How much energy saving is 1 % per year?

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Abstract
In November 2006, the IEE project 'Evaluation and Monitoring for the EU Directive on Energy End-Use Efficiency and Energy Services (EMEEES)' started, with 21 partners and co-ordinated by the Wuppertal Institute. It is the objective of this project to support the smooth implementation of the Directive on energy end-use efficiency and energy services. It will develop necessary tools for implementation and monitoring of the Directive: (1) a system of bottom-up, top-down and integrated methods for the evaluation of energy services and other energy efficiency improvement measures, harmonised between Member States; (2) a set of harmonised default data and benchmarks for the methods; (3) a template and a guide for Member States for the Energy Efficiency Action Plans (EEAPs); and (4) an agreed method for the Commission to assess the plans.

The project will thereby assist the European Commission with practical advice and support, and will also install a platform for exchange. It will build trust and confidence that the overall target of 9 % energy savings within 9 years can be achieved, and will thus support Member States in attaining their target.

The paper presents first results from the EMEEES project, particularly the analysis of existing good practice, the distinction of measures by type of evaluation method, and the template for the EEAPs. It will also present the list of methods for measuring the impact of energy efficiency improvement measures and energy services that will be developed in the project.

Introduction
The Directive on energy end-use efficiency and energy services (2006/32/EC; for the remainder of this paper abbreviated as the ESD) has raised concerns among the Member States about how they could evaluate the energy savings from energy services and other energy efficiency improvement measures implemented in order to achieve the indicative target of 9 % energy savings in the ninth year. A Committee of the Member States and the European Commission has therefore been included in the Directive, with the task to elaborate common and harmonised methods for the evaluation of energy savings.

In November 2006, the IEE project "Evaluation and Monitoring for the EU Directive on Energy End-Use Efficiency and Energy Services" (EMEEES) started, with 21 partners and co-ordinated by the Wuppertal Institute. The project partners include energy agencies, a ministry, two energy companies, and several research institutes and consultancies; they are listed in the acknowledgements. The objective of this project is to assist the Commission in the elaboration of evaluation methods through delivering practical advice, support and results. This includes the development of concrete methods for the evaluation of single programmes, services and measures (mostly bottom-up), as well as with schemes for monitoring the overall impact of all measures implemented in a Member State (combination of bottom-up and top-down).

This paper presents first results from the EMEEES project, particularly the analysis of existing good practice, the distinction of measures by type of evaluation method, and the template for the EEAPs. It will also present examples of draft methods for measuring the impact of energy efficiency improvement measures and energy services.

The paper starts with a short presentation of the EMEEES project. It will continue with the definition of types of evaluation methods and other important definitions, followed by an overview of existing bottom-up evaluation methods. An overview of which evaluation method could be appropriate for which types of energy efficiency improvement measures and energy services will be given. Next, the list of around 20 concrete bottom-up and 15 top-down methods that the project will develop is presented. Finally, an overview of the structure and contents proposed by the project for the energy efficiency action plans that the Member States have to send to the European Commission by 30 June of 2007 is provided.

The EMEEES project

ELEMENTS OF THE EMEEES PROJECT

The support provided by the project to the European Commission and to stakeholders includes

- a collection and comparative analysis of good practice in monitoring and evaluation methods,
- a process for the development of harmonised bottom-up and top-down evaluation methods,
- the concrete development of methods for bottom-up and for improved top-down evaluation, harmonised across the EU,
- combined top-down/benchmarking and bottom-up evaluation methods to prove achievement of the 9 % target, both ex-ante and ex-post,
- six pilot tests on real programmes, services, or other measures, for the methods developed
- a proposal for the structure and methodology of the Energy Efficiency Action Plans to be delivered by the Member States in order to show compliance with the Directive,
- a proposal for a methodology that can be used by the Commission in order to assess the plans and results reported,
- a platform for exchange of information with the Commission and stakeholders, particularly through workshops and the website www.evaluate-energy-savings.eu, and limited ad-hoc advice.

The focus will be on bottom-up methods, since the ODYSSEE consortium (www.odyssee-indicators.org) has developed detailed top-down indicators that only need some further adaptation.

EXPECTED RESULTS

The direct results will be (1) a system of bottom-up, top-down and integrated methods for the evaluation of around 20 types of energy efficiency technologies and/or energy efficiency improvement measures, harmonised between Member States; (2) a set of harmonised input data and benchmarks for these evaluation methods; (3) a template and a guide for Member States for the Energy Efficiency Action Plans; and (4) an agreed method for the European Commission to assess the plans.

In the longer run, the project will make an important contribution to a smooth implementation of the Directive on energy end-use efficiency and energy services. It will build trust and confidence that the overall target of 9 % energy savings within 9 years can be achieved, and will thus support Member States in attaining their target.

Examples of definitions

The text of the ESD itself contains a lot of definitions, first in Article 3, but also implicitly throughout the text. For the development of methods for monitoring and verification of the amounts of energy saved that the Member States have to prove for counting them towards the fulfilment of their 9 % energy savings target, Annex IV is most relevant. However, there remain a lot of open questions and significant room for interpretation. Therefore, the EMEEES project has started to create an own set of definitions to clarify the most important open issues. This paper will first present a clarification on what is an 'energy efficiency improvement measure' and then provide the classification of types of evaluation methods proposed and used by the EMEEES project.

ENERGY EFFICIENCY IMPROVEMENT MEASURES – THE UNIDENTIFIED OBJECT

One of the most important, but yet not very clear definitions is the general definition of " 'energy efficiency improvement measures': all actions that normally lead to verifiable and measurable or estimable energy efficiency improvement" (Article 3 (h) of the ESD).

From this definition, it is not perfectly clear what an 'energy efficiency improvement measure' is. It could be either a technical, organisational, or behavioural measure 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. Or it could be an energy service sold to, or an energy efficiency improvement programme offered to this customer by another company, or the state, or another actor, with the aim to support the customer in implementing a specific technical, organisational, or behavioural measure taken at the end-user's site (or building, equipment, etc.) that improves the energy efficiency of that end-user's facilities or equipment.

Article 1 of the ESD 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.

We therefore conclude that an **energy efficiency improvement measure (EEI measure)** is always a **combination** of

- an energy efficiency improvement promotion measure (EEI promotion measure), and
- an end-use energy efficiency improvement action (end-use EEI action).

An **energy efficiency improvement promotion measure (EEI promotion measure)** is an action by an actor that is not the

Bottom-up evaluation methods

Bottom-up evaluation for the ESD involves four steps:

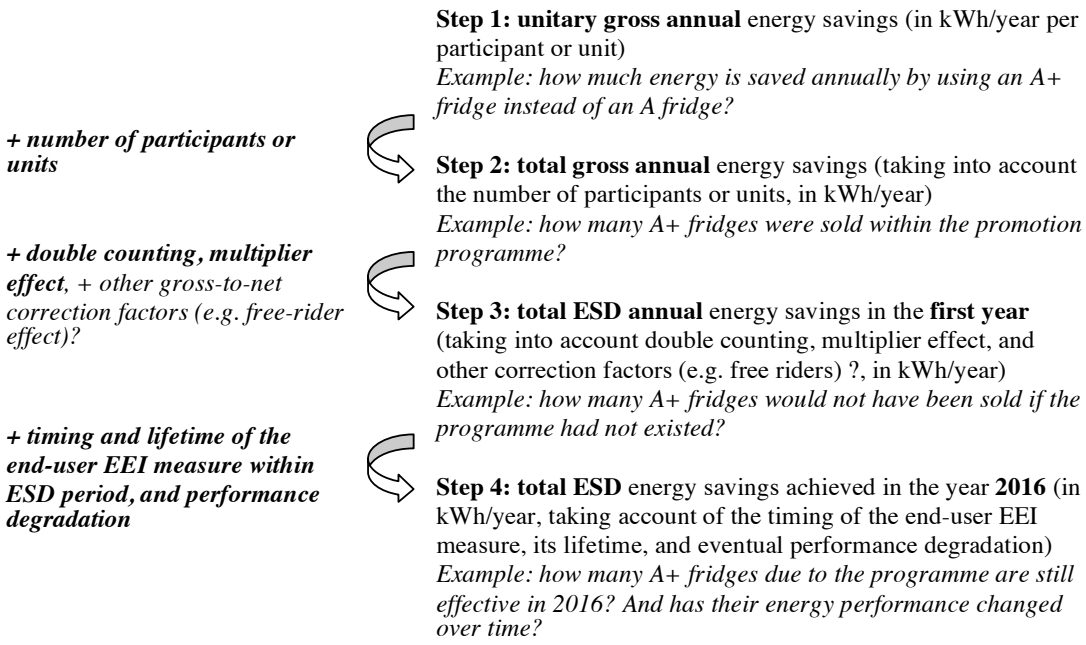

Figure 1. A four steps calculation process in bottom-up methods

final consumer him-/herself, which **supports** the final consumer, or whoever has the power of decision, in implementing the end-use EEI action, or **implements** it for the final consumer. Examples of EEI promotion measures are energy services, energy efficiency improvement programmes, or any other actions in this sense.

An **end-use energy efficiency improvement action (end-use EEI action)** is a technical, organisational, or behavioural action taken at an end-user's site (or building, equipment, etc.), but not necessarily by the end-user himself/herself, that improves the energy efficiency of the energy end-using facilities or equipment, and thereby saves energy.

ASSORTING THE PORTFOLIO: TYPES OF EVALUATION METHODS

Annex IV to the ESD provides proposals on data and methods that can be used particularly for bottom-up evaluations. Taking this into account as well as standard literature on evaluation methods for energy savings, and existing case studies, the following classification of bottom-up and top-down evaluation methods is proposed (see figure 1).

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

- either an energy-efficient equipment (e.g. a CFL or an appliance) or a specific end-use EEI action (such as thermal insulation of a single family home)
- or a participant's premises (dwelling, building, company; e.g. a single family home being insulated or a company taking part in 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 (Annex IV(1.2)), such as changes in heating-degree days or building occupancy, growth in production volume, etc. These changes affect the energy consumption, and so the amount of energy savings as perceived by the end-users. For the ESD, however, what counts are the **net** energy savings in the whole country that are **due to** the EEI measures. These can either be higher or lower than the gross savings. Gross-to-net correction factors have, therefore, to be evaluated. These include factors correcting for double-counting and multiplier effects, explicitly mentioned in the ESD, and possibly for free-rider effects as well.

Table 1 presents the classification of bottom-up methods. The columns relate to the first three of the four steps of a bottom-up evaluation method as defined above. The classification has benefited from existing literature, such as SRCI et al. 2001, TecMarket Works 2004, TecMarket Works 2006, and Vreuls et al 2005a and b.

Typical methods for estimating gross-to-net correction factors are:

1. surveys of participants (and control group and other market actors) to find out reasons for implementing end-use EEI actions
2. monitoring of participants and end-use EEI actions for different promotion measures to avoid double-counting

It will often be possible to gather the necessary data at quite limited costs, if the monitoring is planned before implementing an

Table 1. Classification of bottom-up evaluation methods for energy savings

Methods for measuring or estimating unitary gross annual energy savings	Methods for collecting number of units or participants	Methods for estimating gross-to-net correction factors	Applicable if unit is:	Characterisation of costs and data collection
1 direct measurement a) without normalisation b) with normalisation	A) monitoring of participants and savings per participant	I) and II)	participant (usually)	can be costly; suitable for large buildings or sites, or as a basis for deemed estimates
2 analysis of energy bills or energy sales data (sample or all participants) a) without normalisation b) with normalisation	A) monitoring of participants and savings per participant	I) and c) comparison with control group; or d) discrete choice modelling and other in-depth billing analysis	participant (usually)	can be very costly to collect and analyse, particularly d); may be the only way for information campaigns
3 enhanced engineering estimates for individual units (e.g., calibrated simulation)	A) monitoring of participants/number of actions and savings per participant/action	I) and II)	participant or specific end-use EEI action/ equipment	can be costly; however, if an energy audit is done anyway, small extra cost of monitoring results
4 Mixed deemed and ex-post estimate, e.g. based on sales data, inspection of samples, monitoring of equipment purchased by participants	A) monitoring of number of actions and savings per action	I) and II)	specific end-use EEI action/ equipment (usually)	costs depend on level of accuracy and gross-to-net correction required; monitoring usually straightforward
5 Deemed estimate, e.g. based on sales data, inspection of samples before implementation of the EEI promotion measure being evaluated	A) monitoring of number of actions and savings per action	maybe II; always simplified; maybe inclusion of correction factors in deemed savings per unit	specific end-use EEI action/ equipment (usually)	costs can be quite low, monitoring of number of actions and savings per action may be combined with "anyway" contacts
6 Modelling of the whole stock based on surveys of population samples: end-use EEI actions taken in total and induced by EEI promotion measures	B) stock data (e.g., national statistics)	modelling of energy savings through end-use EEI actions taken in total and induced by EEI promotion measures, based on survey results	participant (usually)	modelling has medium costs, but surveys can be costly if done especially for the evaluation

EEI measure. E.g., in an energy audit programme for industry, only a database must be created tracking measures proposed in the audits. Even participant surveys can be combined with the contacts occurring anyway to provide an EEI measure to the participants. Furthermore, it will only be necessary to evaluate the influence of the whole package of EEI promotion measures targeting a specific end use or type of end-use EEI action. For the ESD, there is no need to distinguish, e.g., the energy-saving effects of an information campaign on energy-efficient lighting in tertiary buildings from the effects of an energy audit programme and/or a financial incentive programme targeting the same subject. If these programmes are offered by different actors, it will be their problem to distinguish their contributions between each other, but not for the Member State's duty vs. the ESD. It is, therefore, a task for the analysis of each specific method (cf. Table 5) to find a solution for the monitoring that is a good compromise between evaluation cost and accuracy. In Table 1, only a very broad characterisation of the costs and data collection issues can be given based on experience, which should be treated with caution.

Top-down evaluation methods

Three types of top-down evaluation methods have been defined, as presented in Table 2. They are classified as top-down methods, since they are based on indicators that are a priori not linked to the effects of EEI promotion measures but look at a whole market or sector. As for bottom-up, the general cost characteristics given should be treated with caution and must be assessed for each single subject of a method (cf. Table 6).

Existing bottom-up evaluation methods

More than 25 case studies were selected in order to provide an overview of existing practices in monitoring and evaluation. The cases were selected to get a balance between sectors and types of EEI promotion measures. Other guiding criteria for the selection were the availability of information and the expectation that there would be well documented quantifications of savings. The cases represent EEI promotion measures that target one or several of the residential, tertiary, industrial, and transport sectors. Different types of EEI promotion measures are also represented. Table 3 lists 24 different promotion measures organised by main sector targeted.

Table 2. Classification of top-down evaluation methods for energy savings

Method	Applicable for evaluation of	Methods for estimating gross-to-net correction factors	Characterisation of costs and data collection
TD 1 – monitoring of diffusion indicators of specific equipment	single types of end-use EEI actions but packages of EEI promotion measures	modelling effects of autonomous energy savings, hidden structure effects, and earlier EEI promotion measures	Monitoring of diffusion can be costly – data may need to be purchased; normalisation and correction can be costly, too
TD 2 – monitoring of specific energy consumption indicators for whole sectors / end uses	packages of EEI measures targeting the sector / end use	modelling effects of autonomous energy savings, hidden structure effects, and earlier EEI promotion measures	statistical data easily available, but normalisation and correction can be costly, as can be exclusion of ETS sectors
TD 3 - econometric modelling (e.g., I/O analysis with price elasticities)	the effects of energy taxes	effects of autonomous energy savings, hidden structure effects, and earlier EEI promotion measures may be included in the price elasticities	cost of establishing an econometric model can be high, cost of running the model can be low

A single EEI promotion measure, or mechanism, can address more than one sector. Most measures entail regulatory (R), financial (F), as well as informative (I) elements at the same time; one is an energy service, actually a mobility service (S). The classification in Table 3 indicates what the main element is. For example, a white certificate scheme has a strong regulatory component although the financial incentive is also very central, rendering it an R/F classification. Furthermore, one promotion measure or mechanism may have several target end-uses and technologies, e.g., lighting, ventilation, ICT, etc. The quantification of savings for each such end-use may be more or less thorough and documented. Hence, the indications given on which bottom-up evaluation method has been used is based on our overall assessment of evaluations of the respective promotion measure.

It should be noted that saving energy is not the only, or even the primary objective, for all the promotion measures listed. Therefore, quantification of savings is typically only one of several factors addressed in evaluations. For example, the overall objective of one of the KfW buildings programmes is to provide soft loans to the general modernisation of buildings in the Eastern parts of Germany. Consequently, an accurate quantification of savings has not always been a priority. However, our list is dominated by cases where energy savings have been a clear and stated primary objective. Most evaluations rely on deemed savings and surveys, with an element of ex-post verification in some cases. Direct measurements are not common according to Table 3 but this is hiding the fact that deemed estimates are generally based on direct measurements, at least in part, and deemed estimates can therefore be quite accurate, depending on the case.

It appears that technology-focused EEI promotion measures in the residential sector are generally easier to evaluate than measures in other sectors. In campaigns with financial incentives for improved lighting, insulation retrofits, or efficient appliances, participation rates can be monitored, free-riders estimated, and average savings calculated on the basis of measurements and samples. Promotion measures in industry are typically based on voluntary approaches and entail energy audits, energy management systems, and sometimes financial support for investments. However, in industry it seems more difficult to isolate the impact of a promotion measure. Frequently, the savings are calculated based on self-reported information concerning investments made and ex-ante enhanced engineering estimates resulting from the energy audit. It is difficult to establish if EEI investments would have, or should have, been made without the promotion measure. Required rates of return may vary with business cycles, non-energy benefits may be an important motivation for investments made, and changes in production may complicate ex-post evaluations. Firms themselves typically provide the information on investment options and pay-back times, and information asymmetry can prevent the agency in charge, or the evaluator, from verifying the information.

In addition to assessing how savings are calculated, we are also investigating the use of gross-to-net correction factors. For bottom-up methods, these corrections include double-counting, multiplier effects, free-riders, and direct rebound effects. Direct rebound effects that are well known, for example increased indoor temperature due to lower heating bills, are typically considered. The level of free riders can be relatively easily estimated against a baseline in a campaign which is limited in time. It is more difficult to determine in a long-running programme such as the one by Elsparefonden, where subsidies are given for switching away from electric heating with simultaneous market transformation efforts to reduce investment costs. It is likely that multiplier effects from lower prices compensate for free riders, but in cases like this it is difficult to establish a clear baseline.

Overall, the case-studies show that savings can be calculated bottom-up, albeit with various difficulties associated with various promotion measures and sectors. In some cases (e.g., free energy audits in Denmark), efforts have been made to measure the effect also with a second method, i.e., by comparing aggregate indicators such as electricity use per employee with a control group. In this case, the billing analysis was inconclusive, whereas an incomplete but detailed evaluation based on a non-representative sample of participants could quantify savings in the sample. It should be noted that a clear strength of the bottom-up approach to evaluation is the information it can yield on opportunities for improving the promotion measure and adjusting it to changing conditions.

Table 3. Energy efficiency improvement promotion measures classified by main type of measure and bottom-up evaluation method used.

	EEI promotion measure	Country	Main type of measure	Bottom-up evaluation method used					
				Direct measurement	Bills & sales data analysis	Enhanced engineering estimate	Mixed deemed and ex-post	Deemed estimate	Bottom-up modelling based on surveys
	Energy taxes	SE	F	top-down evaluation (econometric modelling)					
General	White certificates	IT	R/F				X	X	
General	White certificates	FR	R/F				X	X	
General	Energy Efficiency Committment	UK	R/F				X	X	X
General	RUE Obligations	BE	R/F				X	X	
Residential and tertiary	FEMP	USA	R		X	X		X	X
Residential and tertiary	EPS Building Standards	NL	R	X				X	X
Residential and tertiary	Building regulation in Carugate	IT	R					X	
Residential and tertiary	Elsparefonden	DK	F		X		X	X	
Residential and tertiary	Applicance labelling	NL	I/F						X
Residential and tertiary	Energy+	EU	I				X		
Residential and tertiary	KfW buildings programme	DE	F			X		X	
Residential and tertiary	Helles NRW	DE	F/I				X		
Industry	Free energy audits	DK	I/F		X	X		X	
Industry	Technology Procurement	SE	I/F					X	X
Industry	Investment Deduction Scheme	NL	F/R				X		
Industry	Voluntary Agreement	DK	F/R				X	X	
Industry	Programme for EEI in industry	SE	F/R			X		X	
Industry	Energy Audit Programme	FI	I/F			X	X		
Industry	Industrial EE Network	NO	I/F			X		X	
Transport	ACEA	EU	R	top-down evaluation (based on sales data: diffusion indicator)					
Transport	Ecodriving	NL	I					X	X
Transport	Congestion charging Stockholm	SE	F/R	X	X	X	X		X
Transport	Car sharing	DE	S					X	X

Types of measures: regulatory (R), financial (F), informative (I); energy service (S)

Which method for which energy efficiency improvement measure?

When evaluation methodologies are developed in support of the Energy end-use Efficiency and Energy Service Directive, it is important to classify the EEI measures by the type of evaluation method that is most appropriate to be used for each measure. Often, the answer to this question does not only depend on the type of measure, it also depends on the availability of data for the evaluation, which is country-specific. Therefore, while specifying which evaluation method is ideally to be used for energy efficiency improvement measures (in many cases this would be a bottom-up methodology with correction factors), it is important to keep in mind that many countries will only spend limited budgets on additional data collection. On the other hand, it is clear that a variety of European countries will have to increase their efforts on this issue in the framework of the Directive in order to be able to evaluate the impacts of the energy efficiency improvement measures they have undertaken. The ideal evaluation method is therefore not the one that can measure all impacts in a detailed manner, but the one that is sufficiently exact AND has good chances to be realised by most EU Member States in the framework of the Directive.

For selecting adequate evaluation methods, three important parameters of the evaluation have to be distinguished:

- what type of input data have to be used for the evaluation?
- on what type of sample are these input data averaged (relevant for unit consumption)?
- what kind of methodology is finally used to calculate the ESD savings, based on the input data (relevant in fact for the combination of unit consumption and number of units)?

Such an assessment of which types of evaluation methods are applicable, and which are appropriate to apply for which energy efficiency improvement measure makes use of the existing experience, e.g. from Table 3, the overview of existing evaluations in the MURE Database on energy efficiency measures (www.mure2.com) and literature such as SRCI et al. 2001 or Vreuls et al. 2005b. Based on a very detailed classification of measures derived from the existing classification of the MURE Database on the Internet (about 50 detailed measure types for the residential sector grouped into larger categories and subcategories, around 40 types for transport, 35 types for industry, 45 types for the tertiary sector and 10 types for cross-cutting measures), the EMEEES project discusses for each of the measure types and each sector the most suitable combination of evaluation methods.

The results of this exercise are given in Table 4 in a condensed manner. They provide a first indication of which methods are in principle appropriate for which type of energy efficiency im-

Table 4. Which types of evaluation methods are appropriate to apply for which type of energy efficiency improvement measure

Category	Subcategories	Bottom-up methods	Top-Down methods**
1 Regulation	Standards and norms: 1.1 Building Codes and Enforcement 1.2 Minimum Equipment Energy Performance Standards	 Building stock modelling/ building certificates Equipment stock modelling	 Specific energy consumption indicator Monitoring diffusion of performance standard
2 Information and legislative-informative measures (e.g. mandatory labelling)	2.1 Focused information campaigns 2.2 Energy labelling schemes 2.3 Information Centres 2.4 Energy Audits 2.5 Training and education 2.6 Demonstration* 2.7 Exemplary role of the public sector 2.8 Metering and informative billing*	Deemed savings + surveys Deemed savings + surveys Deemed savings + monitoring + surveys Enhanced engineering estimates/direct measurement + monitoring Deemed savings + surveys Deemed savings + monitoring Building stock modelling/ building certificates/ enhanced engineering estimates/ billing analysis + monitoring Deemed savings	 Diffusion of label classes Specific energy consumption indicators Diffusion of efficient IT appliances
3 Financial instruments	3.1 Subsidies (Grants) 3.2 Tax rebates and other taxes reducing energy end-use consumption 3.3 Loans (soft and/or subsidised)	All: Mixed deemed and ex-post estimates / Enhanced engineering estimates/ Deemed savings + monitoring (all) / (building) stock modelling + surveys	Specific energy consumption indicators Taxes: Econometric modelling / special analysis of specific energy consumption indicators
4 Voluntary agreements and Co-operative instruments	4.1 Industrial Companies 4.2 Commercial or Institutional Organisations 4.3 energy efficiency public procurement 4.4 Bulk Purchasing 4.5 Technology procurement	Benchmarking of targeted sectors or end-uses (e.g. industrial cross-cutting technologies) / Mixed deemed savings and ex-post estimates + monitoring 4.3 to 4.5: Deemed savings / Mixed deemed and ex-post + monitoring or surveys	Specific energy consumption indicators / diffusion indicators Specific diffusion indicators
5 Energy services for energy savings	5.1 Guarantee of energy savings contracts 5.2 Third-party Financing 5.3 Energy performance contracting 5.4 Energy outsourcing	All: Enhanced engineering estimates / Billing analysis/ Mixed deemed savings and ex-post estimates / Direct measurement + monitoring	Specific energy consumption indicators / diffusion indicators
6 EEI mechanisms and other combinations of previous (sub)categories	6.1 Public service obligation for energy companies on energy savings + "White certificates" 6.2 Voluntary agreements with energy production, transmission and distribution companies 6.3 Energy efficiency funds and trusts	Depending on the types and targets of EEI promotion measures (from 1 to 5 above) implemented under the EEI mechanism or as part of the combination; Integrated bottom-up and top-down methods	Specific energy consumption indicators / diffusion indicators, depending on the types and targets of EEI promotion measures (from 1 to 5 above) implemented under the EEI mechanism or as part of the combination

* 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.

** Top-down methods can usually only measure the combined effect of packages of EEI measures targeting one sector (specific energy consumption indicators, econometric methods) or end use (diffusion indicators).

provement measure. However, they are not prescriptive, and each team developing a concrete method will have to reassess this based on the concrete and detailed subject of the method and, e.g., the data availability, and the monitoring possibilities.

A first set of concrete evaluation methods

Within the EMEEES project, up to 20 bottom-up and up to 15 top-down evaluation methods are being developed. They will be methods for monitoring and verifying energy savings that can be counted towards fulfilment of a Member State's energy saving target under the ESD. At the time of writing this paper,

only the choice of which methods shall be developed has been made. At the eceee Summer study, first examples of draft methods will be presented. The published results can be viewed at www.evaluate-energy-savings.eu.

UP TO 20 BOTTOM-UP EVALUATION METHODS

In the Figure 1 above, the four steps of a bottom-up evaluation process have been described. Consequently, the report for a method that has been developed in the EMEEES project or elsewhere will contain the necessary information on how to deal with these four steps. E.g., a type of evaluation method from the list above will be selected, the basic formula for calculating the unitary gross energy savings and the total ESD annual energy savings for the first year will be provided, and methods for collecting the data needed for these calculations in a way ensuring consistency between the 27 EU Member States will be described. If useful, harmonised values or benchmarks for these data will be given that can be used in the years 2008 and 2009. A template for presenting the results of an application of the method will be provided as well.

In general, for all the data to be generated in order to apply one of these bottom-up methods, three levels of accuracy will be distinguished as presented in Figure 2.

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. Selecting the most relevant evaluation effort depends on evaluation conditions such as data availability and accepted threshold for uncertainties on results.

Example: for the evaluation of a programme promoting A+ refrigerators and freezers, many parameters may affect the resulting energy savings. For each parameter, a different level of data/efforts may be used. For instance, the average lifetime of the A+ fridges may be a harmonised EU-wide value (level 1), the average size and energy savings compared to the baseline of the fridges a national value (level 2), and the net number of A+ fridges sold (especially an eventual multiplier effect) a programme-specific value (level 3).

In Table 5, a long list of potential bottom-up methods is presented. The choice is based on criteria such as coverage of sectors and end uses with high energy savings potential, low administrative burden, and coverage both of a selection of end-use EEI actions and EEI promotion measures. Out of this long list, finally at least 15 and up to 20 concrete subjects will be chosen for bottom-up methods that the EMEEES project will develop.

UP TO 15 TOP-DOWN EVALUATION METHODS

In the EMEEES project, the top-down evaluation methods will be derived from indicators existing within the ODYSSEE project (www.odyssee.org). An exception are the econometric modelling methods that are appropriate for estimating the effects of energy taxation. Therefore, a top-down method includes a report describing how it can be derived from an ODYSSEE indicator, and the template for presenting the results of an application of the method.

ODYSSEE indicators are already normalised for changes in weather, increase in the size of dwellings, penetration of central heating, structural changes between industry sectors. However, as the ESD acknowledges, the development of a top-down indicator as such does not tell whether it is due to an EEI promotion measure or to other factors. Therefore, for estimating the energy savings induced by EEI promotion measures, the need remains to adjust the ODYSSEE indicators for the following influencing factors:

- The autonomous trend of energy efficiency improvement due to technological progress and other policies not directly aiming at energy efficiency improvement
- The effect of changes in energy prices
- The direct rebound effect (e.g., increased indoor temperatures after thermal insulation of a building)

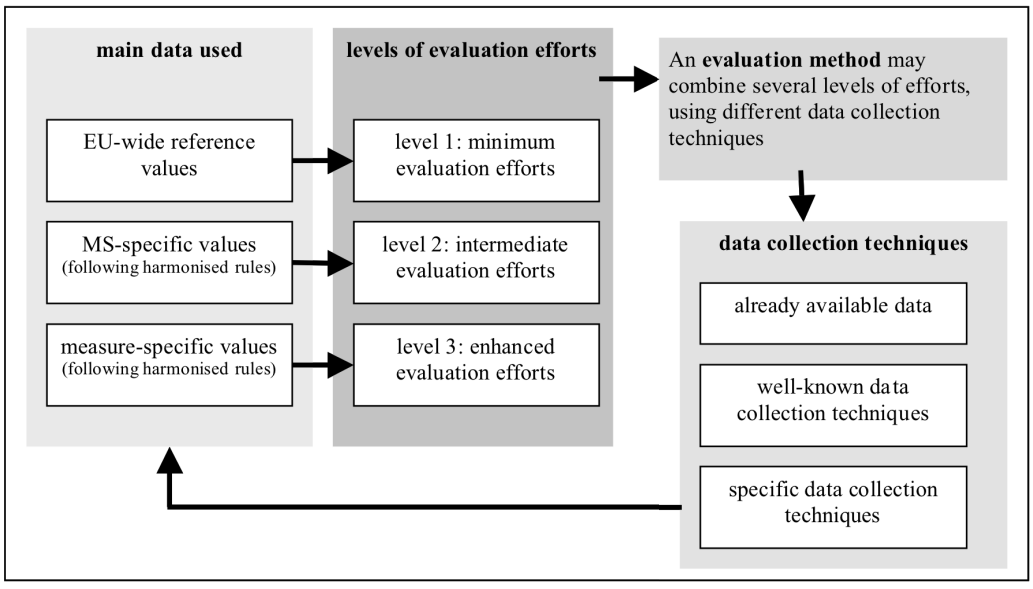

Figure 2. Level of evaluation efforts related to data collection techniques

Table 5. Potential subjects for bottom-up evaluation methods the EMEEES project will develop

Sector	end use or end-use EEI action	EEI promotion measure
Residential	1 Energy performance of new buildings	Building legislation (also as 'early action')
	2 Building envelope improvement (existing buildings)	Package: Advice, audits, financial incentives plus building legislation
	3 Improvement of heating system (including circulator)	Package: Advice, audits, financial incentives plus building legislation
	4 Energy-efficient white goods (appliance purchased anyway)	Package: Advice, label, financial incentives and EcoDesign
	5 Hot water *or* Improvement of ventilation/air conditioning	Package: to be determined
Tertiary	6 Energy performance of new non-residential buildings	Building legislation (also as 'early action')
	7 Building envelope improvement (non-residential buildings)	Package: Advice, audits, financial incentives plus building legislation
	8 Improvement of heating system (including circulator) (non-residential buildings)	Package: Advice, audits, financial incentives plus building legislation
	9 Improvement of lighting system	Package: Advice, audits, financial incentives plus building legislation
	10 Improvement of ventilation/air conditioning system	Package: Advice, audits, financial incentives plus building legislation
	11 Office equipment	Package: Advice and label and EcoDesign
Industry	*6a Energy performance of new non-residential buildings*	*Building legislation (also as 'early action')*
	12 Building envelope improvement (non-residential buildings)	Package: Advice, audits, financial incentives plus building legislation
	8a Improvement of heating system (including circulator) (non-residential buildings)	*Package: Advice, audits, financial incentives plus building legislation*
	9a Improvement of lighting system	*Package: Advice, audits, financial incentives plus building legislation*
	10a Improvement of ventilation/air conditioning system	*Package: Advice, audits, financial incentives plus building legislation*
	13 High efficiency electric motors and variable speed drives	Package: Advice, audits, financial incentives and EcoDesign
	14 Industrial processes, e.g., for heating of solids and liquids, or for drying	Package: Advice, audits, financial incentives or Energy Performance Contracting
Transport	15 Vehicle (car, bus, truck) energy efficiency	Package: car labels, tax or other rebates, campaign
	16 modal shifts in passenger traffic, including towards non-motorised traffic	e.g., congestion charges, infrastructure measures, mobility management
	17 Eco-driving	Package: campaign and training
	18 Traffic reduction	Tax reduction on deduction of transport costs vs. home office costs; integrated planning
General	Tertiary and industry end uses	19 Energy performance contracting
	Tertiary and industry end uses	20 Energy audits
	Tertiary and industry end uses	21 Voluntary agreements with end use sectors
	All types of end uses, for which no financial incentives exist	22 Focused information campaigns

Methods 1 to 18 are targeting a specific end use or type of end-use EEI action. They will usually allow to evaluate the effects of a package of EEI promotion measures, but also if only one or two elements of the package mentioned here are implemented.

The assessment of the direct rebound effect can rely on estimates, so there is a link to bottom-up methods here.

Autonomous trend and price effect can be measured in two ways: through econometric regression analysis or from literature survey.

In the econometric analysis, the indicator of energy savings is explained by different variables, one of which will be the time, to capture the trend and another one the energy price. A typical regression can be as follows:

$$\ln ES = a + b\,T + c \ln P + d \ln A + e \ln ES_{-1} + K$$

with :

- ln: logarithm.
- ES: energy saving indicator
- b: autonomous trend
- T: time
- P: energy price.
- c: price elasticity
- A: macro economic variable (e.g. GDP) to capture the impact of business cycles
- d: elasticity to GDP
- K: constant coefficient

The estimate of the regression coefficient will be made over a period ending before the effects of measures will have to be assessed (e.g. before 1995). Then using the coefficient, the impact of the different effects will be removed over the recent period on which the method will calculate the ESD savings (Figure 3). The price will be separated into two components: ex-tax price and tax. In reality, it is likely to be difficult to make econometric corrections with too many variables. If the results with too

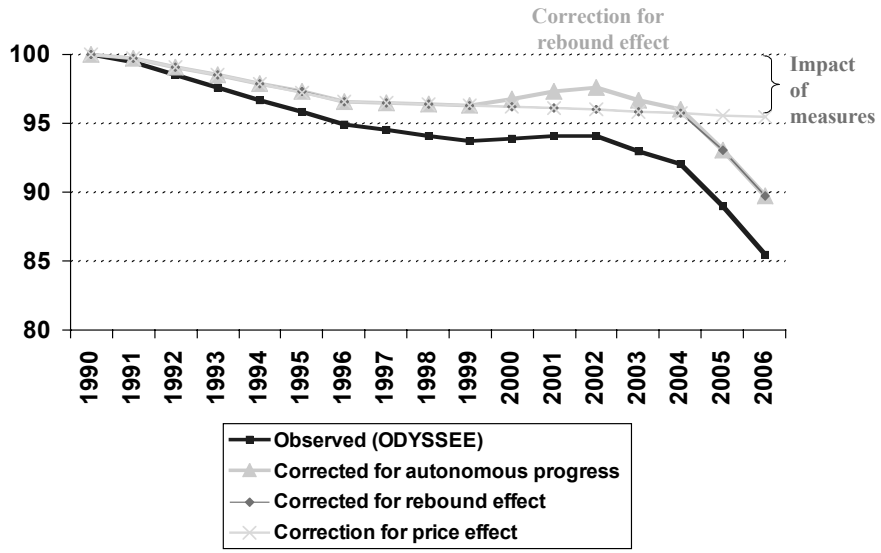

Figure 3. Corrections to clean indicators from factors not linked to EEI measures (example)

Table 6. The 15 top-down evaluation methods the EMEEES project is planning to develop

Sector	end use or end-use EEI action or horizontal EEI measure	Type of method
Residential	1 Building envelope improvement and heating systems	energy consumption indicator
	2 Residential electricity energy use excluding thermal uses	energy consumption indicator
	3 Specific white goods	market diffusion indicator
	4 Solar thermal collectors	market diffusion indicator
Tertiary	5 Building envelope improvement and heating systems	energy consumption indicator
	6 Tertiary electricity energy use excluding thermal uses	energy consumption indicator
Industry	7 Industrial thermal fuel use (excluding electricity)	energy consumption indicator)
	8 Industrial electricity consumption	energy consumption indicator
	9 Industrial CHP (without feeding into the grid)	market diffusion indicator
Transport	10 New car energy efficiency	energy consumption indicator
	11 Improvement of the car, bus, and truck stock	energy consumption indicator
	12 Modal shift in passenger transport	energy consumption and/or modal split indicator
	13 Modal shift in goods transport	energy consumption and/or modal split indicator
General	14 Energy taxation	econometric modelling
	15 Focused information campaigns	market diffusion indicators

many variables are not significant, variables will be removed from the right to the left.

In Table 6, the list of the 15 top-down methods that the project is planning to develop is presented. The choice is based on criteria such as coverage of sectors and end uses, and the existence of ODYSSEE indicators for the different Member States.

A structure for the energy efficiency action plans

The energy efficiency action plans (EEAP), which have to be prepared by each Member State, fulfil a two-fold purpose. On the one hand, in the EEAP the Member States need to present their provisions on instruments and policies to be implemented in order to fulfil the ESD target (information that needs to be presented all EEAP i.e. in 2007, 2011, 2014). On the other hand, the Member States need to present the results achieved in terms of energy saving related to the target (information to be presented in the EEAP 2011 and 2014). In short, the EEAP is a summary of all the efforts (ex-ante and ex-post) conducted in one country towards the improvement of energy end-use efficiency.

When aiming at keeping the EEAP as comprehensive as necessary and as condensed as possible, and at creating a basis for receiving comparable reports from the Member States, it is helpful to make available an outline on the main structural elements of an EEAP. Having in mind the requirements of the ESD, the following elements constitute the EEAP:

- **calculation of the national indicative target**, which is to be presented in the first EEAP 2007 and calculated according to Annex I of the ESD. A specific issue that needs to be solved and reported here is the precise definition of the interface of the sectors and end-user segments inside the scope of ESD in contrast to the sectors which are addressed by the emission trading scheme;
- **Sectoral assessment of EEI programmes and energy services:** Under this chapter energy efficiency improvement (EEI) programmes, energy services, and other EEI measures

are described in a sector-by-sector assessment. The sectors are structured according to Annex III of the ESD (residential sector, tertiary sector, industry sectors – excluding those segments of end-energy use, which are covered by the emission trading scheme, transport sector). The outline for reporting is then the same for all sectors. It consists of

- a **description of single EEI measures:** This part includes a comprehensive description of each EEI measure that will have an effect on energy savings during the years 2008 – 2016 including a notion on the status of implementation.
- an **assessment of total ESD energy savings in the sector** expected for the period 2008-2016, which includes a bottom-up as well as a top down assessment. For the **bottom-up assessment** the effects of single EEI measures are summed up and corrected with the necessary gross-to-net correction factors (measure interaction / double counting, free-rider effect, multiplier effect, differing lifetimes). The Member States are not obliged to do this quantitative assessment already with the EEAP 2007, but they are invited to communicate preliminary results if available, particularly on 'early action', since the purpose of the plan is to show how the Member States plan to reach their target. The **top-down assessment** should differentiate between an assessment of energy efficiency trends in the period 1995-2005/6 (i.e. the most recent year available), which covers most of the period of 'early action' and, in the second and third EEAPs, 2007 and the 2008-2016 period. Furthermore, the assessment needs to include a description on the treatment of methodological issues such as cleaning of exogenous factors, cleaning of structural effects, autonomous energy savings and price-induced energy savings.
- **Methodologies applied:** The bottom-up as well as the top-down assessment needs to include an analysis of the methodologies applied, i.e. shortcomings of the methodology (measure/programme per measure/programme), data gaps (measure/programme per measure/programme) and a description of the activities planned to overcome methodological shortcomings and data gaps.

- **Description of horizontal measures:** Several measures such as energy taxes or general information campaigns have a cross-sectoral impact. Therefore they are reported in a separate chapter. The energy saving impact of horizontal measures is established in a top-down evaluation. In principle, the effect of horizontal measures should already be included in the sectoral top-down evaluation, because by definition horizontal measures affect several or all ESD-relevant sectors. Therefore the assessment of horizontal measures is simply a cross-sectoral summary of the sectoral top-down assessments. However, the effects of energy taxation should be dealt with separately.
- **Specific measures according to the ESD:** The ESD contains obligatory measures (promotional activities, qualification, accreditation and certification of energy services providers, removal of impeding transmission and distribution tariffs etc.) and compulsory optional measures (involvement of the utilities and of the public sector), which need to be transposed by all Member States. Although the kind of transposition of these measures should already be included in the description and assessment of the sectoral and horizontal measures, from the point of view of easy monitoring of ESD implementation it seems to be reasonable to summarise these "specific ESD-measures" in a separate chapter of the EEAP. It needs to be emphasised, however, that Member States are not obliged to report on the transposition of these measures before 17 May 2008 (except for a few selected issues that need to be reported already in the EEAP 2007).
- **Institutional provisions:** This point refers to the assignment of one or more verifying bodies in the Member States. The Member States are not obliged to report on that item before 17 May 2008.

Due to limited time for preparation and due to constraints on data availability in probably all Member States, the EEAP 2007 may contain only a limited amount of quantitative assessment. Member States are invited to report the evaluations already available at that point of time, but for the EEAP 2007 the ex-ante quantitative assessment is not compulsory according to the text of the directive. The focus of the EEAP 2007 is therefore on the definition of the action plan itself, that means on the description of policy measures and energy services that the member states have already implemented or supported, or are planning to implement or support in order to achieve the target. However, in order to know how much more needs to be done, an evaluation of 'early action' will be instrumental.

Conclusions and Outlook

How much energy saving is 1 % per year? This depends on the perspective taken. E.g., within a system of obligations for energy companies to save a certain amount of energy each year, the agreement can be to use very simple deemed savings approaches to prove fulfilment of the targets. By contrast, to know the real effect of its policies, the government may have consultancies prepare full ex-post bottom-up evaluations of net energy savings, including all potential gross-to-net correction factors such as overlap of the EEI programmes by the energy companies with other EEI policies and energy services; free-rider, multiplier, and direct rebound effects; measure retention; etc. Top-down methods might be used to control the overall consistency of the calculated savings.

Just as these are two examples of special perspectives on what is an "energy saving", the perspective of the 9 % target over 9 years – averaging 1 % per year – for the Member States under the ESD is a very special one. The methods to prove achievement of the target by achieving a certain amount of ESD energy savings will, therefore, be very special methods for this objective. One may expect them to be pragmatic in order to minimise administrative burden and particularly the cost of monitoring.

It will often be possible to gather the necessary data at quite limited costs, if the monitoring is planned before implementing an EEI measure. In addition, it will only be necessary to evaluate the influence of the whole package of EEI promotion

measures targeting a specific end use or end-use EEI action. For the ESD, there is no need to distinguish, e.g., the energy-saving effects of an information campaign on energy-efficient lighting in tertiary buildings from the effects of an audit programme and/or a financial incentive programme targeting the same subject. It is, therefore, a task for the analysis to find a solution for the monitoring that is a good compromise between evaluation cost and accuracy.

On the other hand, methods on the same type of EEI measure must be consistent between Member States: this is the task of 'harmonisation'. Here, the concept of the three levels of evaluation efforts and accuracy will be crucial. It will be assessed for each of the methods developed, which parameters can be defined as EU level averages, or should be evaluated at national or even lower level. Such Member State-specific evaluations will need to use harmonised methods, i.e., methods that allow to consider differences between Member States, but do not favour one over the other and make the results comparable between Member States. A specific issue here is also, how to evaluate the energy savings from 'early action' between 1995 and 2007, as far as allowed for the ESD.

With the EMEEES project, we hope to contribute to clarification of the question for this paper from the ESD perspective: How much energy saving is 1 % per year in the framework of the 9 % targets set by the Member States under the ESD, and as a result of the energy efficiency improvement programmes, energy services, and other energy efficiency improvement measures that the Member States create or stimulate in order to fulfil their target?

The results of our work will be discussed with the Member States and with the expert public in a series of workshops and conferences, and will be available as soon as they are publishable at www.evaluate-energy-savings.eu.

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Partners in the EMEEES project.

Project partner	Country
Wuppertal Institute for Climate, Environment, 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
Electricité de France (EdF)	FR
Enova SF	NO
Motiva Oy	FI
Department for Environment, Food and Rural Affairs (DEFRA)	UK
ISR – University of Coimbra (ISR-UC)	PT
DONG Energy	DK
Centre for Renewable Energy Sources (CRES)	GR