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

EMEEES bottom-up case application 19: Voluntary agreements – billing analysis method (industry and tertiary sectors)

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SenterNovem

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coordinated by

Wuppertal Institute for Climate, Environment and Energy

supported by

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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:

Project Partner	Country
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
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 (DONG)	DK
Centre for Renewable Energy Sources (CRES)	EL

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Contents

1 Summary

1.1 Title of the method

Voluntary agreement (VA) with industrial or tertiary sector branches/sub-sectors and their individual companies – billing analysis method.

1.2 Type and details of EEI activities and definitions covered

End use EEI action	
Sector	Industry
Energy end use	Various end use actions concerning efficient use of energy carriers
Efficient solution	Within the framework of energy management, the agreement focuses on improving energy efficiency in production processes, utilities, logistics and buildings as well as in the supply chain.
EEI Facilitating measure	
Types of EEI facilitating measures	Voluntary agreements at the level of branches/sub-sectors and individual companies within those branches/sub-sectors.

1.3 Detailed definition of EEI activities covered

Here it concerns the following actions taken by energy end users for improving their energy efficiency.

- Improved energy management;
- enhanced investment;
- increased technology innovation;
- enhanced technology diffusion;
- change in product design, composition of processed materials and resource use (e.g. thinner and lighter bottles, better recycling, etc.);
- change in energy supply structure (e.g. introduction of CHP appliances or domestic generation of renewables);
- use of energy services such as energy audits;
- awareness and motivation.

1.4 General specifications

The calculation model starts with the energy use and is defined as energy purchased by the individual participant in the VA (level 3a). In level 3b, our view takes into account delivered energy from the individual participant to other organisations than an energy distribution company (sold energy) and deals with net energy use. Level 3c gives possibilities to include special items for energy savings, like supply chain efficiency and energy savings throughout the entire product life cycle. Furthermore, level 3c calculations could also include expansion themes. We propose that Member States can decide to take such level 3c possibilities into account if they are able to transparently and solidly calculate and report the saving values concerned and avoid double-counting.

Necessary information:
Level 3a: Purchased energy: retrieved by f.e. energy distribution companies;
Level 3b: Sold energy based on information on the company: not only retrieved by f.e. the energy distribution companies, but also by the company concerned;
Level 3c: Specific information on the company concerned and/or information from other companies.

Furthermore, attention must be paid to the increased risk (from level 3a to level 3c) of double counting of energy savings, since some end use actions implemented within the VA can also be taken into account elsewhere. Via normalisation, the calculation model pays attention to the situation in which the energy efficiency is improved, while the annual energy consumption still increases.

Industrial companies that are participants in the VA may also be involved in the European Emission Trading System (ETS).[1] In the situation that installations of a company are included in the ETS (representing only a part of the company), the energy use for the "ESD-part" of the company must be cleared from ETS influences. Thus, the energy use of ETS installations has to be calculated and substracted from the total annual energy purchased and delivered. For this purpose, specific data from the company itself is needed. It should be ensured that the annual energy consumption is restricted to the non-ETS part. For such a situation, the level 3a approach is not appropriate.

1.5 Formula for unitary gross annual energy savings

For this case application, the unit is one final consumer (participant in the voluntary agreement scheme).

Level 3a calculation

Unitary gross annual energy savings =
[annual energy consumption]$_{t-1}$ – [annual energy consumption]$_t$

Equation 1

Level 3b calculation

Unitary gross annual energy savings =
[annual energy consumption- delivered energy in year]$_{t-1}$ – [annual energy consumption - delivered energy in year]$_t$

Equation 2

Level 3c calculation

Unitary gross annual energy savings =
[annual energy consumption- delivered energy in year]$_{t-1}$ – [annual energy consumption - delivered energy in year]$_t$ +
$\Sigma_{actions}$ *([annual energy consumption in the product chain]$_{t-1}$ – [annual energy consumption in the product chain]$_t$)*

Equation 3

(Exploring the possibilities for) calculating energy efficiency throughout the chain (level 3c) is optional and thus not in any case obligatory.

[1] In the situation that the whole company participate in the ETS it is not included in the calculations under the ESD.

Recommended application example:
Since the early nineties, the Netherlands uses the Direct Energy Efficiency Index (DEEI) as good practice. This index encompasses all three normalisation factors discussed here. It also relates the energy savings to energy efficiency improvements. Furthermore, the use of such a DEEI results straightforwardly in the estimation of the total ESD-savings for year y (for detailed information on DEEI, see Appendix II).

1.6 Indicative default value for annual unitary energy savings

No default values are available and possible.

1.7 Formula for total ESD annual savings

The formula for the total ESD (net) annual energy savings is as follows:

Total ESD annual energy savings $_t$ =

total gross annual energy savings $_t$ - Σ [energy savings accounted to other policies *(and, maybe, to autonomous actions and changes)**]$_t$

Equation 6

* only if the aim is to calculate additional energy savings

1.8 Indicative default value for energy savings lifetime

Based on experiences, the following **defaults for the energy savings lifetimes** for energy savings realised in VA could be taken into account, if no other (more) reliable information is available:

- 10% have a energy savings lifetime of 2 years. This corresponds with good energy management and monitoring;
- 75% of the annual saving have a energy savings lifetime of 8 years. This corresponds with the saving lifetimes of CHP, waste heat recovery, efficient compressed air systems, efficient motors/variable speed drives and efficient pump systems;
- 15% of the annual savings have a energy savings lifetime of 25 years (this period is in line with the saving lifetime of improvements in building envelope, glazing and utilities.

1.9 Main data to collect (for level 3a to 3c evaluation efforts)

Data needed in calculation for (level 3a)	Corresponding data sources
Data 1	Actual energy consumption (in fact purchased energy): registry/databases to collect details about participants
Data 2	Conversion values as provided for by the Energy Service Directive (ESD, 2006/32/EC) or national values
Data 3	Normalisation factors to exclude changes in actual energy consumption not related to energy efficiency improvement; calculating a DEEI as in the Dutch example
Data 4	An estimate of energy savings due to autonomous progress and actions by participants (only if the aim is to calculate additional energy savings), e.g., from Bottom-up modelling based on surveys; registry/databases to collect details about end-use actions taken by participants and other facilitating measures that influenced them; statistical analysis of participant vs. non-

	participant data of energy consumption
Data to be collected (level 3b)	**Corresponding data sources**
Data 1 to 4	As for level 3a
Data 5	Information on energy delivered to other facilities: registry/databases to collect details about participants
Data to be collected (level 3c)	**Corresponding data sources**
Data 1 to 5	As for level 3b

Data 6	Additional information on (deemed) energy savings (estimation, calculation) in the supply chain or the products:
	- Installed energy efficient equipment;
	- Transport & logistics;
	- Generation of renewable energy only insofar this concerns discounting energy purchased and energy delivered;
	- Side-effects within the production facility; positive spill-over effects from newly installed energy efficient devices leading to higher efficiency values;
	- assessment of sales data of products manufactured by industrial facilities (may include the use of control groups) (ONLY if not calculated elsewhere, avoid double counting)
	  - surveys among the participants to assess the portion/number of implemented end users actions;
	  - surveys among industries, for assessing the participant rate.

Concerning the end-use actions taken and the possible other facilitating measures that influence them, several options to enhance energy efficiency in industry, such as audit programmes, inplementation of an Energy Management Systems or Long Term Agreements, Energy Performance Contracting (ESCOs), third-party financing options, etc., can be taken into account. Krarup and Ramesohl developed the following table (included in Vreuls 2005), being a systematic and comprehensive coverage of energy efficiency end use actions that may be taken by participants to a VA scheme, and the likely influence the scheme may have.

Options	**Requirements**	**Timeframe**	**Impact of agreement schemes**
Change in product design, composition of processed materials and resource use (e.g. thinner and lighter bottles, better recycling, etc.).	Strategic commitment and long-term decisions with regard to a change of technical paradigms, process technologies and resource structures.	Long term.	Minor effects.
Change in energy supply structure (e.g. introduction of CHP appliances or domestic generation of renewables)	Strategic commitment and long-term decisions with regard to energy infrastructure and fuel imput.	Medium/long term.	Some effects, depending on policy mix (e.g. CHP policy in the Netherlands).
Increased technology innovation.	Strategic commitment and long-term investment into R&D.	Long term.	Minor effects.
Enhanced investment.	Change in strategic and operative business goals as well as altered decision criteria and procurement procedures.	Short/medium term.	Some effects, depending on policy mix (e.g. subsidies) and mandatory requirements (e.g. in Denmark)
Enhanced technology diffusion.	Increased communication, exchange of practical experience and generation of new network links, and even energy-related cooperation of competitors.	Medium Term.	Some effects, depending on existing cooperation and competition.

Options	Requirements	Timeframe	Impact of agreement schemes
Improved energy management.	Integrated approach and systematic search for improvement options, changes in organisational routines, staff empowerment.	Medium term.	Some effects depending on design of scheme (e.g. integration of audits in Denmark and Finland).
Awareness and motivation.	Mobilisation of company stakeholders, provision of information, know-how and expertise, and continious discussion of the issue.	Short/medium term	Some effects.

The use of energy services such as energy audits could be added to this table.

2 Introduction

2.1 Twenty bottom-up case applications of methods

Within EMEEES, task 4.1 provided methodological materials in the internal working paper “Definition of the process to develop harmonised bottom-up evaluation methods”, version 20 April 2007; an update has been published as an Appendix to the report on Bottom-up methods at www.evaluate-energy-savings.eu. Based on this draft report, concrete bottom-up case applications were developed by EMEEES partners within task 4.2, and reference values were to be specified within task 4.3.

This report deals with case application 19 “Voluntary agreements – billing analysis method” developed by SenterNovem.

Eleven project partners have developed concrete bottom-up case applications for a specific type of technology or energy efficiency improvement measure or end-use action. All gave comments and input to the methods developed by the other organisations.

The 20 case applications developed are presented in the table below:

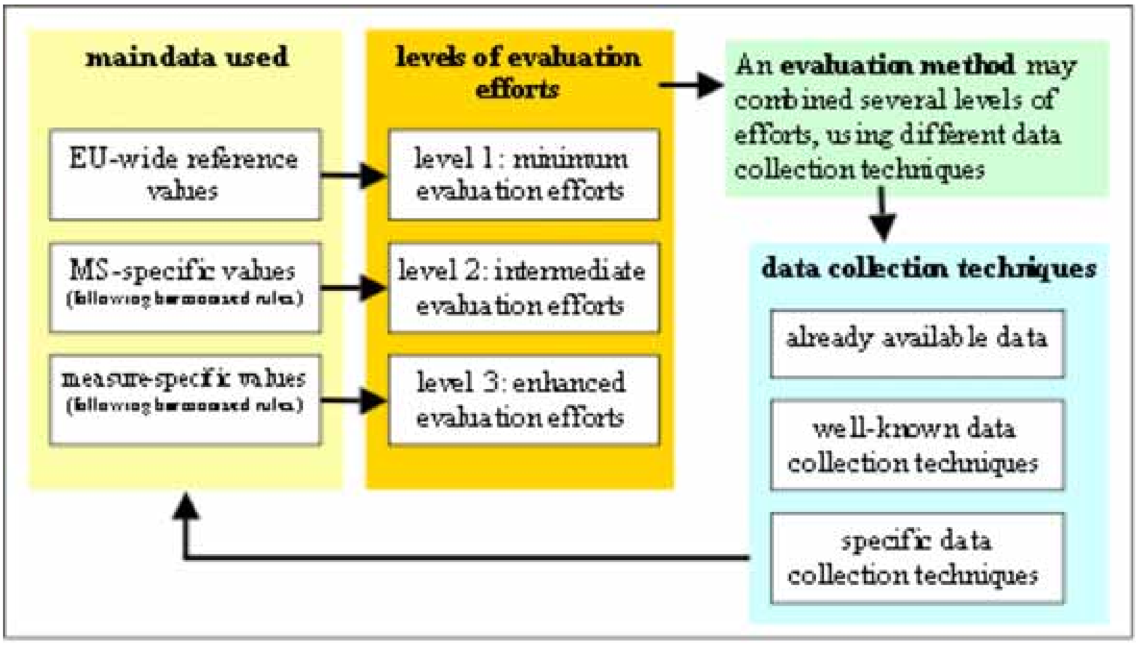
N°	End-use or end-use action, technology, or facilitating measure	Sector	Responsible organisation
1	Building regulations for new residential buildings	Residential	SenterNovem
2	Improvement of the building envelope of residential buildings	Residential	AEA
3	Biomass boilers	Residential	AGH-UST
4	Residential condensing boilers in space heating	Residential	Armines
5	Energy efficient cold appliances and washing machines	Residential	ADEME
6	Domestic Hot Water – Solar water heaters	Residential	AGH-UST
7	Domestic Hot Water - Heat Pumps	Residential	AGH-UST
8	Non residential space heating improvement in case of heating distribution by a water loop	Tertiary	eERG
9	Improvement of lighting systems	Tertiary (industry)	eERG
10	Improvement of central air conditioning	Tertiary	Armines
11	Office equipment	Tertiary	Fraunhofer
12	Energy-efficient motors	Industry	ISR-UC

N°	End-use or end-use action, technology, or facilitating measure	Sector	Responsible organisation
13	Variable speed drives	Industry	ISR-UC
14	Vehicle energy efficiency	Transport	Wuppertal Institute
15	Modal shifts in passenger transport	Transport	Wuppertal Institute
16	Ecodriving	Transport	SenterNovem
17	Energy performance contracting	Tertiary and industry end-uses	STEM
18	Energy audits	Tertiary and industry end-uses	Motiva
19	Voluntary agreements – billing analysis method	Tertiary and industry end-uses	SenterNovem
20	Voluntary agreements with individual companies – engineering method	Tertiary and industry end-uses	STEM

2.2 Three levels of harmonisation

In order to be as practicable as possible and to stimulate continued improvement, the harmonised reporting on bottom-up evaluation is structured on three levels (cf. figure 1).

Figure 1: Three levels of harmonisation



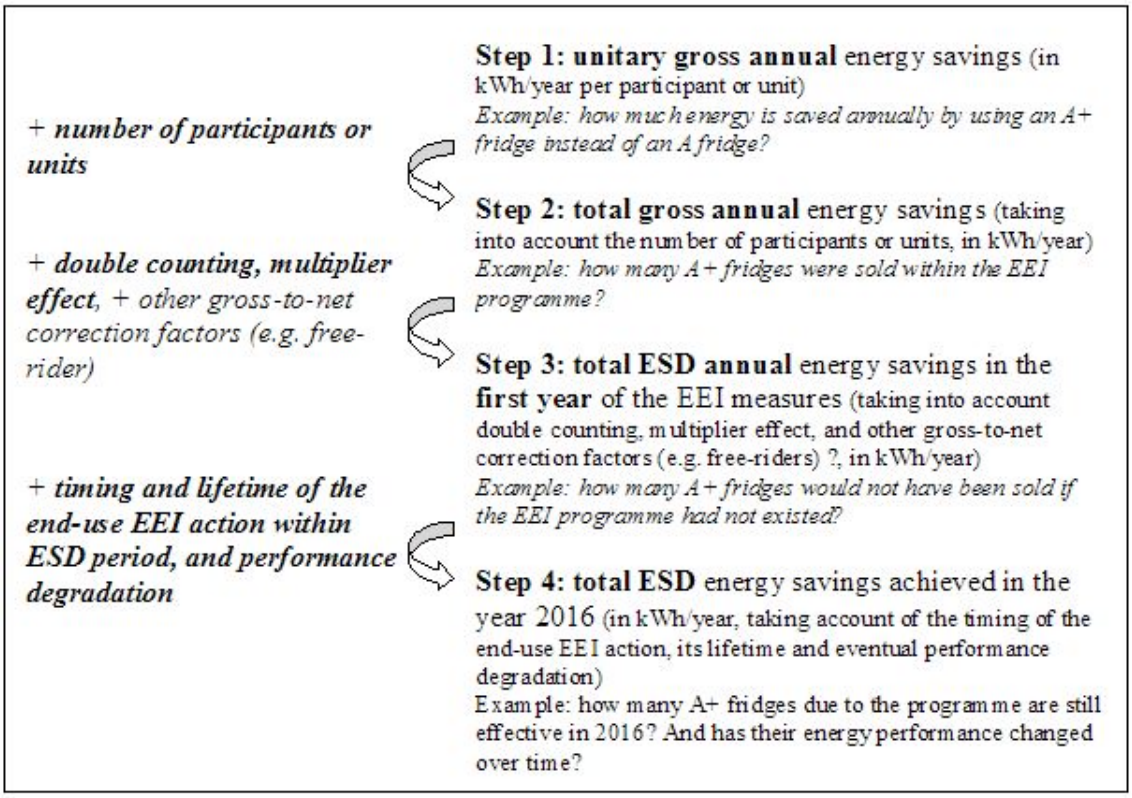
As a consequence, the EMEEES case applications for bottom-up evaluation methods present:

- EU wide reference values, if applicable;
- Guidelines how Member States can use country-specific values following harmonised rules;
- Guidelines how measure- or action-specific (national) values can be developed, following harmonised rules.

2.3 Four steps in the calculation process

The harmonised rules for bottom-up evaluation methods are organised around four steps in the calculation process (cf. figure 2). These steps are presented in detail in the report for WP 4.1.

Figure 2: Four steps in the calculation process



The reports on the concrete bottom-up case applications follow the format of these four steps and they each hold six chapters plus some annexes:

1. summary
2. introduction
3. step 1: unitary gross annual energy saving
4. step 2: total gross annual energy savings

5. step 3: total ESD annual energy savings

6. step 4: total ESD energy savings for year "i"

2.4 Pilot tests

Additional to the development of the 20 bottom-up case applications, some of these cases were tested in practice in Work Package 8.
Pilot tests of the following case applications were performed by EMEEES partners in Italy, France, Denmark, and Sweden:

EMEEES case application	Sector	Italy	France	Denmark	Sweden
Building envelope improvement	Residential		X		
Energy-efficient white goods	Residential	X			
Biomass boilers in the residential sector	Residential		X		
Condensing Boilers	Residential	X	X		
Improvement of lighting system	Tertiary (industry)				X
High efficiency electric motors	Industry	X			
Variable speed drives	Industry	X			
Energy audits	Tertiary and industry end uses			X	
Energy performance contracting	Tertiary and industry				X

The following EEI measures were evaluated ex-post using the above-mentioned EMEEES bottom-up case applications:

Country	Subject	Sector(s) addressed
France	Condensing boilers, building envelope improvements and compact fluorescent lamps under the French White Certificates.	Residential
Italy	Schemes under the Italian White Certificates system	Residential, tertiary, industry
Sweden	Energy Efficiency Investment Programme for Public Buildings (2005-2008)	Public non-residential buildings
Denmark	Energy audits performed in Denmark between 2006 and 2008	Industry, tertiary

As a result of the pilot tests, some of the case applications tested were updated to reflect the findings of the tests.

3 Step 1: Unitary gross annual energy savings

3.1 Step 1.1: general formula and calculation model

"Voluntary agreements with branches/sub-sectors and their individual companies"

Voluntary Agreements (VA) are multi-party programmes aimed at reducing energy consumption among a group of commercial and/or industrial energy users, generally defined according to their industry branche (sub-sector) or trade sector. Voluntary Agreements typically consist of the following crucial elements[2]:

Negotiated energy use reduction targets. The government or an agency of the government enters into negotiation with individual energy consumers or their industrial association to establish energy efficiency goals. These goals may be expressed in a number of ways and vary between Member States:

- a reduction of energy use per unit of energy production;
- implementation of a facility area (expressed in terms of percentage from a baseline level);
- attainment of industry-specific benchmarks for energy use;
- reduction of the (total) energy consumption;
- implementation of all energy efficiency end use actions with a given maximum pay back time (in this case, EMEEES case application no 20, specifying a method based on end-use actions implemented, may be more appropriate);
- other.

The agreement also defines the period, over which these energy reduction goals are to be achieved. In some cases, the participants' commitments to Voluntary Agreements are legally binding;
Measurement scheme. Most voluntary agreements contain a measurement scheme that specifies the criteria to be used in setting targets, methods for quantifying energy use, definitions of baselines and benchmarks, monitoring and methods of calculation of savings;
Technical assistance services. Many voluntary agreements contain mechanisms for providing technical assistance to end users that join the agreement. These services may include technical information dissemination, training, facility auditing and consulting, project design review and assistance in implementing the measurement scheme;
Sanctions for non-compliance/incentives for compliance. Sponsors of Voluntary Agreements have used a wide variety of mechanisms to encourage participating enterprises to meet their obligations. These mechanisms have included:
Threat of regulation. Some governments have implied that imposition of strict emission limits or prescriptive equipment standards will result from persistent non-compliance or refusal to participate in Voluntary Agreements;
Withholding of operating permits. In some countries, compliance with Voluntary Agreements is required for the renewal of environmental permits;
Exemption from taxes. A number of governments, including those in the United Kingdom, Denmark, Sweden and the Netherlands, exempt facility owners in selected industries from fuel and or electricity taxes if they participate in and meet the obligation of industry-wide Voluntary Agreements;
Emission trading credits. A number of governments, including the Canadian government, have made provisions for tradable 'early action credits' for emission reduction activities within the framework of Voluntary Agreements;
Economic incentives. Participants in Voluntary Agreements may be offered fiscal incentives

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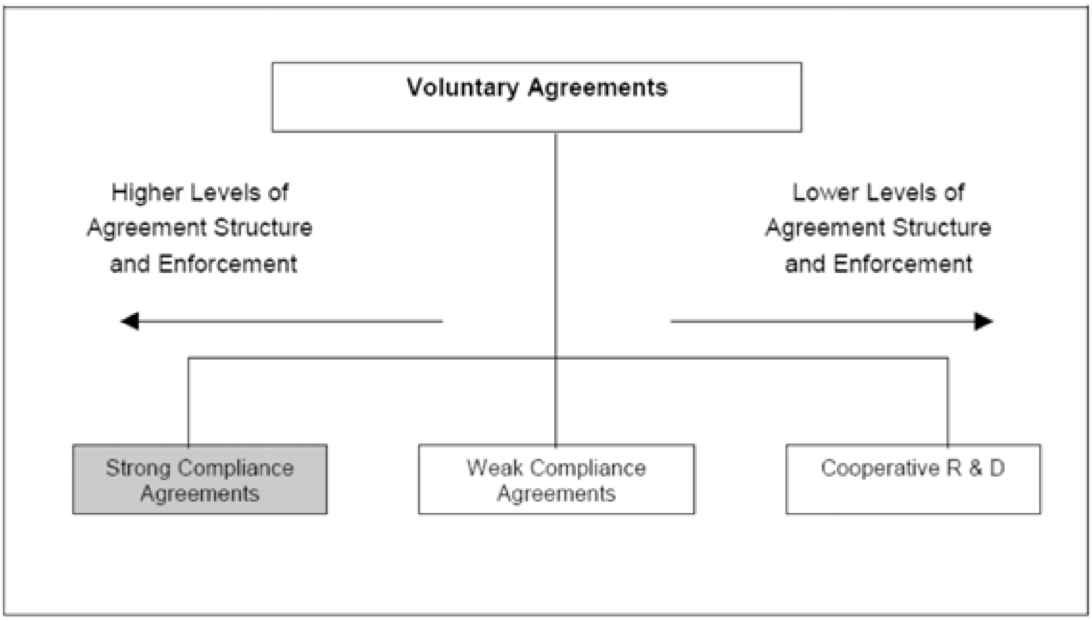
[2] H. Vreuls, Evaluating Energy Efficiency Policy Measures DSM Programmes, (2005) International Energy Agency, p. 123-125.

such as rebates, credits against corporate income taxes, investment subsidies or reduced-interest loans, for implementing energy efficiency end use actions.

An IEA/OECD review (2003) of national policies with regard to climate change identified three main types of Voluntary Agreement Programmes, as summarised in figure 5.2. Despite the indication of Cooperative R&D in the scheme, this case application only focuses on VAs characterised by stronger compliance. Cooperative R&D will thus not be further elaborated below. The main types are:

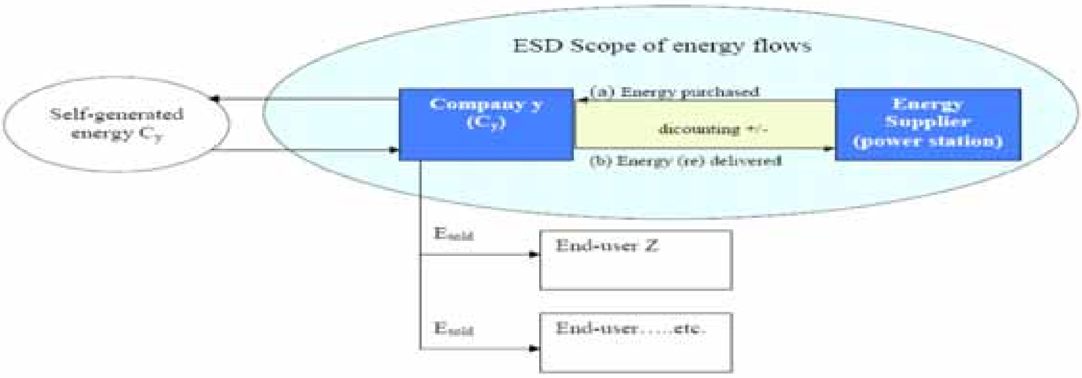
Figure 5.2 Varieties of Voluntary Agreements



Strong compliance agreements. These arrangements are characterized by penalties for non-compliance for all facilities over a certain size, clearly-defined energy reduction goals set at the facility (as opposed to the branch) level and clearly defined measurement schemes.
Weak compliance agreements. These arrangements are characterised by voluntary participation, goals that may be set at the facility or branch level, measurement schemes that allow for a variety of reporting methods and incentives for non-compliance (without penalties for non-compliance).

As stated above, this case application focuses on the industrial voluntary agreements, which contain most of the features of strong compliance agreements, such as clearly-defined goals and sound monitoring schemes. However, particularly in industry practical experience has shown that penalties for non-compliance are not a necessary precaution for obtaining good saving results. Furthermore, the concept of voluntary agreements becomes a non-voluntary policy if non-participation is penalised.
Purchased energy is the ESD's scope. Self-generated energy not being expressed in discounting figures and energy sellings to other end users are beyond the scope of the ESD. This is illustrated in figure 3.

Figure 3: ESD's scope of energy flows



Taking this scope into account, the calculation model starts with the energy use, which is defined as purchased energy for the individual participant in the VA (level 3a). In level 3b, we expand our view to take also into account delivered energy from the individual participant to other organisations than an energy distribution company (delivered energy). We also deal with the net energy use. Level 3c gives possibilities to include special items for energy savings, like energy savings in the entire product life cycle. Member States can decide to take such level 3c possibilities into account if they are able to transparently and solidly calculate and report the saving values concerned, and exclude double counting, e.g., with other calculations of energy savings due to policy promoting energy-efficient appliances in the market.

None of the formulas given below explicitly deal with production values. Production values are nevertheless important for understanding the real energy savings over a period of time (either on a year by year basis or the average of a 5-years' term). However, production values cannot be considered as being 'single' but may vary depending on a company's mode of production. A baker produces bread (in several varieties), while Philips electronics produces several totally different products (semi-conductors, flat screens, refrigerators) with entirely different modes of production and thus production values. The variety of production modes throughout the EU is therefore simply of too large a scale to incorporate in a single formula. For this reason, production values are not taken into account in the formulas concerning the calculation of gross annual energy savings. Member States themselves should define solutions for dealing with production values under step 1.5 concerning normalisation factors, for which they can use their own (country-specific) methodologies.

Furthermore, attention must be paid to the increased risk (from level 3a to level 3c) of double counting of energy savings, since some end use actions implemented within the VA can also be taken into account elsewhere (see step 3.2). The calculation model deals with the (total) annual energy consumption, which is equal to the (total) annual energy demand under level 3a calculation and gives attention to energy efficiency improvements, while the total annual energy consumption (equal to the total annual energy demand) may still increase (see step 1.3 normalisation factors).

Data necessary for the level 3a to 3c calculations:

- Level 3a: Purchased energy: retrieved by f.e. energy distribution companies;
- Level 3b: Sold energy based on information on the company: not only retrieved by f.e. the energy distribution companies, but also by the company concerned;
- Level 3c: Specific information on the company concerned and/or information from other companies.

Calculations of the unitary gross annual energy savings can be done using the formulas as mentioned below.

Level 3a calculation

Unitary gross annual energy savings =
[annual energy consumption]$_{t-1}$ – [annual energy consumption]$_{t}$

Equation 1

Level 3a calculation refers to the purchased (=measured) energy. Annual energy consumption is the summation of all purchased energy sources (electricity, gas, heat, fuels etc). For this summation, the energy sources have to be converted to a single energy unit (see step 1.4).

Annual unitary energy consumption might grow in despite of generated energy savings, so there are only relative energy savings. A sufficient degree of normalisation factors applied should enable to calculate the relative energy savings.

Furthermore, in some cases a participant generates energy (e.g. Photovoltaic, wind, CHP) and delivers (a part of) this to the energy distribution company or to another energy user, which results in a lower net purchased energy. Also the generation of renewable energy that is used inside the company is not included in the unitary annual energy consumption, since it is not purchased.

Level 3b calculation

Level 3b calculation goes one step further than level 3a calculation, by (also) dealing with the energy sales to other end users. If a company (e.g. in case of CHP) delivers energy sources (e.g. heat or electricity) to other end users, these deliveries should be subtracted from his (net) purchased energy.

Unitary gross annual energy savings =
[annual energy consumption- delivered energy in year]$_{t-1}$ – [annual energy consumption - delivered energy in year]$_{t}$

Equation 2

Level 3c calculation

Level 3c gives possibilities to included special items for energy savings depending on the specific industrial Voluntary Agreement. One example is energy savings throughout the entire product chain, from raw material extraction to disposal (the entire product life cycle) in the Dutch VA (LTA2 and LTA3). This makes it possible for businesses to extend their (energy) gains beyond their own operations, and to contribute to gains by the consumers, buyers/clients and raw material suppliers.
This approach is included in the Dutch VA as Energy Efficiency Product Development (EEPD) and distinguishes three areas in which further energy savings can be made:

1) Sustainable products: The key question here is: where in the life cycle of a product can (energy) gains be made? Working on sustainable products can result in a relatively simple, new and energy efficient product, but also in a new innovative system;
2) Optimizing transport, logistics and product chains:
Substantial energy savings can sometimes be made in the distribution of products

and the materials needed to make them. This optimisation leads to a reduction in the energy used in the transport and storage per unit product.

3) Sustainable industrial estates:
Companies can work together and with governments to reduce energy consumption in sustainable industrial estates by e.g.:
   - Exchanging energy, raw materials and water (for example in the form of residue heat, residue cold and residue materials);
   - arranging the shared use of utilities and commercial functions (such as combined heat and power, waste water purification, compressed air);
   - joint collection, disposal or processing of waste.

The following example illustrates this approach:

A cooling company decides to purchase other packing material, which contributes significantly to the insulation of the cooled food products meant to be transported to the food distributors by another company. The costs of the energy end-use action have been made by the cooling company, but the transporting company enjoys the energy savings. Without paying special attention to chain efficiency, situations occur in which generated energy savings cannot be attributed to companies investing in these end use actions.

If one includes energy savings thoughout the chain, the calculation has to be done on the level of each individual end use action taken. If a participant takes more than one end use action, the energy savings for each individual end use action have to been added.

The following formula illustrates how this chain approach can be taken into account.[3]

Unitary gross annual energy savings =
[annual energy consumption- delivered energy in year]$_{t-1}$ – [annual energy consumption - delivered energy in year]$_t$ +
$\Sigma_{actions}$ *([annual energy consumption in the product chain]$_{t-1}$ – [annual energy consumption in the product chain]$_t$)*

Equation 3

Annual energy consumption in the product chain = energy use related to the product being targetted by the specific end use actions.

This annual energy consumption is determined by using assumptions concerning the time of operation, average use of appliances, etc. Therefore the energy savings for end use actions in the product chain must be considered as deemed savings.

Futhermore, ET -influences of energy savings outcome under the ESD must be normalised. Namely, industrial companies being participants in the VA may also be involved in the European Emission Trading System (ETS). Article 2 excludes these for the ESD. So the

[3] It is important to stress that (exploring the possibillities for) calculating energy efficiency throughout the chain is optional and thus not in any case obligatory. For the determination of the energy savings it suffices to only take into account the parts of the life cycle, where changes take place due to an energy efficiency end use action. After the determination of the total savings an allocation of effects to specific end use actions should be made in order to get viable saving values. An allocation scheme could be part of the instrument and should be developed in the near future. Furthermore, cooperation between Member States opting for inclusion of chain effiency in their voluntary agreements is desireable.

annual energy consumption of those participants may not be taken into the unitary savings. There are two options:

a) only the energy use of the installation under the ETS is excluded;
b) the participant that has an installation under the ETS is excluded.

Situation b. is dealt with in step 2 (total gross annual energy savings). Situation a. results in substraction of the energy use of the ETS installation from the energy use of the participant. For this situation the annual energy consumption in equation 1-3 has to be changed according to:

> *Annual energy consumption* = [annual energy consumption] – [annual energy consumption ETS installation(s)]

Equation 4

In the situation that an industrial company introduces a new installation during its participation in the VA and that installation meets the criteria to be included in the ETS, a high but virtual decrease of energy consumption from year to year will be the result. Namely, if an installation under the VA meets the ETS criteria, it will be necessarily subjected to the ETS monitoring system and thus excluded from the monitoring methodology under the ESD. The result of this shift will be a rather high but virtual decrease of energy consumption. The ESD does not take into account such a shift. The virtual decrease of energy consumption must not count as ESD energy savings.

3.2 Step 1.2: Baseline

Baselines for industrial Voluntary Agreements concern normalised energy consumption 'before' EEI measures, i.e., counterfactual that would have been without end-use actions or facilitating measures.

The baseline should be the energy consumption at the participating company (or company unit/plant) "before the EEI facilitating measure is implemented". Corrections for external conditions can be made according to the normalisation factors as listed below. Especially relevant for an industrial company to correct for are factors like plant throughput, level of production, volume or added value, and changes in GDP level (see normalisation factor (e) below). Expressing the "before" energy consumption as an average consumption over a fixed base period, e.g. a few years before the EEI measure is initiated, is one way to deal with external conditions when establishing the baseline.
In this way, there is no distinction of the starting point for baseline, either if the objective of the evaluation is to calculate all energy savings, or to calculate additional energy savings. However, the counterfactual to be used for the measurement years (during the VA period, i.e., after the base period) to compare the actual consumption in this years with is different.

All energy savings
For this case application on calculating energy savings for ESD reporting, the assumption that the baseline is the situation before implementing a VA-framework.

This approach includes all improvements taken by the participants within the VA, no matter whether an end use action is taken autonomously by the participant, is (also or only) supported by other facilitating measures (e.g. tax reduction, grants), or a is result of mandated environmental improvements. To avoid double counting in reports, special attention has to be given to this subject (in step 3.2).

The baseline for all energy savings is the normalised consumption in the base period. If also the actual energy consumption in the measurement year is normalised, it should be possible to calculate all energy savings from the difference (see equatoin 1).

Additional energy savings
In the evaluation of industrial Voluntary Agreements scenarios taking into account the potential energy efficiency improvement in the period relevant for the agreement in a 'business-as-usual' situation while also considering expected structual changes are often used. That will be the baseline for additional energy savings. Additional energy savings are those that, as an effect of an EEI measure, come on top of those that energy consumers, investors, or other market actor would have done by themselves anyway (cf. EMEEES WP 4 summary report, Vreuls et al.) for more explanations).

Potential ways to estimate the baseline (counterfactual) for additional energy savings for the measurement years are:

- Bottom-up modelling based on surveys;
- registry/databases to collect details about end-use actions taken by participants and other facilitating measures that influenced them;
- statistical analysis of participant vs. non-participant data of energy consumption

According to evaluations, between the 50-60% of the reached energy efficiency values in industry must generally be attributed to VAs. In some cases much lower values are attributed. According to case studies within the AID-EE framework, an attribution of 60% took place in Denmark (by means of the implementation of an EMS; VAs on EE combined with subsidies)[4] and 16-18% in Norway (by means of the implementation of an EMS; representation of 2% of the total energy consumption of industry measured over the period 1996-2004)[5].

3.3 Step 1.3: Requirements for normalisation factors

"Since the early nineties the Netherlands uses the Direct Energy Efficiency Index (DEEI) as good practise. This index encompasses all three normalisation factors. It also relates the energy savings to energy efficiency improvements. Furthermore the use of such a DEEI results straightforwardly into the estimation of the total ESD-savings for year y (for detailed information on DEEI, see Appendix II)

When calculating relative energy efficiency savings (both if all or additional savings are to be calculated), highly detailed information on inividual energy saving actions (device specifications such as energy use (according to energy labels of energy efficient devices), life expectancy, exact date of operationability for determining the precise generated energy efficiency in a year, etc.) is necessary. Furthermore, implementation of energy efficient devices may have positive spill-over effects, resulting into a higher overall efficiency througout the production process. These issues need to be accounted for but it can be argued that highly detailed information and extra assumptions for normalisation are necessary in order to achieve plausible calculation results.

Finally, the industrial annual energy consumption is influenced by fluctuations in the production process and sometimes also by weather conditions. Annex IV (1.2) to the ESD holds several examples of such conditions, which need to be taken into account into normalisation or adjustments. The following three main conditions for normalisation can be

[4] Karin Ericsson, 2006
[5] Gunnar Modig, 2006

distinguished:

1. plant throughput, level of production, volume or added value

It is recommended to include reporting reporting obligations in the VAs in order to receive the data annually prior to the level 3a to 3c energy saving calculations under the ESD. Furthermore it is important that Member States normalise the production values for which they should define solutions on the base of their own (country specific) methodologies. Below are given some examples which can be taken into account in the solutions.

- Value: Companies can opt for corrections based on their sales values. For example: company x produces 100 cathode ray tube televisions (CRT) in year y, with a sales value of 20.000 Euro. In year z it produces 120 CRT's with a sales value of 30.000. Energy costs per kWh in year y is equivalent to year z. Company x reached a higher sales value for its energy used in year z in relation to year y. This approach is preferred by many companies;
- Volume**:** Companies can opt for volume normalisations. For example: company x produces 100 CRT's using y kWh in year t. Due to some energy efficiency end use actions (generating z efficieny) company x produces 120 CRT's using y-z kWh in year u. The higher production volume of company x in year u is then realised with lesser energy use in relation to year t.

2. Structural production change

It is recommended to include reporting obligations in the VAs in order to receive the data annually prior to the level 3a to 3c energy saving calculations under the ESD.

This is the case, when a structural change is made in a company's production process. A structural change means a company's shift to a new mode of production resulting in a.o. energy efficiency. Such a shift does not necessarily be the consequence of taking part in a VA[6] but can very well be the result of just company economics. For example: company x shifts from the production of CRTs in year y to the production of LCD televisions in year z, for which it imports all relevant parts from company t in order to assemble the LCD TVs and make them ready for use. This shift saves energy. A baseline is necessary to take this energy efficiency into account. For this baseline, either a reference year can be chosen for determining the difference between the situation before and after the structural change or a correction factor can be applied.
If a country opts for using a baseline, it should use two baselines; one for determining the difference between the 'before and after situation' (year of change$^{t\text{-year } x}$) and the difference between the year of change and subsequent years (year of change$^{t+1,2,3,etc}$). If a country opts for the use of a correction factor, this factor must represent both the before and after situation. Such factors remain fixed unless a new structural change of a company's mode of production takes place.

In all cases however, special attention should be given to companies which effectuate a structural change by outsourcing a mode of production to another company. When such a situation occurs, the outsourcing company cannot claim energy efficiency caused by its structural change. Outsourcing must be dealt with in the calculation of chain efficiency (level 3c calculation), but can accidentally (also) be taken into account in the level 3b calculation. Concerning outsourcing, caution is necessary to avoid double countings.

3. Weather (temperature)

[6] If it is part of the VA, it is taken into account in the range of 50-60% energy efficiency values which must be attributed to VAs. See also step 1.2 Baseline.

It is recommended to include reporting reporting obligations in the VAs in order to receive the data annually prior to the level 3a to 3c energy saving calculations under the ESD. Normalisation for seasonal influences is important for industrial (buildings) sectors; specifically cooling and heating sectors. Temperatures vary over years, which logically leads to fluctuations in energy use of f.e. cooling and heating sectors. Such fluctuations could be erroneously attributed to energy efficiency or energy inefficiency. Such an attribution can be overcome by approptiate normalisation.

For the first two conditions for normalisation the situation in year 0 is taken as the reference situation. For the third condition the rule of principle is to take an average year functioning as the reference situation for weather conditions (year x) followed by normalisation of the energy use in year x+t to that reference year. This normalisation can take place either on a yearly basis or over a longer period, for which solid (normalisation) factors must be developed and used.

3.4 Step 1.4 Specifying the calculation method and its three related levels

Level 3a
The method is based on energy bills. This information should be available on the level of companies. The utilization of normalisation conditions will need specification of the energy use from the company and sometimes also from the concerned energy source (energy distributor).

Level 3b
Additional to level 3a, information on the energy delivered to other end users is needed at the level of the participant in the VA to whom this situation is relevant. The method is still a billing analysis.

Level 3c
Additional to level 3a and 3b, detailed information is needed, depending on the specific elements that are added to widen the scope of energy savings. The use of normalisation factors can be very complicated and might cause a high additional data demand. The additional analysis are usually estimates, either enahnce engineering or a mix of deemd and ex-post data.

3.4.1 Conversion factors

The energy sources have a specific energy content and for the ESD these sources are added using either the conversion factors in Annex II of the ESD or the factors included in the first NEEAP. In this context, the introduction of a CHP could lead to different impacts between Member States. Namely, Member States can either choose between the default co-efficient factors of 1 or 2,5 as provided for by the ESD for savings in kWh electricity or Member States could opt for another factor, clearly justified in their first NEEAP.

3.4.2 Considering the direct rebound effect

The direct rebound effect is assumed not to be relevant within this case application.

3.4.3 From EMEEES tasks 4.2 to 4.3: defining values and requirements

Default values are not possible within this approach of calculating energy savings for industrial VAs at level 3.

4 Step 2: Total gross annual energy savings

4.1 Step 2.1: Formula for summing up the number of actions

Actions here concern energy end use actions. The total gross annual energy saving is the result of adding up the energy savings for the individual participants in the Voluntary Agreement. These calculated energy savings (determined by using level 3a to 3c calculations) are f.e. the result of actions such as 1) generation of energy by an energy end user sold to energy suppliers; 2) selling energy to other end users, 3) introduction of sustainable energy or installations meeting ETS requirements, etc.).

The total gross annual energy saving is the summing up of the energy savings for the individual participants in the Voluntary Agreement.

Level 3a to level 3c:

Formula for participants:

$$\textit{Total gross annual energy savings} = \sum_{i=1}^{n} [\textit{gross annual energy savings of participant } i]$$

Equation 5

The gross annual energy savings of a participant I are calculated with formulas 1 to 3, according to the level 3a, 3b, or 3c chosen.

One should keep in mind that the outcomes of the calculation of the energy savings of participants can differ, depending on the specific situation of a participant. Energy consumption subject to the ETS must be excluded (cf. formula 4).

4.2 Step 2.2: Requirements and methods for accounting for the number of actions

The participants in the VA are well-known. The energy savings for each participant have been calculated in step 1. They just need to summed up, as shown in step 2.1, equation 5. No further requirements apply.

For the evaluation of the additional energy savings impact of the Voluntary Agreement, monitoring of actions is crucial for retrieving information on the type of end use actions resulting in savings and the parts of the total savings to be attributed to the Voluntary Agreement. But this will not be necessary when calculating all energy savings by this bllling analysis.

The actions included are depending on the selected level. For level 3a all energy efficiency end use actions within the company are taken into account. During the step of double counting, attention has to be given to the participation in subsidy schemes, tax reduction, grants etc. This is also the situation for level 3b, that only brings additional energy deliveries from companies into the energy calculations. For level 3c the additional selected end use actions within the VA that also takes into account energy in the product chain are specifically relevant.

When calculating the chain efficiency (level 3c), attention must be paid to possible double counting effects. Safeguards against double countings must be clearly described.

5 Step 3: Total ESD annual energy savings

5.1 Step 3.1: Formula for total ESD annual savings

The formula for the total ESD (net) annual energy savings is only influenced by double counting, when calculating all energy savings. When calculating additional energy savings, also energy savings due to autonomous end-use actions taken by the participant and other autonomous changes need to be removed from the result. How the double counting is included in the formula depends on country specific choices. We are in favor of subtracting energy savings resulting for specific energy efficiency improving actions and facilitating actions. As follows:

Total ESD annual energy savings $_t$ =

total gross annual energy savings $_t$ - Σ [energy savings accounted to other policies *(and, maybe, to autonomous actions and changes)**]$_t$

Equation 6

* only if the aim is to calculate additional energy savings
With $_t$ = duration of the VA in years.

5.2 Step 3.2: Requirements for avoiding double counting

There are three options to avoid double counting:

a) all savings that are also influenced by other policies are substracted from the savings calculated for the VA;
b) all savings that are also influenced by other policies are substracted from those policies;
c) all savings that are also influenced by other policies are divided between the VA and the other policies and a so a part of saving are substracted from the savings calculated for the VA;

<u>Ad a. Substract from VA savings</u>
Other policies like subsidy schemes, tax reductions, or regulations are often focussed on appliances, installations or buildings. To translate energy savings (that are accounted for) to other policies, information on the deemed or measured savings that are attributed to participants in the VA is needed.

It should also be assured that savings are calculated in line with the normalisation of energy use/savings withing the VA. The (deemed or measured) energy use related to the appliances etc. should be excluded from the energy use for the lifetime period of savings being used outside the VA.

<u>Ad b. Substract from other policies</u>
Other policies like subsidy schemes, tax reductions or regulations are often only focussed on appliances, installations or buildings. Since the participants in the VA are known, it should be easy to mark them during the implementation the policies and to exclude their savings resulting from the use of other policies.

<u>Ad c. Divide savings between policies</u>
This is the same situation as described under ad a. with additional efforts to attribute part of the savings to the different policies. This attribution (%) can be kept the same over the whole period or changing over time. This attribution has to be motivated and reported/argued.

Option b seems to have the lowest workload as it is a simple approach. Option a is more complicated as one has to take care of normalisation and lifetime, which indeed differs between the participants in the VA (and other policies). Furthermore this option neglects interaction between various facilitating measures and neither does it take into account the sequence of implementation of end use actions. All together, option a leads to inappropriate outcomes. Option c holds the highest workload as it needs additional research on proper attribution; a possible solution may be to agree upon the arbitrary division of the total savings over the various policies facilitating measures once every three to five years. Because of double counting issues being a country's specificity, Member States themselves should decide on which option represent their specific situation at best.

5.3 Step 3.3: Requirements for taking account of technical interactions

The VA include a broad range of energy efficiency improving actions. At level 3c, also energy savings outside the own organisation can be included. At the company level, the decision-making process includes selection of (combination) of end use actions.
As the calculation is on the difference between the energy consumption from year to year, the problem of technical interaction is not relevant for the calculation.

5.4 Step 3.4: Requirements for multiplier energy savings

The multiplier energy savings refers to additional energy savings as indirect results of the Voluntary Agreement. As we take the total energy savings of the participants in the VA into account in the equations, these multipliers refer to energy savings outside the VA.

The information related to multipliers is not available in the reporting within the VA, so if one wants to take multipliers into account, additional data and specific research will be needed.

5.5 Step 3.5: Requirements for the free-rider effect

The free-rider effect is not explicitly mentioned in the ESD. The choice of all energy savings for the equations and the energy use in the previous year as reference for the energy savings includes also free-riders. If the aim is to calculate additional energy savings, the free-rider savings (autonomous savings) need to be removed (see also section 3.2 on baselines and formula 6 above). If the baseline is modified to only account for additional energy savings, free-rider energy savings will be automatically excluded, and so do not have to be introduced in equation 6.

One could argue that investments in appliances, equipment and installations with a relatively short pay back time (2-5 years) would also take place in the absence of the VA. On the other hand, it is also well known that many end-use actions even with short to medium pay-back times are not taken due to varriours barriers. VAs are an instrument which can stimulate industry to implement these cost-efficient investments. It depends on the monitoring system of a VA whether information on pay-back times of implemented end use actions is easily available or not.

6 Step 4: total ESD energy savings for 2010 and 2016

For the Voluntary Agreement the energy savings are calculated annually. If the VA is still in place for 2010 and for 2016, there is no need to take into account the energy saving lifetime. The energy savings can be calculated using the formulas presented in step 1 to 3, taken the energy use in the base year (as t-1 in the formula) and the energy use in 2010 or 2016 (as t in the formula).

Total ESD energy savings resulting from VAs are then those calculated for the year 2010 or 2016.

If a Voluntary Agreement stops prior to 2010 or 2016, energy saving lifetimes are relevant.

6.1 Requirements for the energy saving lifetime

Behavioural changes regarding energy efficiency usually last not longer than some years. Improvements in building envelope and glazing are long lasting, so are the resulting energy savings. CWA 27 proposed energy saving lifetimes for houses, commercial building, transport and industry. Table 1 shows the proposed default values within industry.

	EEI measure	Factors				Saving lifetime (*)	
		Economic lifetime	Behavior /Social	Non-retention	Mainte-nance	Harmonised	Default
49	Econometer		X				2
50	Optimal tyre pressure		X				1
51	Efficient driving style		X				2
	Industry (not part of emission trading)						
	Technical						
52	Combined heat and power	X					8
53	Waste heat recovery						8
54	Efficient compressed air systems	X					8
55	Efficient electric motors/variable speed drives						8
56	Efficient pumping systems			X			8
	Organisational						
57	Good energy man. & mon.	X			X		2

For the energy saving lifetime in industry the end use actions can be grouped into:

Good housekeeping, energy management system etc. These have a default value of 2 years;
Technical improvement in appliances. These have a default value of 8 years;
Improvement in building envelope, glazing and utilities. These have a lifetime of 25 years.

As stated before the Netherlands uses the Direct Energy Efficiency Index (DEEI) for the calculation of the energy efficiency resulting from the Long Term Agreement (LTA). This DEEI also deals with the savings life time of several end use actions. Within the Dutch industrial LTA for proces efficiency, the following experiences show up:

- energy efficiency of end use actions in the process, strategic projects and renewable energy (from geothermal energy), CHP storage and geothermal energy pumps. This category contributes for 75% to the Energy Efficiency Index;
- Energy efficieny of end use actions in buildings and utilities contribute for 10% to the Energy Efficiency Index;
- Energy efficiency of end use actions for good housekeeping, which contribute for 10% to the Energy Efficiency Index;
- 5% of improvements are related to other end use actions.

Based on these experiences the following **defaults for the energy savings lifetimes** for energy savings realised in VA could be taken into account, if no other (more) reliable information is available:

- 10% have a energy savings lifetime of 2 years. This corresponds with good energy management and monitoring as mentioned in the table above;
- 75% of the annual saving have a energy savings lifetime of 8 years. This corresponds with the saving lifetimes of CHP, waste heat recovery, efficient compressed air systems, efficient motors/variable speed drives and efficient pump systems (mentioned in the table above);
- 15% of the annual savings have a energy savings lifetime of 25 years (this period is in line with the saving lifetime of improvements in building envelope, glazing and utilities (group 3 as mentioned above).

6.2 Special requirements for early actions

The definition of early actions may include two possibilities (to be clarified by the European Commission and the ESD Committee):

- *early (EEI) 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 that still have a lasting effect during 2008-2016, are eligible

OR

- *early energy savings* from end-use actions initiated between 1995 and 2008, with the end-use actions having a lasting effect in 2010 (for the intermediate target) or 2016 (for the overall target).

If early energy savings are accepted, a contribution to the target in 2016 can only be counted if the energy saving lifetime is greater than 8 years plus the time between installation and 2008. This needs to be proven. The same holds, respectively, for the intermediate target in 2010.

For VA with energy savings prior to 2008, based on the default energy saving lifetimes one:

can for the year 2010:

- count 75% of the annual savings for the period 2002-2007
- count 15% of the annual savings for the period 1985-2007

can for the year 2016:

- count 15 % of the annual savings for the period 1991-2007

6.3 How to treat uncertainties

It was not possible for this case application to devise a specific method for treating uncertainties. Uncertainties for this method relate predominantly to the normalisation that is crucial. When calculating additional energy savings, also the amount of autonomous change is subject to uncertainties.

7 Appendix I Energy content of selected fuels for end use — conversion table

	K (NCV)	Kgoe (NCV)	kWh (NCV
1 kg coke	28 500	0,676	7,917
1 kg hard coal	17 200 — 30 700	0,411 — 0,733	4,778 — 8,528
1 kg brown coal briquettes	20 000	0,478	5,556
1 kg black lignite	10 500 — 21 000	0,251 — 0,502	2,917 — 5,833
1 kg brown coal	5 600 — 10 500	0,134 — 0,251	1,556 — 2,917
1 kg oil shade	8 000 — 9 000	0,191 — 0,215	2,222 — 2,500
1 kg peat	7 800 — 13 800	0,186 — 0,330	2,167 — 3,833
1 kg peat briquettes	16 000 — 16 800	0,382 — 0,401	4,444 — 4,667
1 kg residual fuel oil (heavy oil)	40 000	0,955	11,111
1 kg light fuel oil	42 300	1,010	11,750
1 kg motor spirit (petrol)	44 000	1,051	12,222
1 kg paraffin	40 000	0,955	11,111
1 kg liquified petroleum gas	46 000	1,099	12,778
1 kg natural gas(1)	47 200	1,126	13,10
1 kg liquified natural gas	45 190	1,079	12,553
1 kg woon (25% humidity)(2)	13 800	0,330	3,833
1 kg pellets/wood bricks	16 800	0,401	4,667
1 kg waste	7 400 — 10 700	0,177 — 0,256	2,056 — 2,972
1 Mj derived heat	1 000	0,024	0,278
1 kWh electrical energy	3 600	0,086	1(3)

Source: Energy Service Directive (ESD, 2006/32/EC), Annex II
(1) 93 % methane.
(2) Member States may apply other values depending on the type of wood most used in the respective Member State.
(3) For savings in kWh electricity Member States may apply a default co-efficient of 2,5 reflecting the estimated 40 % average EU generation efficiency during the target period. Member States may apply a different co-efficient provided they can justify it.

8 Appendix II Determining the DEEI & proving the changes in the DEEI

General information on the Dutch LTA
Since the early 1990's, the Ministry of Economic Affairs has been making long-term agreements (or covenants) with various energy-intensive sectors as part of Dutch energy policy. Due to the success of these so called first-generation LTA's, the government and industry decided to sign new agreements, known as LTA2. This covenant spans 2001 to 2012. The larger energy-intensive companies have not signed LTA2 but are instead participating in the Benchmark Covenant. Medium-sized (and sometimes smaller) enterprises are taking part in LTA2. To qualify for participation in LTA2, a sector must use at least 1 PJ of energy annually, 80% of which should be consumed by the sector's constituent companies. LTA2 is signed by three Government Ministers (Economic Affairs; Agriculture, Nature and Food Quality; and Spatial Planning, Housing and the Environment), the provincial authorities, the Association of Dutch Local Authorities (VNG), the participating companies and relevant trade organizations. In July 2008, LTA3 was signed. LTA3 is in fact an intensification and exension of LTA2.

Within the LTA also sub-agreements are possible; those with or without subsidies, other forms of support, audits, etc. The Netherlands does not calculate the energy efficieny on the level of individual end use actions but on the level of the individual companies. For the latter the total energy use per company is important. This data, including the data on the purchased in energy carriers, is available of all companies participating in the LTA. Under the LTA efforts have been made to determine the energy savings on the the level of indivual end use actions, yet without success.

LTA2 participants are required to report each year on the progress of their activities relating to the covenant. These corporate monitoring reports give companies a general view of how well they are succeeding in realising their energy efficiency targets. Based on that, the management can confirm the company policy, or make an interim revision.
The relevant Competent Authority will use the *corporate monitoring report* to assess whether a company is making enough effort to realise its *energy conservation plan* (ECP): the company's energy efficiency goals, the end use actions intended to employ, and the schedule for reaching the goals. In each sector, the corporate monitoring reports are *aggregated*. This gives the branch organization an actual picture of progress *and* of the eventual need for additional facilitating measures.

A corporate monitoring report in relation to LTA2 provides a yearly insight into the company's progress with implementing the Long-Term Agreements, regarding:
the implementation of the *energy conservation plan* (ECP), distinguishing end use actions for each facility in process efficiency (*good housekeeping*) and the so-called *expansion themes*;
the implementation of systematic *energy care* in the company.
The report must at any rate contain data on the improvement in energy efficiency in the relevant facility/facilities compared to 1998 (reference year), and the realized emissions reduction of CO_2.

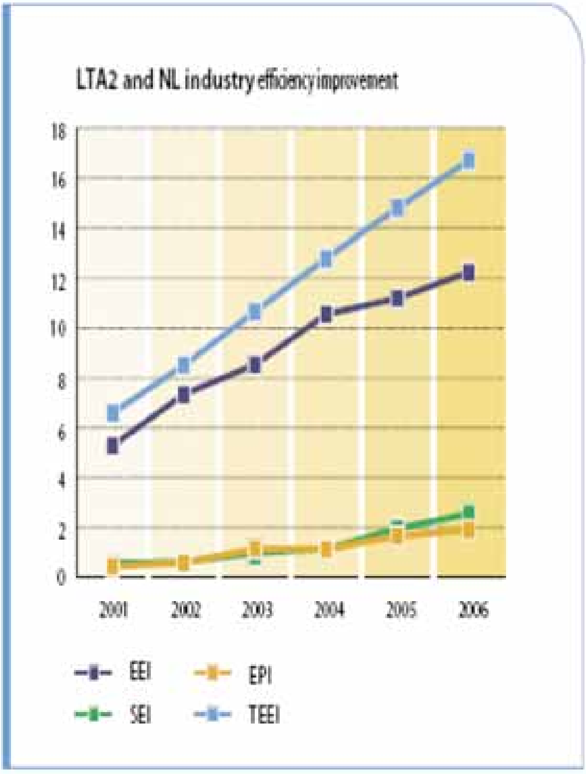
Energy efficiency improvement

The total energy efficiency improvement of LTA2 comprises three indices. The index improvements are added up to a total improvement (see Definition of Terms). This total energy efficiency improvement (TEEI) improves by 1.9% in 2006 compared to 2005 and reaches a total of 16.7% at the end of 2006 with respect to the year of reference 1998 (see **figure 2**).

The average annual total energy efficiency improvement amounts to 2.1%. The share of the energy efficiency in this improvement is 64%, the share of the application of sustainable energy is 15% and the share as a result of energy efficient product development is 21%.

With the new European guideline for energy services the monitoring of energy savings will change. The consequences of the guideline for the method of monitoring in the LTA2 context will be mapped out in 2007 and applied in 2008. The aspects 'sustainable energy' and 'energy efficient product development' are points for special attention here.

Figure 2. Energy efficiency Improvement per index for LTA2 sectors (in %)



Source: Ministry of Economic Affairs, Ministry of Housing, Spatial Planning and Environment, Ministry of Agriculture, Nature and Food Quality and Ministry of Transport, Public Works and Water Management, November 2007.
http://www.senternovem.nl/LTA/publications/monitoring/index.asp and
http://www.senternovem.nl/lta/publications/_publicationdatabase/longterm_agreements_on_energy_efficiency_in_the_netherlands_results.asp

The Dutch LTA only deals with direct energy use, thus the real figures for the amount of direct energy used in a certain year in relation to reference year 1998 (year 0).

The Dutch monitoring system is based on information concerning energy efficiency being provided by individual companies. The overall realised energy efficiency is reported aggregatedly on the level of sub-sectors.

The overall realised energy efficiency is reported by means of an (direct) energy efficiency index, which consists of volume effects, structural effects and energy savings effects.

An impression of the functioning of the EEI is given below.

The Direct Energy Efficiency Index (DEEI)[7]

The energy efficiency of direct energy use will be expressed as the direct energy efficiency index (DEEI). This index shows the quantitative improvement in direct energy efficiency that has been reached in any year regarding direct energy use, in relation to the year of reference.

The direct energy efficiency index (DEEI) is determined by comparing actual direct use E_x in the year x with a referential use $E_{reference}$. This referential use is determined on the basis of 'performance' (production) in the year x and specific use in the reference year.

Figure 2: Relations between direct energy efficiency index, energy use, performance and savings.

$$\text{DEEI (direct Energy efficiency index) in year x} = \frac{\dfrac{\text{Direct energy use in year x}}{\text{Perform in year x}}}{\dfrac{\text{Direct energy use in ref. year}}{\text{Perform. in ref. year}}}$$

⇓

$$\text{DEEI (direct Energy efficiency index) in year x} = \frac{\text{Direct energy use in year x}}{\text{Specific use in ref. year} * \text{Perform. in year x}}$$

$$\text{Savings and influences} = (\text{Specific use in ref. year} * \text{Perform in year x}) - \text{Direct energy use in year x}$$

The direct energy efficiency index for a sector as a whole is influenced, next to the executed savings projects, by several factors such as companies joining the scheme and companies leaving it, new products, altered product specifications and product quality, altered raw material specifications, government demands (environment, workplace conditions etc.), integration or specialisation, climatic variations and differences in manning levels. The effect of these factors is shown and at times can lead to adjustments, if the OGE agrees; these adjustments are then shown further by determining, next to the unadjusted DEEI, an adjusted DEEI, where the effect of the mentioned factors is included as an adjustment. Other factors cannot lead to adjustments, but can further explain developments; these are also shown in the monitoring process.

Calculation of the direct energy efficiency index (DEEI)

General definitions of the direct energy efficiency index
The direct energy efficiency index in year x is the quotient of actual direct energy consumption in year x (Ex) and a referential use (Ereference) which indicates what amount of direct energy consumption would have been necessary if the volume of production for year x had been manufactured with the same consumption per unit product as in the reference year. This quotient is multiplied by 100 so as to express it as a percentage in relation to the year.

The DEEI of one product
The simplest case is the calculation of the direct energy efficiency index (DEEI) over one single activity (product). The direct energy efficiency index gives the proportion of the

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consumption per unit of that product for the present year and the reference year; thus the DEEI is the non-dimensional quotient of consumption in the present year (Ex) and the reference consumption (Ereference).

Formula: direct energy efficiency index for one product in one department

$$DEEI_x = \frac{E_x}{V_x * (E_0 / V_0)} * 100 = \frac{E_x}{V_x * e_{spec,0}} * 100 = \frac{E_x}{E_{reference}} * 100$$

Wherein:
- $DEEI_x$ = direct energy efficiency index in the year x
- E_0 = direct energy use in the reference year
- E_x = direct energy use in the year x
- V_0 = performance in the reference year
- V_x = performance (production volume) in the year x
- $e_{spec,0}$ = specific use (E_0/V_0) in the reference year
- $E_{reference}$ = reference use for the present year

The DEEI for a combination of products in one company
The DEEI for a combination of activities within one company is calculated by way of actual use and the sum of reference uses for the various products.

Formula: direct energy efficiency index for several products in one department

$$DEEI_x = \frac{\sum_{p=1}^{n} E_{x,p}}{\sum_{p=1}^{n} \left[\frac{E_{0,p}}{V_{0,p}} * V_{x,p} \right]} * 100 = \frac{E_x}{\sum_{p=1}^{n} e_{spec,p} * V_{x,p}} * 100 = \frac{E_x}{E_{reference}} * 100$$

Wherein:
- $DEEI_x$ = direct energy efficiency index in the year x
- $E_{0,p}$ = direct energy use attributed to product p in the reference year, with $\sum_{p=1}^{n} E_{0,p} = E_0$ = direct energy use in the reference year
- E_x = total direct energy use of the company in the year x
- $V_{0,p}$ = performance in the reference year for product p
- $V_{x,p}$ = performance in the year x for product p
- $e_{spec,p}$ = specific use for product p in the reference year
- n = total number of products included in the monitoring
- $E_{reference}$ = reference use for the present year

The DEEI for a combination of products and companies/departments
The direct energy efficiency index over several companies with several products is calculated by way of the sum of actual use by the companies and the sum of the reference use for the companies in relation to all products.

Formula: direct energy efficiency index for several products in several departments

$$DEEI_x = \frac{\sum_{b=1}^{m} E_{x,b}}{\sum_{b=1}^{m} E_{reference,b}} * 100 = \frac{\sum_{b=1}^{m} E_{x,b}}{\sum_{b=1}^{m} \left[\sum_{p=1}^{n} e_{spec,b,p} * V_{x,b,p} \right]} * 100 = \frac{\sum_{b=1}^{m} E_{x,b}}{\sum_{b=1}^{m} \left[\sum_{p=1}^{n} \left[\frac{E_{0,b,p}}{V_{0,b,p}} * V_{x,b,p} \right] \right]} * 100 = \frac{E_x}{E_{reference}} * 100$$

Wherein: $DEEI_x$ = direct energy efficiency index in the year x

E_x = total direct energy use over the group of MJA companies in the year x

$E_{reference}$ = reference use over the group of MJA companies and products in the year x

$E_{reference,b}$ = reference use for company b over the products in the year x

$E_{x,b}$ = direct energy use in the year x for company b

$e_{spec,b,p}$ = specific use for product p in company b in the reference year

$V_{x,b,p}$ = performance in year x for product p in company b

$V_{0,b,p}$ = performance in the reference year for product p in company b

$E_{0,b,p}$ = direct energy use in the reference year for product p in company b

n = total number of products

m = total number of participating companies within the sector

9 Appendix III Justifications and sources

Arentsen, M. (2004). *Evaluation of LTA-1 and LTA-2 up and untill 2002, Part A: Evaluation from a governmental perspective.* Enschede: Center for Clean Technology and Environmental Policy, University of Twente.

Ericcson, K. (2006, April). *Evaluation of the Danish voluntary agreements on energy efficiency in trade and industry.*
Retrieved March 26, 2008, from: http://www.aid-ee.org/documents.htm

Modig, G. (2006, March). *Evaluation of the industrial energy efficiency network in Norway.*
Retrieved March 26, 2008, from: http://www.aid-ee.org/documents.htm

Handbook energy efficiency monitoring of direct energy consumption in long-term agreements, Novem, Utrecht, February 1999
http://www.senternovem.nl/LTA/publications/monitoring/index.asp

IEA/OECD (2003), *Energy policies of IEA Countries, 2003 review,* from:
http://www.iea.org/textbase/nppdf/free/2000/compendium_2003.pdf

International Energy Agency, Sittard, Demand Side Management programme, Operating Agent. (2005, October). *Evaluating energy efficiency policy measures & DSM programmes, Volume I: evaluation guidebook.*
Retrieved March 26, 2008, from: http://dsm.iea.org/ Tasks_and_Projects / Completed Tasks / Task 1 Subtask 9 / Publications / Evaluation_Guidebook_Volume 1

Long-Term Agreements on energy efficiency in the Netherlands, Results of 2006, SenterNovem, November 2007
http://www.senternovem.nl/lta/publications/_publicationdatabase/longterm_agreements_on_energy_efficiency_in_the_netherlands_results.asp

Vreuls, H. (2005), *Evaluating Energy Efficiency Policy Measures DSM Programmes,* International Energy Agency