the period, for which the results of the evaluation of the EEI measures are provided here?</i>
<b>Responsible body for implementation</b>	<i>Names and contacts</i>
<b>If available: expected (ex-ante) annual energy savings in 2016</b>	<i>Quantity in GWh per year that is expected to be achieved in 2016</i>

<b>Results of the EEI measure evaluated</b>		
<b>General description of the baseline (situation without the measure)</b>	<i>Baselines for the level of energy consumption and/or situation of the market related to the efficient solution (short description)</i>	
	<i>Results</i>	<i>Uncertainty range</i>
<b>Total ESD annual energy savings in 2016 (in GWh)</b>		
<b>Unitary gross annual energy savings (in kWh/year, first year)</b>		
<b>Gross number of implemented actions / participants by {year #, end of period of evaluation}</b>		
<b>Total gross annual energy savings (in GWh/year, first year) achieved by {year #, end of period of evaluation}</b>		
<b>Share of multiplier and free-rider(?) effects (+ double counting discount, when relevant)</b>		
<b>Total ESD annual energy savings (in GWh/year, first year) achieved by {year #, end of period of evaluation}</b>		
<b>Share of actions still effective in 2016</b>		
<b>Average level of performance for the end-use actions in 2016 (compared to first year of implementation)</b>		
<b>Information about the cost-effectiveness of the measure (if available)</b>	<i>For instance: total expenses, transaction and administrative costs, investment costs per actions, energy cost savings for the national economy and for the end user, etc.</i>	

<b>Description of the evaluation</b>	
<b>Detailed description and explanations of the baseline used</b>	<i>Description of the "before" situation used (see section VI.2)</i>
<b>Main data sources used / main evaluation activities</b>	<i>Statistics, surveys, on-site inspections, etc.</i>
<b>General treatment of the uncertainties</b>	<i>See section IV.1</i>
<b>General formula / calculation model used</b>	<i>See sections VI.1 and VI.4 (the details of the calculation should be added in an annex)</i>
<b>Normalisation factors applied</b>	<i>See section VI.3</i>
<b>Level of evaluation efforts related to the unitary gross annual energy savings and difficulties faced</b>	<i>See section IV.1 (detailed description of definitions of level 2 and 3 values should be added in an annex)</i>
<b>Details about the monitoring of the number of actions/participants</b>	<i>See section VII.2</i>
<b>Gross-to-net factors applied</b>	<i>See section VIII.1</i>
<b>Details about multiplier effect (when relevant)</b>	<i>See section VIII.4</i>
<b>Details about double counting (when relevant)</b>	<i>See sections VIII.2 and VIII.3</i>
<i>Details about free-rider effect (when relevant) (?)</i>	<i>See section VIII.5</i>
<b>Details about savings lifetime</b>	<i>See section IX.4.1</i>
<b>Details about performance degradation</b>	<i>See section IX.4.2</i>
<b>Other available documents related to the measure and its evaluation</b>	

### ► “Final” check-list

Based on the feedback from the several dissemination activities of EMEEES (here mainly the discussions with the Commission), the initial template was updated in a check-list which corresponds more to the expectations of the Commission and the Member-States. So far, this is only a proposal, which could be used as a basis for the discussion in the EDMC. This “final” check-list is presented hereafter.

#### ► Measure(s) and evaluation details

Name of the measure (or group of measures):

Contact person(s) for the measure(s):

Organisations involved in the measure(s) implementation:

Contact person(s) for the evaluation:

Organisations involved in the evaluation:

► **Short description of the measure(s)**

Target group:

Targeted type of final energy (fuel) and end use:

Concrete end-use actions facilitated (please list)<sup>65</sup>

Period for which the measure has been evaluated:

Short description of the measure(s) (including eligibility requirements for participation/actions, level of financial incentives, if any, and role of actors)<sup>66</sup>:

► **Main results**

It is possible to present values for *all* energy savings (compared to the status quo without any of the targeted end-use actions) and for energy savings *additional* to the end-use actions taken autonomously by final consumers or other actors.

**All** annual energy savings in 2016 (or 2010) (in GWh):

**Additional** annual energy savings in 2016 (or 2010) (in GWh):

Other important results:

► **Calculation process, STEP 1: Unitary gross annual energy savings**

- **Is an average or a participant-specific value used** (in kWh per unit, per action or per participant):

is it :

- a level 1 default average value ? Please provide the value:
- a level 2 national average value? Please provide the value:
- a level 3 measure-specific average value? Please provide the value:
- a level 3 participant-specific value ?

<sup>65</sup> ESD Annex III provides examples (a) to (o) of end-use actions, which are not exhaustive

<sup>66</sup> The Appendix to this checklist provides a non-exhaustive list of types of measures

- **calculation method(s) used:**

- direct measurement
- billing analysis
- enhanced engineering estimates
- mix of ex-ante and ex-post data
- deemed savings
- other:

- **definition of the baseline:**

for the calculation of the unitary gross annual energy savings:

- level 1: implicit baseline in the default value ?
- level 2: average energy consumption based on national statistics or samples ?
- level 3 (measure-specific): average energy consumption based on measure-specific definition/eligibility requirements of energy-efficient end-use actions, regional statistics or samples ?

In these cases, is the baseline based on

- the stock (before action) situation?
- the inefficient market (without measure) situation?
- another reference situation for new buildings or equipment? If yes which?

Or is the baseline a

- level 3 (individual) baseline: before action energy consumption specific to the participants, based on measurements, metered data or energy bills ? Or energy consumption of the participants if they would not have taken advantage of the evaluated measure ?

- **definition of the value of specific energy consumption for the energy-efficient solution:**

for the calculation of the unitary gross annual energy savings:

- level 1: implicit average value in the default value ?
- level 2: average energy consumption based on national statistics or samples ? How has the energy-efficient solution been defined (e.g., threshold value for specific energy consumption or specific technology parameter or choice):
- level 3 (measure-specific): average energy consumption based on measure-specific definition/eligibility requirements of energy-efficient end-use actions, regional statistics or samples ?

- **main data used:**

Level 1 (European) data (and vintage):

Level 2 (national) data (and vintage):

Level 3 (measure-specific) data:

- **normalisation factors:**

→ What normalisation factors (see ESD Annex IV(1.2)) were taken into account?

How were they applied:

- **conversion factors:**

→ Was it necessary to use conversion factors (see ESD Annex II + caution: for the ESD, Net Calorific Values shall be used)?

If yes, specify the factors used:

- *rebound effect (optional):*  
→ Was a possible rebound effect considered:  
If yes, how:

► **Calculation process, STEP 2: Total gross annual energy savings**

- **accounting method:**
  - national (or specific) register or database of final consumers or other actors benefiting from the measure
  - other direct accounting (e.g. by vouchers or applications):
  - market analysis
  - survey among participants (all or sample?)
  - survey among a sample of the whole population

→ Was the accounting completed by ex-post verifications (e.g. on-site inspections):

- **main data used:**

Level 2 (national) data (and vintage):

Level 3 (measure-specific) data:

► **Calculation process, STEP 3: Total ESD annual energy savings**

- **double counting**<sup>67</sup> (see ESD Annex IV(5)):  
→ are other measures targeting the same end-users' group or the same energy end-uses and/or end-use actions?  
If yes, how were double counting risks managed:  
  
→ is there any risk of overlap between national and regional or local measures?  
If yes, how was it addressed:
- **technical interaction**<sup>68</sup> :  
→ is there any possibility of overlap between actions?  
If yes, how was it considered:
- **multiplier effects** (see ESD Annex IV(5)):  
→ was the evaluated measure (or group of measures) designed to have multiplier effects?  
→ what multiplier effects were expected?  
→ how were these multiplier effects monitored over time:

<sup>67</sup> Double counting may occur when two measures overlap (e.g. grants and energy audits schemes for industrial companies).

<sup>68</sup> Technical interaction may occur when two actions overlap (e.g. improving both the insulation and the heating system of a building). This is considered a special form of the double-counting issue.

→ what was the result (in GWh/year of the *all* or *additional* annual energy savings reported above)?

- free-rider effects (only if *additional* energy savings have been calculated):

→ were possible free-rider effects considered?

If yes, how were they taken into account:

→ what was the result (in GWh/year of the *all* annual energy savings reported above)?

- *time lag (if relevant):*

→ *was there any risk of time lag in the measure implementation?*

*If yes, how was it addressed:*

→ *does the evaluated measure (or group of measures) include energy efficiency requirements?*

*If yes, how was the compliance ensured / monitored:*

#### ► **Calculation process, STEP 4: Total ESD annual energy savings in 2016 (or 2010)**

- **lifetime of energy savings:**

○ a level 1 European value ? if yes, harmonised or default value?

○ a level 2 national value ?

○ a level 3 measure-specific value ?

○ a level 3 participant-specific value ?

- *persistence effect (optional):*

→ *were the results monitored / controlled over time?*

*If yes how (and what reasons of changes in the results were considered):*

- **early energy savings** (see ESD Annex I(3)):

→ were energy savings from end-use actions taken before 2008 but after 1995 (in special cases 1991) reported?

If yes,

○ how much savings do they represent (*in GWh/year of the all and additional annual energy savings reported above*)?

○ were special calculation rules applied (e.g., a different baseline)?

○ how is it ensured that they will be still effective in 2016?

#### ► **Evaluation quality and uncertainties**

→ what are the specifications / guidelines used to ensure the evaluation quality?

→ how are missing data handled?

→ can the uncertainties on the results be assessed or qualified? If yes, please provide the results

► **Monitoring and evaluation costs**

→ What types of costs are related to the monitoring and evaluation of the measure (or group of measures)?

→ Can these costs be assessed (e.g. in € for the whole evaluation, or in €/kWh saved)?

► **References**

*(mention here the reports produced and any document used for the evaluation)*

## Annex II: proposed list and definitions of facilitating measures

### ► Instruments referred to and/or defined in ESD

As highlighted in part VII-, the term "facilitating measure" is not explicitly referred to in the ESD, but some types of facilitating measures and EEI mechanisms are defined in ESD article 3:

- “(e) **‘energy service’**: *the physical benefit, utility or good derived from a combination of energy with energy efficient technology and/or with action, which may include the operations, maintenance and control necessary to deliver the service, which is delivered on the basis of a contract and in normal circumstances has proven to lead to verifiable and measurable or estimable energy efficiency improvement and/or primary energy savings*”;
- “(f) **‘energy efficiency mechanisms’**: *general instruments used by governments or government bodies to create a supportive framework or incentives for market actors to provide and purchase energy services and other energy efficiency improvement measures*”;
- “(j) **‘energy performance contracting’**: *a contractual arrangement between the beneficiary and the provider (normally an ESCO) of an energy efficiency improvement measure, where investments in that measure are paid for in relation to a contractually agreed level of energy efficiency improvement*”;
- “(k) **‘third-party financing’**: *a contractual arrangement involving a third party — in addition to the energy supplier and the beneficiary of the energy efficiency improvement measure — that provides the capital for that measure and charges the beneficiary a fee equivalent to a part of the energy savings achieved as a result of the energy efficiency improvement measure. That third party may or may not be an ESCO*”;
- “(l) **‘energy audit’**: *a systematic procedure to obtain adequate knowledge of the existing energy consumption profile of a building or group of buildings, of an industrial operation and/or installation or of a private or public service, identify and quantify cost-effective energy savings opportunities, and report the findings*” (see also ESD article 12);
- “(m) **‘financial instruments for energy savings’**: *all financial instruments such as funds, subsidies, tax rebates, loans, third-party financing, energy performance contracting, guarantee of energy savings contracts, energy outsourcing and other related contracts that are made available to the market place by public or private bodies in order to cover partly or totally the initial project cost for implementing energy efficiency improvement measures*” (see also ESD article 9, 11);
- “(s) **‘white certificates’**: *certificates issued by independent certifying bodies confirming the energy savings claims of market actors as a consequence of energy efficiency improvement measures*”

Moreover, other policy instruments and programme types are referred to in ESD Annex III as cross-sectoral or horizontal measures:

- “*Cross-sectoral measures*
  - (p) **standards and norms** that aim primarily at improving the energy efficiency of products and services, including buildings;
  - (q) **energy labelling** schemes;
  - (r) **metering**, intelligent metering systems such as individual metering instruments managed by remote, and **informative billing**;
  - (s) **training and education** that lead to application of energy-efficient technology and/or techniques;”
- “*Horizontal measures*
  - (t) **regulations, taxes** etc. that have the effect of reducing energy end-use consumption;
  - (u) **focused information campaigns** that promote energy efficiency improvement and energy efficiency improvement measures;”

### ► General taxonomy of Facilitating measures and EEI mechanisms

Promotion instruments and EEI mechanisms as listed above from ESD contents express main possibilities suggested by the Directive for MS to encourage implementation of EEI measures. However this presentation is not systematic (e.g. third-party financing gets its own definition but is also a particular instrument of the more general category defined as “*financial instruments for energy savings*”).

A more systematic taxonomy is proposed by IEA guidebook [Vreuls 2005a p.16]:

Category	Subcategories
1 Regulation	1.1 Building Codes and Enforcement 1.2 Minimum Equipment Energy Performance Standards
2 Information	2.1 General Information 2.2 Labelling 2.3 Information Centres 2.4 Energy Audits 2.5 Education and Training 2.6 Demonstration 2.7 Governing by Example
3 financial instruments for energy savings	3.1 Project or Product-related Subsidies (rebates) 3.2 Targeted Taxes, Tax Exemption, Tax Credits 3.3 Financing Guarantees 3.4 Third-party Financing Facilitation 3.5 Reduced-interest Loans 3.6 Bulk Purchasing 3.7 Grants 3.8 Technology procurement

	3.9 Certificate trading systems
4 Voluntary Agreements	4.1 Industrial Companies 4.2 Energy Production, Transformation and Distribution Companies 4.3 Commercial or Institutional Organisations
5 Combinations	

**Table 17 - taxonomy for policy instruments in IEA guidebook**

These instruments are also defined in the guidebook [Vreuls 2005a pp.16-19].

For our methodology, we have to use in priority ESD terms and definitions. So we propose to adapt the IEA guidebook taxonomy with ESD terms:

<b>Category</b>	<b>Subcategories</b>
1 <i>Regulation</i>	<i>Standards and norms:</i> 1.1 Building Codes and Enforcement 1.2 Minimum Equipment Energy Performance Standards
2 Information and legislative-informative measures (e.g. mandatory labelling)	2.1 <i>Focused information campaigns</i> 2.2 <i>Energy labelling schemes</i> 2.3 Information Centres 2.4 <i>Energy Audits</i> 2.5 <i>Training and education</i> 2.6 <i>Demonstration*</i> 2.7 <i>Exemplary role of the public sector</i> 2.8 <i>Metering and informative billing*</i>
3 <i>Financial instruments</i>	3.1 <i>Subsidies (Grants)</i> 3.2 <i>Tax rebates and other taxes reducing energy end-use consumption</i> 3.3 <i>Loans (soft and/or subsidised)</i>
4 <i>Voluntary agreements and Co-operative instruments</i>	4.1 Industrial Companies 4.2 Commercial or Institutional Organisations 4.3 <i>energy efficiency public procurement</i> 4.4 Bulk Purchasing 4.5 Technology procurement
5 <i>Energy services for energy savings</i>	5.1 <i>Guarantee of energy savings contracts</i> 5.2 Third-party Financing 5.3 <i>Energy performance contracting</i> 5.4 <i>Energy outsourcing</i>
6 <i>EEI mechanisms and other combinations of previous (sub)categories</i>	6.1 Public service obligation for energy companies on energy savings including “ <i>White certificates</i> ” 6.2 <i>Voluntary agreements</i> with energy production, transmission and distribution companies 6.3 <i>Energy efficiency funds and trusts</i>

\* Energy savings can be allocated to these subcategories only if a direct or multiplier effect can be proven. Otherwise they must be evaluated as part of a package. Terms in *italic* are these used in the ESD.

(Table 10 - proposed taxonomy for instruments (fit to ESD terms), see also page 64)

This taxonomy is just a proposal in order to list the methods to set up for accounting for number of actions. It should be reviewed by the Commission and/or the Committee to know whether such a taxonomy can be used.

Anyway, MS may use other facilitating measures and therefore set up the corresponding evaluation methods. In this case, they have to ensure their proposal is accepted by the Commission, and these methods have to comply with ESD requirements and with this methodology (if confirmed by the Commission). Especially, the methods should propose three level of efforts, which can be used by all MS, so that once a new facilitating measure is addressed, the same method is used by all, in order to ensure an harmonised evaluation system.

## Annex III: examples of data collection techniques

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### ► Example of data collection techniques used by evaluation firms

A list of data collection techniques is presented by the firm TecMarket Works<sup>69</sup> (see <http://www.tecmarket.net/data.htm>):

Data collection categories	Data collection techniques
One-to-one Data Collection	<ul style="list-style-type: none"> <li>- Interviews - structured and unstructured</li> <li>- Surveys - mail, fax, telephone and Internet</li> </ul>
One-to-many Data Collection	<ul style="list-style-type: none"> <li>- Focus groups</li> <li>- Delphi panels</li> <li>- Workshops for problem definition and solution</li> <li>- Expert panels</li> </ul>
Observation	<ul style="list-style-type: none"> <li>- Billing Data</li> <li>- End-use Metering</li> <li>- Diaries and trip logs</li> <li>- Observation in experimental settings</li> <li>- Content analysis</li> </ul>
Existing Data	<ul style="list-style-type: none"> <li>- Bibliographic searches</li> <li>- Data from Central or Federal state and local sources</li> <li>- Market databases</li> <li>- National opinion data</li> <li>- Corporate databases</li> <li>- Internet searches</li> </ul>
Integrated Data Tracking and Management	<ul style="list-style-type: none"> <li>- Database design and testing</li> <li>- Forms design</li> <li>- Automated field data collection with personal digital assistants and remote data collection hardware</li> </ul>
Analytical Techniques	<ul style="list-style-type: none"> <li>- Univariate analysis</li> <li>- Contingency table analysis</li> <li>- Multivariate analysis</li> <li>- Discrete choice</li> <li>- Discriminate analysis</li> <li>- Billing analysis</li> <li>- Statistical adjusted engineering analyses</li> <li>- Analysis of metered data</li> </ul>

### ► Example of monitoring and data collection systems used by national bodies

The volume II of IEA guidebook [Vreuls 2005b] presents case studies about evaluation systems and examples for eight countries (Belgium, Canada, Denmark, France, Italy,

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<sup>69</sup> TecMarket Works is one of the reference US firms specialised in evaluating EE programmes. For instance, they coordinate the team which set up the Californian Evaluation Framework [TecMarket Works 2004] and the Californian Evaluation Protocols [TecMarket Works 2006].

Republic of Korea, The Netherlands, Sweden). These case studies are presented following a standardised frame, where section 3.2 refers to “overview of monitoring system and data collection”. This section for each country provides examples of monitoring and data collection systems.

## Annex IV: examples of information sources for developing a new bottom-up evaluation method

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The issues related to the evaluation of energy efficiency programmes have been investigated for more than 30 years, as soon as DSM programmes were implemented in reaction to the oil crisis of 1974. The literature and experiences on this subject are then a significant source of information for developing evaluation methods.

We list here some sources we consider very useful. This list does not aim to be exhaustive, and experts can be used to other sources. For instance, we recommend the list of sources and bibliographic summaries presented in the appendix B of [SRCI 2001].

Moreover, the review of evaluations made within EMEEES WP2 is of course a major source of information for tasks 4.2 and 4.3 which will develop bottom-up evaluation methods. Besides the CWA27 document (see section IX.2) is also an important source concerning the issues related to saving lifetime.

It is considered important here to provide examples of additional interesting sources, in case readers look for a basis for their research.

This list contents three categories of sources :

- "classical" sources for scientific literature
- sources for evaluation reports and/or case studies
- sources for evaluation methods and methodology

### ► "Classical" sources for scientific literature

#### The "classical" search engine

- [www.sciencedirect.com](http://www.sciencedirect.com): the search engine of the Elsevier editions, including many reference journals about energy issues, as *Energy Policy*, *Energy and Buildings*, etc.
- [www.scopus.com](http://www.scopus.com): one of the “largest abstract and citation database of research literature and quality web sources”, covering many editors, and with powerful tools to help searching the most interesting results (e.g. Scopus provides results both from literature databases and from referenced web-sources<sup>70</sup>)
- <http://scholar.google.com>: contrary to the previous engine, Google scholar is free to use<sup>71</sup>, it also provides a significant amount of results, including research reports not usually referenced in classical literature database, but the sorting of the results is not always easy to use

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<sup>70</sup> The results from web-sources are provided by the search engine Scirus ([www.scirus.com](http://www.scirus.com)), which is free of use and can be used without passing through Scopus

<sup>71</sup> Searching for publications is free. Then the access to the publications depends on their hoster.

Other similar search engines exist (e.g. [www.sagepub.com](http://www.sagepub.com)), and experts are often used to a particular one. The results from such sources are very valuable when not much experience is already available on a subject and/or for issues still stimulating debates among experts (e.g. rebound effect).

### Well-known conferences on energy efficiency

More and more conferences are organised to deal with energy efficiency issues. We selected here three of them, of particular interests 1) due to the quality of their proceedings, and 2) because their resources are available through their websites (free or not depending on the conference policy):

- [www.iepec.org](http://www.iepec.org): the *International Energy Program Evaluation Conference* is held every two years, and its proceedings gather state-of-the-art papers on most of key evaluation issues and on many experiences of evaluation
- [www.aceee.org](http://www.aceee.org): the *American Council for an Energy Efficient Economy* organises regularly events on energy efficiency, especially the summer studies on energy efficiency in buildings and in industry, and its website provides many interesting proceedings and other resources
- [www.eceee.org](http://www.eceee.org): the *European Council for an Energy Efficient Economy* also organises summer studies every two years, whose proceedings are available on its website

### ► Sources for evaluation reports and/or case studies

Many organisations concerned with energy efficiency programmes maintain databases of evaluation reports, research works and/or case studies.

Here is an arbitrary selection of some of them (some are available from the EMEEES website<sup>72</sup>):

- [http://ec.europa.eu/energy/intelligent/index\\_en.html](http://ec.europa.eu/energy/intelligent/index_en.html): the "IntellEbase" search engine provides an access to more than 600 projects funded within the SAVE and ALTENER programmes of the European Commission
- [http://ec.europa.eu/energy/efficiency/ecodesign/studies\\_en.htm](http://ec.europa.eu/energy/efficiency/ecodesign/studies_en.htm): the EcoDesign studies provide a good overview and state-of-the-art information on Energy using Products
- <http://dsm.iea.org/Publications.aspx?ID=18>: the volume II of the IEA guidebook [Vreuls 2005] presents the case studies of the evaluation system of eight countries (Belgium, Canada, South Korea, Denmark, France, Italy, Netherlands, Sweden)
- the appendix A of the European guidebook [SRCI 2001] presents eight case studies of

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<sup>72</sup> [http://www.evaluate-energy-savings.eu/emeees/en/evaluation\\_tools/bottom-up.php](http://www.evaluate-energy-savings.eu/emeees/en/evaluation_tools/bottom-up.php)

energy efficiency programmes

- <http://www.calmac.org/search.asp>: the search engine of the CALifornia Measurement Advisory Council provides an access to most of the evaluation reports about California energy efficiency programmes conducted using Public Goods Charge funds
- <http://www.cee1.org/db/search/search.php3>: the search engine of the Consortium for Energy Efficiency provides an access to more than 450 research and/or evaluation reports performed in North-America (United States and Canada) about energy efficiency programmes
- <http://www.osti.gov/bridge/basicsearch.jsp>: the search engine of the Office of Scientific & Technical Information of the US Department of Energy provides an access to the studies sponsored by the US DoE
- <http://www.caddet.org/infostore/>: the search engine of the Centre for Analysis and Dissemination of Demonstrated Energy Technologies provides an access to short description of more than 1500 projects about energy efficiency
- <http://www.energie-cites.org/>: the website of the network of European cities maintains a database of more than 500 short case studies of actions or programmes implemented by the members of the network
- <http://www.managenergy.net/casestudies.html>: Managenergy is a initiative of the European Commission to support the work of actors working on energy efficiency and renewable energies at the local and regional level, its website provides short case studies and a list of useful links

## ► Sources for evaluation methods and methodology

We present here a selection of bibliographic references based on three criteria:

- **recognition and/or use** by international or national institutions and/or by energy efficiency professionals (utilities, ESCo, regulatory or other public bodies)
- **up-to-date contents** (based on current state-of-art and/or recent experiences)
- **wide methodological scope** (covering most of main evaluation issues)

Reference	Contents
<b>International Performance Measurement and Verification Protocol [IPMVP 2002]</b>	Prepared for the US Department of Energy (DoE), IPMVP stands as an international reference for M&V (Measurement and Verification) of energy savings. Main inputs from IPVMP are: <ul style="list-style-type: none"> <li>- 4 M&amp;V options to quantify gross energy savings</li> <li>- description of measurement techniques and issues</li> </ul>
<b>Guidelines for the Monitoring, Evaluation, Reporting, Verification, and</b>	Prepared for the US Environmental Protection Agency and US DoE, the MERVC guidelines were developed to evaluate CDM (Clean Development Mechanism) and JI (Joint Implementation) projects within Kyoto protocol framework. Main inputs from MERVC are: <ul style="list-style-type: none"> <li>- global approach from ex-ante registration to ex-post verification</li> </ul>

<b>Certification of energy-efficiency projects for climate change mitigation</b> [Vine 1999]	<ul style="list-style-type: none"> <li>- methodological approach to evaluate net energy savings (estimating gross results, then a baseline, and finally net results)</li> <li>- guidelines to estimate ex-ante an initial baseline (through performance benchmarks), and then to re-estimate it ex-post (through surveys, discrete choice or regression models), in order to better capture free-rider effect</li> <li>- quality assurance guidelines, to ensure quality of performed evaluations and thus reliability of results</li> <li>- reporting forms</li> </ul>
<b>A European ex-post evaluation guidebook for DSM and EE service programmes</b> [SRCI 2001]	<p>Prepared for the European Commission within a SAVE project, the European guidebook stands as an international reference for evaluation preparation and planning guidelines. Main inputs from the European guidebook are:</p> <ul style="list-style-type: none"> <li>- guidelines for evaluation planning</li> <li>- synthetic description of the basic concepts related to the evaluation of EE programmes (especially gross-to-net correction factors)</li> <li>- description of the main techniques for data collection and energy savings calculation</li> </ul>
<b>California Energy Efficiency Protocols and Evaluation Framework</b> [TecMarket Works 2004, TecMarket Works 2006]	<p>Prepared for the California Public Utilities Commission (CPUC), both manuals provide detailed guidelines for energy efficiency programmes evaluation to the evaluation experts and programme managers in charge of it. The Californian Evaluation Framework covers all evaluation issues, forming a very complete state of the art of evaluation practices in United States. The protocols present official requirements and recommended process for programmes evaluation under CPUC regulation. Main inputs from Californian manuals:</p> <ul style="list-style-type: none"> <li>- systematic approach of evaluation work, divided in main issues: M&amp;V and impact evaluation, process evaluation, market transformation evaluation, uncertainty, sampling, cost-effectiveness</li> <li>- detailed treatment of all evaluation key issues (with a significant bibliography)</li> <li>- detailed requirements and organisation of an evaluation scheme in a given regulatory framework</li> </ul>
<b>Evaluation guidebook for evaluating energy efficiency policy measures &amp; DSM programmes</b> [Vreuls 2005]	<p>Prepared within task I of IEA DSM Programme<sup>73</sup>, IEA guidebook objective is “<i>to provide practical assistance to administrators, researchers, and policy makers who need to plan assessments and to evaluators who carry out evaluations of energy efficiency programmes</i>”, especially programmes related to Kyoto greenhouse gas targets. Main inputs from IEA guidebook:</p> <ul style="list-style-type: none"> <li>- a methodological approach based on seven key elements: statement of policy measure theory, specification of indicators, development of baselines for indicators, assessment of output and outcome, assessment of energy savings, calculations of cost-effectiveness, choice of level with regard to the evaluation effort</li> <li>- application of this framework to four main types of EEI programmes (regulation, information, economic incentives,</li> </ul>

<sup>73</sup> International Energy Agency Demand-Side Management Programme, see <http://dsm.iea.org>

	<p>voluntary agreements) and to combinations of these types</p> <ul style="list-style-type: none"> <li>- detailed and standardised description of main evaluation experiences of eight countries (Belgium, Canada, Denmark, France, Italy, Republic of Korea, The Netherlands, Sweden)</li> </ul>
<p><b>Evaluation and comparison of utility's and governmental DSM-programmes for the promotion of condensing boilers [Haug 1998]</b></p>	<p>Contrary to previous references, this SAVE project is not general but specific to a particular energy efficient solution (condensing boilers). It was selected because it presents a well-detailed evaluation approach and because it represents an example of specific material to be used developing a specific method. Main inputs from this particular evaluation:</p> <ul style="list-style-type: none"> <li>- a concrete and detailed evaluation framework, especially to study factors influencing programme success</li> <li>- significant material about market transformation issues, which can be used for other cases of promotion of efficient appliances</li> <li>- significant technical material useful for developing method for other energy efficiency programmes related to heating</li> </ul>

## Annex V: proposals for rules to share energy savings between overlapping measures

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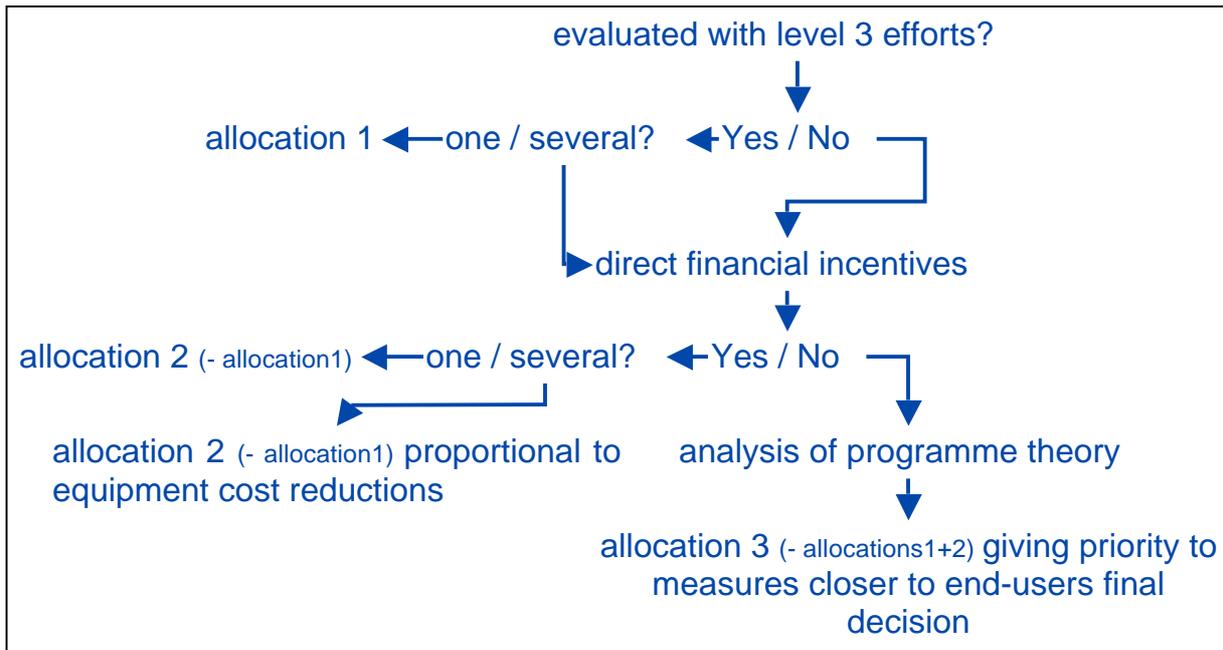
For Member-States which would like to share energy savings between overlapping measures, in order to better know what are the contributions of each measure to their target, propositions of sharing rules are presented below.

For these rules, priority for allocating energy savings depends on two criteria:

- level of evaluation effort
- type of facilitating measure
  
- **1<sup>st</sup> priority – level 3 of evaluation effort:** when some of the overlapping measures have been evaluated with level 3 effort, then their energy savings are allocated to them exclusively. If several "level 3-evaluated" measures overlap, then sharing of energy savings according to the following priorities
  
- **2<sup>nd</sup> priority – measures with direct financial incentives<sup>74</sup>:** when some of the overlapping measures use direct financial incentives, then their energy savings are allocated (if they were not yet allocated to a 1<sup>st</sup> priority measure). If several measures with direct financial incentives overlap, then sharing of energy savings between them, **proportionally to the cost reduction they provide to final end-users.**
  
- other cases (remaining measures not "level 3-evaluated" and without direct financial incentives):
  - step 1: representing programme theory
  - step 2: drawing a hierarchy between overlapping measures, from the measure the most next to final decision of end-user to the measure the most far from this final decision
  - step 3: allocate energy savings of measures next to final decision, as long as energy savings remain to be shared

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<sup>74</sup> direct financial incentives mean here financial incentives proposed to final end-users so that costs of EEI measures for final end-users are reduced



→ example : case of four overlapping measures

- measure 1 : general information for industries (about energy savings potential and announcing measure 2)
- measure 2 : energy audit programme for industries
- measure 3 : subsidies scheme for efficient cogeneration
- measure 4 : specific feasibility assessment to assess cost-effectiveness of a cogeneration unit for a big manufacturing plant

Measure 4 will be evaluated with level 3 effort. So its energy savings will be first allocated.

Measure 3 includes direct financial incentives, so its energy savings will be allocated, deducting energy savings of measure 4.

Measure 2 is next to final decision of end-users, so its energy savings will be allocated, deducting energy savings of measures 4 and 3.

Measure 1 is far from final decision. Unless concrete evidences are reported to show the link between this measure and energy savings, no energy savings are allocated to it. If concrete evidences are reported, then energy savings are allocated, deducting energy savings of the three other measures.

→ it should also be detailed how are deducted the results from one measure to the next ones:

- either overlap can be expressed in terms of number of equipments or participants, and then it is the number of equipments or participants which is deducted
- either overlap can only be expressed in terms of energy savings, then it should be taken into account that only part of energy savings of these measures may overlap (especially when one of the measure is evaluated with specific data, giving a result different to national average energy savings per equipment or participant)

## Annex VI: list of values for the saving lifetime

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This annex presents the list of values defined within the CWA27 (see section IX.2).

	End-use action	Factors				Saving lifetime (*)	
		Removal <sup>75</sup>	Effective application <sup>76</sup>	System changes <sup>77</sup>	O&M <sup>78</sup>	Harmonised	Default
	<b>Households</b>						
	<i>Technical</i>						
1	Insulation: building envelope					>25	
2	Draught proofing		X				5
4	Windows/glazing					24	
5	Replace hot water storage tank					15	
6	Insulation of hot water pipes					>25	
7	Heat reflecting radiator panels					18	
8	Small boilers					17	
9	Large boilers				X		17
10	Heating control		X		X		5
11	Heat recovery systems					17	
12	Hot water saving faucets					15	
13	Heat pump (household)					17	
14	Efficient chillers or room air conditioner					10	
15	New/upgraded district heating					20	
16	Solar water heating					19	

<sup>75</sup> for economical reasons

<sup>76</sup> related to social and behavioural reasons

<sup>77</sup> changes in building stock or occupancy

<sup>78</sup> conditions of commissioning, operation and maintenance

	End-use action	Factors				Saving lifetime (*)	
		Removal <sup>75</sup>	Effective application <sup>76</sup>	System changes <sup>77</sup>	O&M <sup>78</sup>	Harmonised	Default
17	Efficient cold appliances					15	
18	Efficient wet appliances					12	
19	Consumer electronic goods		X	X			3
20	Efficient bulbs CFL		X	X			(6000 h)
21	Luminary with ballast systems					15	
22	Energy efficient architecture					>25	
23	Micro-CHP	X			X	x	8
24	PV-panels					23	
	<i>Organizational</i>						
25	Hydraulic balancing of heating					10	
	<i>Behavioural</i>						
26	Electricity saving		X				2
27	Heat saving		X				2
28	Feedback on use from smart meters		X				2
	<b>Commercial / Public sector</b>						
	<i>Technical</i>						
29	Windows/glazing					24	
30	Insulation: building envelope					>25	
31	Heat recovery systems					17	
32	Energy efficient architecture					>25	
33	Heat pumps (commercial sector)					20	
34	Efficient chillers in AC					17	
35	Efficient ventilation systems					15	
36	Commercial refrigeration		X	X			8
37	Energy efficient office appliances	X		X			3
38	Combined heat and power	X					8
39	Motion detection light controls					10	
40	New/renovated office lighting					12	

	End-use action	Factors				Saving lifetime (*)	
		Removal <sup>75</sup>	Effective application <sup>76</sup>	System changes <sup>77</sup>	O&M <sup>78</sup>	Harmonised	Default
41	Public lighting systems					13	
	<i>Organizational</i>						
42	EMS (monitoring, ISO)	X					2
	<b>Transport</b>						
	<i>Technical</i>						
43	Efficient vehicles						(100000 km)
44	Low resistance tyres for cars		X				(50000 km)
45	Low resistance tyres for trucks	X					(100000 km)
46	Side boards on trucks						(500000 km)
47	Tyre pressure control on trucks						(500000 km)
48	Fuel additives	X	X				2
	<i>Organizational</i>						
49	Modal shift		X				2
	<i>Behavioural</i>						
50	Econometer		X				2
51	Optimal tyre pressure		X				1
52	Efficient driving style		X				2
	<b>Industry (not part of emission trading)</b>						
	<i>Technical</i>						
53	Combined heat and power	X					8
54	Waste heat recovery						8
55	Efficient compressed air systems	X					8
56	Efficient electric motors/variable speed						8

	End-use action	Factors				Saving lifetime (*)	
		Removal <sup>75</sup>	Effective application <sup>76</sup>	System changes <sup>77</sup>	O&M <sup>78</sup>	Harmonised	Default
	drives						
57	Efficient pumping systems			X			8
	<i>Organizational</i>						
58	Good energy man. & mon.	X			X		2

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

### Explanation values

- value agreed: **99**
- harmonised value not possible: **cells in grey** \_\_\_\_\_
- Lifetime in hours of km driven: **(9999)**

### Descriptions:

1. Insulation: building envelope: Insulating material within the building envelope (e.g. cavity wall insulation, solid wall insulation or roof insulation).
2. Draught proofing: Material that fills gaps around doors, windows etc. to increase the air-tightness of buildings.
3. [Empty]
4. Windows/glazing: Glazing with good thermal properties.
5. Replace hot water tank: Installation of a new hot water storage tank with foam insulation.
6. Insulation of hot water pipes: Installation of insulating material on unexposed hot water pipes.
7. Heat reflecting radiator panels: Insulation material installed between radiators and the wall to reflect heat back into the room.
8. Small boilers: Individual boilers of no larger than 30 kW output.
9. Large boilers: Individual or communal boilers larger than 30 kW output.
10. Heating controls: Timing devices, thermostats and radiator valve thermostatic controls.
11. Heat recovery systems: Installation of systems to recover and recirculate heat.
12. Hot water saving faucets: Faucets with flow restrictors.
13. Heat pump (household): Ground source or air to air heat pumps for internal heating.
14. Efficient chillers or room air conditioner: Energy efficient air conditioning units for homes.
15. New/upgraded district heating: Heating supplied from a centralised heat source.

16. Solar water heating: Solar thermal collectors for hot water supply.

17. Efficient cold appliances: Refrigerators, freezers for household use that have a good energy efficiency rating e.
18. Efficient wet appliances: Dish washers, washing machines and tumble driers for household use that have a good energy efficiency rating.
19. Consumer electronic goods: Household electronic products (e.g. TV, DVD player, set-top box, home computer).
20. Efficient bulbs CFL: Compact fluorescent lamps for household use.
21. Luminary with ballast system: Lighting units with dedicated efficient lamp fittings.
22. Energy efficient architecture: Dwelling design that optimises thermal properties of building materials, orientation of building to natural light and heat sources and the use of natural ventilation
23. Micro-CHP: Individual combined heat and power units for households.
24. PV-panels: Photovoltaic solar panels.
25. Hydraulic balancing of heating: Adjusting household heating system so that hot water for heat is distributed between rooms in an optimal balance.
26. Electricity saving: Behaviours that lead to the saving of electricity (e.g. switching off lights in empty rooms, turning electronic goods off).
27. Heat saving: Behaviours that lead to the saving of heat (e.g. turning heating off when rooms not in use).
28. Smart meters: A class of electricity or gas meters that provides the user with enough information to allow them to moderate their consumption.
29. Windows/glazing: See (4) above.
30. Insulation: building envelope: See (1) above.
31. Heat recovery systems: See (11) above.
32. Energy efficient architecture: Building design that optimises thermal properties of building materials, orientation of building to natural light and heat sources and the use of natural ventilation.
33. Heat pumps (commercial sector).
34. Efficient chillers in AC: Efficient chilling systems for use in building air conditioning.
35. Efficient ventilation systems: System mechanically controlled which extracts the foul air with in an appropriate amount as to ventilate, and supplies new preheated air in the principal parts by the means of blowing inlets.
36. Commercial refrigeration: refrigeration units.
37. Energy efficient office appliances: Office electronic products (e.g. desktop or laptop computers, printers, photocopiers, fax machines).
38. Combined heat and power: Combined heat and power units for commercial sector.
39. Motion detection light controls: Detectors that switch off lights when nobody is present.
40. New/renovated office lighting: Efficient lighting systems for offices.
41. Public lighting systems: Outside lighting for public spaces.
42. EMS (monitoring, ISO): Use of Energy Management System such as monitoring and improvement or ISO14000.
43. Efficient vehicles: Vehicles that consume a low amount of primary energy (e.g. petrol or diesel) for distance travelled.
44. Low resistance tyres for cars: Tyres that have a low rolling resistance.
45. Low resistance tyres for trucks: See (44) above.
46. Side boards on trucks: Aerodynamic additions for heavy goods vehicles.
47. Tyre pressure control on trucks: Automatic tyre pressure monitoring device for heavy goods vehicles.
48. Fuel additives: Additives that increase the combustion efficiency of fuels.

49. Modal shift: Change of mode of transport to a more energy efficient form (e.g. cars to bikes, or trucks to freight trains).
50. Econometer: Fuel consumption feedback device for cars and trucks designed to increase fuel efficient driving style.
51. Optimal tyre pressure: Maintenance of optimal tyre pressure.
52. Efficient driving style: Adoption of driving style designed to increase fuel efficiency.
53. Combined heat and power: Combined heat and power units for the industrial sector.
54. Waste heat recovery: Use of heat generated as a by-product of industrial processes or other sources.
55. Efficient compressed air systems: Use of efficient air compressors, or efficient use of existing air compressors.
56. Efficient electric motors and variable speed drives: Use of efficient electric motors/drives or motors/drives that provide smooth changes in drive.
57. Efficient pumping systems: Use of efficient pumps in industrial processes.
58. Good energy management and monitoring

## Sources

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