Guidelines for the ex-post evaluation of 20 energy efficiency instruments applied across Europe

Suzanne Joosen
Mirjam Harmelink

January 2006

Project executed within the framework of the Energy Intelligence for Europe program, contract number EIE-2003-114

Content

1 Introduction

1.1 Overview of the AID-EE project

In May 2006 the European Commission published Directive on Energy End-Use Efficiency and Energy Services. The directive aims at increasing end-use energy efficiency throughout different sectors of the economy. The project called **A**ctive **I**mplementation of the proposed **D**irective on **E**nergy **E**fficiency (AID-EE) is initiated to support a successful implementation of the proposed directive and is supported within the framework of the Intelligent Energy for Europe (EIE) Programme of the European Commission.

The AID-EE project has two main objectives:

1. Reconstructing and analysing the policy implementation processes for the purpose of identifying and explaining key factors behind successes and failures in energy efficiency policies.
2. Actively disseminating knowledge on implementation, monitoring and evaluation of policy instruments in the field of energy efficiency improvement through (among others) an advanced course for policy makers, energy agencies and energy companies.

Figure 1 provides an outline of the different work packages within the AID-EE project. The figure shows that the project starts with the development of a common framework and the establishment of criteria for the policy instruments that will be assessed in detail in the work packages 2, 3 and 4. This report is the first deliverable of the project and holds the common framework for the ex-post evaluation of policy instruments.

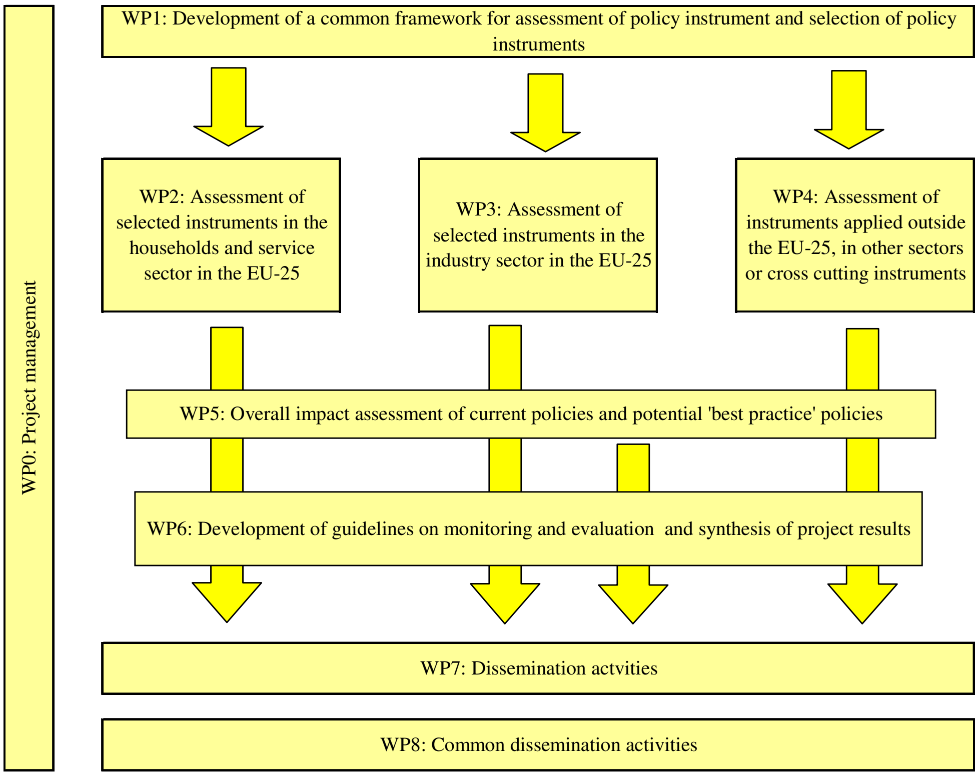

Figure 1 Outline of the AID-EE project.

1.2 Aim of this guide

The purpose of developing a guide for the ex-post evaluation of energy efficiency policies across Europe is that within these project specialists from different institutes carry out the assessment of instruments in the various sectors, and we want to ensure that these assessments are carried out in a comparable way.

1.3 Reading guide

First the background of theory-based evaluation is described in Chapter 2. The consequences for what this means for evaluation in practice is elaborated in Chapter 3. Furthermore definitions of several basic terms are given in this chapter. Chapter 4 provides guidance on how the effectiveness and efficiency of instruments can be determined. Reporting guidelines are presented in Chapter 5 and the list of criteria for the selection of policy instruments is given in Chapter 6.

2 Theory on evaluation

2.1 Theoretical background on evaluation

In a perfect policy cycle first policies are formulated, in the next step policies are implemented and ultimately policies are put in practice leading to energy savings. After policies have been implemented they should be monitored and evaluated, and results of the monitoring and evaluation process might lead to a reformulation or even an abolishment of policies. Ex-post policy evaluation is an essential element in the possible reformulation/reorganisation of policies (see Figure 2).

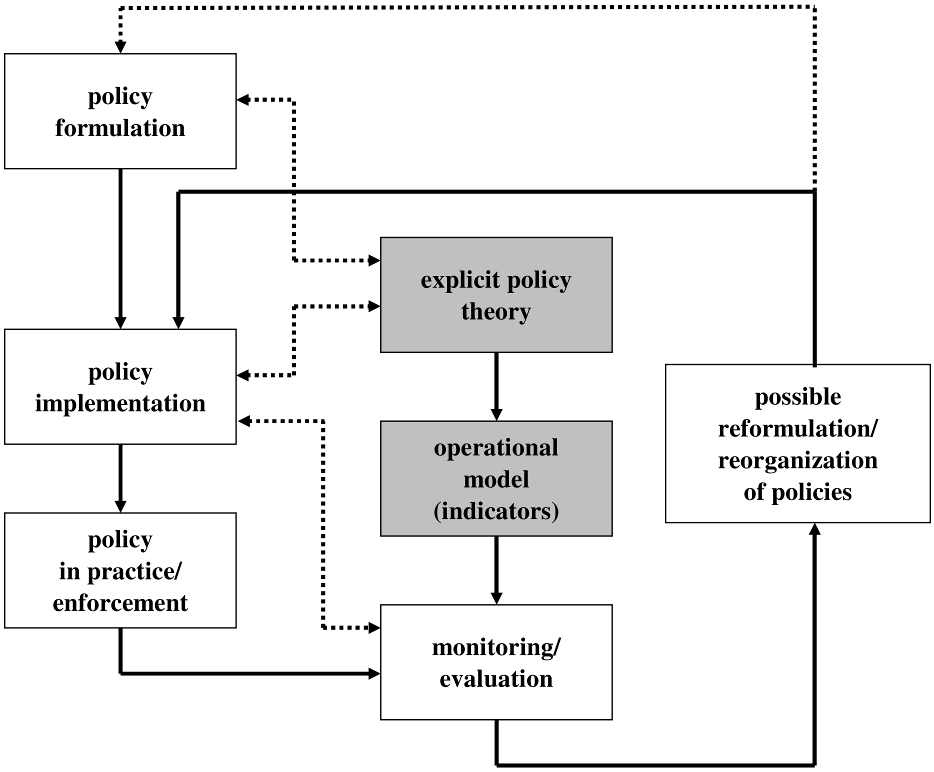

Figure 2 Outline of the policy cycle and the role of the program theory in the policy cycle.

2.2 Main questions

Ex-post policy evaluation in principle boils down to answering the following two main questions:

- What was the contribution of policy instruments in the realisation of policy targets? (net impact and effectiveness of policy instruments)?
- What was the cost effectiveness of policy instruments, and could targets have been reached against lower costs (efficiency of policy instruments)?

These questions can be answered at two levels (i) at the programme level (in case the effect and effectiveness of a package of policy instruments aimed at reaching a specific target is evaluated) and (ii) at the instrument level (in case the effect and effectiveness of one specific policy instrument is evaluated).

It must be noted that next to effectiveness and efficiency policy makers are often also interested in "other" effects, like employment, social inequality, etc. So a third question which often needs to be answered: What other major impacts (outside the domain of the policy target) did the policy have)?

2.3 Attention for policy evaluation

Ex-post policy evaluation of energy and climate change policies is getting more common: however the number of executed studies is still limited. Much research is targeted towards the implementation of specific instruments (e.g. projects on Cold and Wet Appliances, Efficient Domestic Ovens, Circulation Pumps, energy taxation and voluntary agreements) but substantially less research is aimed at systematically evaluating the key factors behind the success and failure of energy efficiency and climate policies (ex-post evaluation). Knowledge is however growing in this area. For example:

- Within the SAVE programme, the project entitled "A European Ex-post evaluation guidebook for DSM and EE Service Programmes" (SRC, 2001)[1] developed general guidelines for ex-post evaluation of DSM and EE Services. The developed guidelines were tested for a number of DSM and EE Service programmes in the European Union.
- The IEA DSM IA (Task 1) is also expected to publish an "Evaluation Guidebook on the Impacts of DSM and EE Programmes on Kyoto's GHG Targets".
- Furthermore specific countries have showed initiatives in this field. For example, all policies in the Netherlands now require an ex-post evaluation and the Ministry of Finance has established generic guidelines for ex-post policy evaluation (Dutch Ministry of Finance, 2002)[2].

[1] SRC,2001: A European Ex-post evaluation guidebook for DSM and EE Service Programmes. SRC (Ed).
[2] Dutch Ministry of Finance, 2002: Regulation performance data and evaluation research national authorities, Den Hague, 2002

2.4 Methods applied in ex-post evaluation

A variety of methods are applied in ex-post evaluation of policies. The simplest method is the 'top-down' monitoring of indicators on energy consumption per sector or end use. Based on general statistics a hypothetic baseline development in energy use is determined (frozen efficiency) and the actual energy use is subtracted from this amount to determine the energy saving. This method does not provide any insight on the actual effect of policies as the calculated amount of energy saving is the aggregation of 'autonomous' savings and policy induced savings.

Another approach is the (detailed) econometric modelling of the effect of policy instruments. In econometric modelling a list of factors (one of which is the analysed policy instrument) is drawn up that potentially could affect (specific) energy use in a sector. Through statistical methods the impact of the analysed policy instruments can be estimated. This method does not provide insight on the 'why' an instrument had impact or not.

A third approach is the methods working with policy theories. The general principle is that a likely theory is drawn up on how the policy instrument should achieve its targeted effect in terms of energy efficiency improvement or energy savings. Several term are used for this kind of approaches such as logic model analysis (Megdal, 2005)[3] and the realistic evaluation theory (SRC, 2001). The advantage of this approach is that insight is gained in the chain of cause-impact relationships that eventually has to lead to energy savings. The drawback of this approach is that a lot of detailed bottom-up information in needed. In the AID-EE project we will work with a policy theory approach.

2.5 Theory based policy evaluation

The method that we will apply in this project is the theory based policy evaluation. The theory-based approach is not new and has been used numerous times to evaluate policies. The method of theory-based policy evaluation is extensively described and illustrated (Rossi et al., 2004)[4]. In the energy sector the method was used to design, evaluate and adapt 'market transformation' programs in the field of energy efficiency in California (Blumstein et al, 2000)[5]. Though overall, the application in evaluating energy efficiency policies has been limited and the method was so far not applied in a systematic way in the energy efficiency policy implementation process.

[3] Megdal (2005). Using program logic model analysis to evaluate & better deliver what works. Paper presented at the ECEEE Summer Study 2005. Paper number 5117
[4] Rossi, P M Lipsey and H Freeman 2004: Evaluatio: A systematic approach. 7th edition, Sage Publications, Thousand Oaks, CA, United States.
[5] Blumstein C, S Goldstone, L Lutzenhiser (2000). A theory-based approach to market transformation, in Energy Policy, 28, pp 137-144

In practice, theory-based policy evaluation boils down to establishing a plausible theory on how a policy instrument (or a package of instruments) is expected to lead to energy efficiency improvements. Application of the theory-based approach in ex-post policy evaluation means that the whole policy implementation process is unravelled to evaluate the effectiveness and efficiency of the different steps of the implementation process. Through this unravelling insight is gained on 'where something went wrong in the process of policy design and implementation' and 'where the keys are for improving the effectiveness and efficiency'.

Most methods used in ex-post policy evaluation of policy instruments focus on 'final effects' i.e. energy savings and CO_2 emission reductions. Characteristics of the theory-based policy evaluation method compared to other ex-post evaluation methods are that it:

- Evaluates the whole policy implementation process and not just focuses on the final effects (i.e. efficiency improvement and CO_2 emission reduction). This means that besides a quantitative analysis also a qualitative analysis of the reasons behind different developments is carried out.
- Quantifies, to the extent possible, the "successes and failures" of policy instruments through the development of indicators for each step in the implementation process.
- Provides insight on why policies succeeded or failed and how they can be improved.

3 Practical framework to evaluate individual policy instruments

3.1 Introduction

This chapter provides an overview of the practical steps that have to be followed in executing a theory based policy evaluations. Furthermore this chapter provides an overview of the definitions that will be used within the framework of this project.

3.2 Executing a theory based evaluation

For the assessment of a policy instrument or programme the “theory-based policy evaluation” includes the following steps:

1. In the first step, the policy instrument is characterised. This is a description of the policy instrument including: objectives and targets, end-use areas and technologies targeted, the period the policy instrument was active, target groups, policy implementing agents, available budget, available information on initial expected effect, effectiveness and cost-efficiency of the instrument, the national context, addressed market failure to overcome and how, etc.

2. In the second step, a policy or program theory is drawn-up with the help of available (official) documents. A policy or program theory includes all the assumptions on the way policy instruments should reach their targeted effect. Sometimes the policy theory is clearly described in official documents and well known by the policy makers. In these cases we speak of an “explicit policy or program theory”. In most cases the policy theory for a specific instrument is not clearly described and in these cases the program theory is drawn up based on experiences with similar instruments and we speak of an “implicit policy or program theory”. Drawing up a policy theory in practice includes documenting all implicit and explicit assumptions in the policy implementation process, and mapping the cause-impact relationships including the relationships with other policy instruments. Also the barriers the policy instrument is intended to overcome and the interaction with other policy instruments in overcoming the barriers is included in the policy theory.

3. In the third step, the program theory is translated to concrete (quantifiable) indicators. This means that for each assumed cause-impact relation an indicator is

drawn up to “measure” if the cause-impact relation actually took place and to “measure” if the change (or part of the change) that took place is due to the implementation of the policy instrument (i.e. the policy instrument was the causal force). This step also includes the development of the necessary formulas to calculate the net impact, effectiveness and cost-efficiency. Finally expected success and failure factors are coupled to the indicators.

4. In the fourth step, the cause-impact relations, the indicators and the success and failure factors are visually reflected in a flowchart. Two examples of such flowcharts are given in Figure 4 for the subsidy scheme in the Netherlands the Energy Premium Regulation (EPR) and in Figure 3 for the building standard in the Netherlands called the Energy Performance standard (EPN).

5. In the fifth step, the policy theory is verified through interviews with policy makers and implementing agents and other actors involved in the implementation and monitoring of the policy instrument.

6. In the sixth and final step:
    - All available information is gathered and analysed to draw up the indicators;
    - Conclusions are drawn on the net impact, the effectiveness and cost-efficiency of the policy instrument using the formulas and indicators. It must be noted that in general countries have an energy and climate policy, which includes many individual instruments. In case an individual instrument operates without interference of other instruments (e.g. directed to a specific target group, technique), it is no problem to determine its net impact. However, usually a package of instruments is responsible for the achieved energy savings. In the approach of the AID-EE project the energy savings are ascribed to the decisive instrument. A characteristic of a decisive instrument is that it results in direct energy savings. Which instrument is decisive is based on expert experiences. In the relationship with other instruments the instruments, which required for properly functioning of the decisive instrument are described. In the presented final outcomes the possible influence of related instruments has to be carefully reported. It must be noted that the method takes into account interactions between instruments in a descriptive manner, i.e. the method explicitly focuses on the relationship and interactions with other policy. However, the method does not provide quantitative insights if instruments are either reinforcing or weakening each other. The method is aimed with providing policy makers with insight on the relationship between instruments but we did not have the aim and means within the project

to quantify this relationship (would be an interesting subject for follow up research).

- Analyses are made on the success and failure factors attributed to the analysed instruments;
- Recommendations are formulated to improve the net impact, the effectiveness and/or the efficiency. These recommendations particularly concern the combination of the policy instrument or package with further instruments targeting the same end use, sector and technical or organisational energy efficiency measures. By how much could the net effect and effectiveness be improved due to the improvement of the instrument or the combination with further instruments? What would be the impact on the costs and hence the efficiency/cost effectiveness?

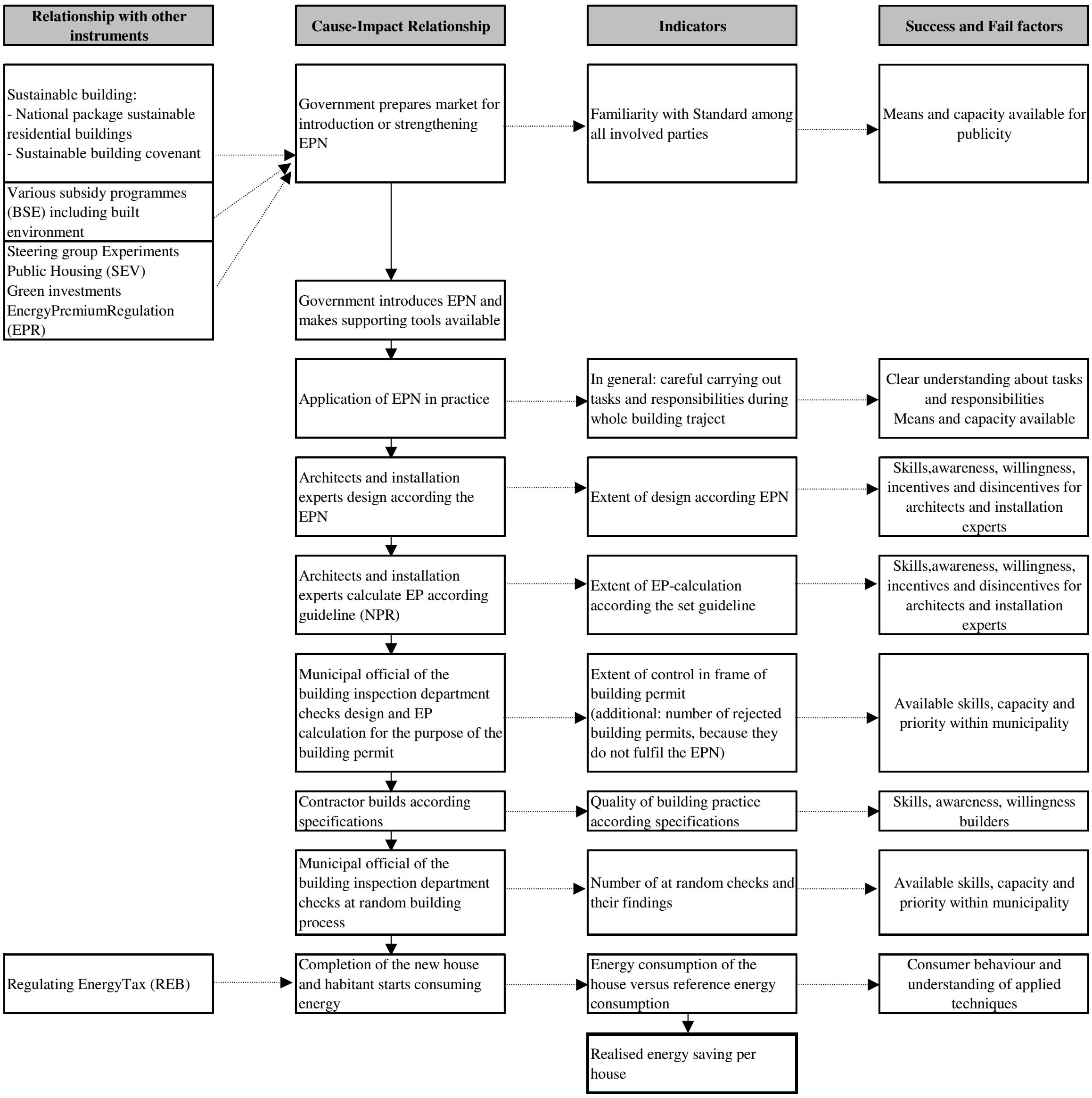

Figure 3 Policy theory on the way the Energy Performance Standard (EPN) should lead to energy savings and CO_2 reduction, including the link with other policy instruments, a list of indicators to ‘measure’ if assumed cause-impact relations actually occurred and possible success and fail factors

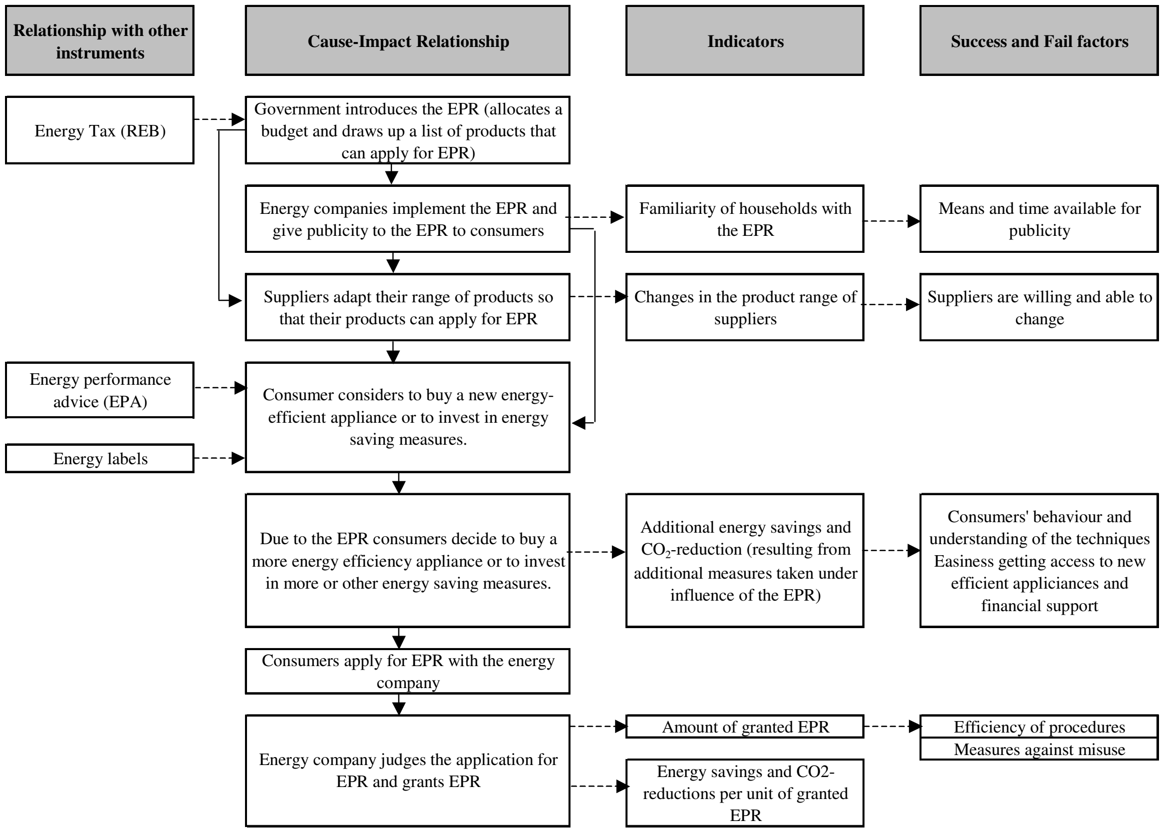

Figure 4 Policy theory on the way the Energy Premium Regulation (EPR) should lead to energy savings and CO_2 reduction, including the link with other policy instruments, a list of indicators to 'measure' if assumed cause-impact relations actually occurred.

3.3 Definitions

For a clear communication and to avoid misunderstanding terminology within the project must be clearly defined. For the used definitions we tried to stay closely to the definitions used in the proposed Directive on energy efficiency.

Energy efficiency policy	Overall set of activities by the government or another funding or implementing agent to promote energy efficiency, normally existing of a coherent package of different policy instruments, with specific overall targets and strategies.
Measurable energy efficiency policy instrument	Specific activity initiated by the government or another funding or implementing agent directly targeting energy end users to stimulate them to implement energy-efficiency measures (e.g. subsidy or fiscal scheme, vol-

	untary agreement, legal obligation etc.), which is aimed to result in concrete verifiable energy savings.
Soft efficiency policy instrument	Specific activity initiated by the government or another funding or implementing agent, which is aimed at supporting the implementation and execution of measurable energy efficiency instruments. The net impact of these instruments in term of verifiable energy saving can in most cases not be determined.
Supportive energy efficiency framework mechanism	A policy action aiming to overcome disincentives that prevent market actors from the pursuit and implementation of cost-effective energy efficiency programmes and services. Thus, mechanisms do not target end users but *energy companies* and other market actors who would offer energy efficiency programmes and services to end users
Energy efficiency measures	Technical measures and changes in behaviour that lead to verifiable and measurable improvements in end-use energy efficiency, and thus to final energy savings.
Energy savings or energy conservation	. Change in absolute energy consumption (PJ) per technology, (sub)sector and period against a predefined reference (either a specific technology or period).
Energy efficiency improvement	Ratio between energy use and the related achievement (e.g. the energy used per unit of GDP,value added, km driven)
Net Impact	Net energy savings and related net CO_2 emission reductions that can be attributed to a specific energy efficiency instruments taking free rider, spill over, rebound, and possible further dynamic effects into account.
Effectiveness	The net impact of a policy instrument (here: an energy efficiency policy instrument) in relation to the policy targets set (here in particular: in relation to the total potential energy savings and CO_2 emission reductions that are available from the energy efficiency measures targeted by the instruments during the time the instruments are in place, taking into account free rider, spill over, rebound effects and possible further dynamic effects)
Cost-efficiency	The ratio between the additional costs caused by the instrument for the end-user, the society as whole or the government, and the net impact of the investigated instrument.

4 Net impact, effectiveness and cost-efficiency

4.1 Net impact

The net impact for a policy instrument aimed at energy saving is expressed in avoided final energy consumption (final energy savings in PJ). If necessary, later on, the figures can be converted in avoided primary energy (in PJ) and avoided CO_2 emissions (in Mton). The net impact of an energy efficiency policy instrument is the difference between the energy use that would have occurred if no energy efficiency policies would have been in place (the reference situation) and the actual energy use. This means that we clearly have to define the reference technology (or the reference behaviour) that would have been applied in the absence of the energy efficiency policy. The different steps that need to be followed are outlined in Figure 5.

- The upper line (green line) is the frozen efficiency energy level. Which is the energy use that would have occurred if nothing would have chance (in terms of applied technology and implemented policies) since 1990.
- The centre line (black line) is the reference energy use. This is the energy use that most probably would have occurred in case the investigated energy efficiency instrument would not have been in place in the period 1990-2000.
- The difference in energy use between the upper and centre line reflect the changes in energy due to autonomous application of more efficient technologies or more energy efficient behaviour and the effect of existing policies. Hence this includes savings from free riders.
- The bottom line (red line) is the actual monitored energy use.
- The difference in energy use between the centre and the bottom line is the net impact of the policy instrument investigated. (This includes spill-over effects and a correction for rebound effects this can however not be visualised in the graph).

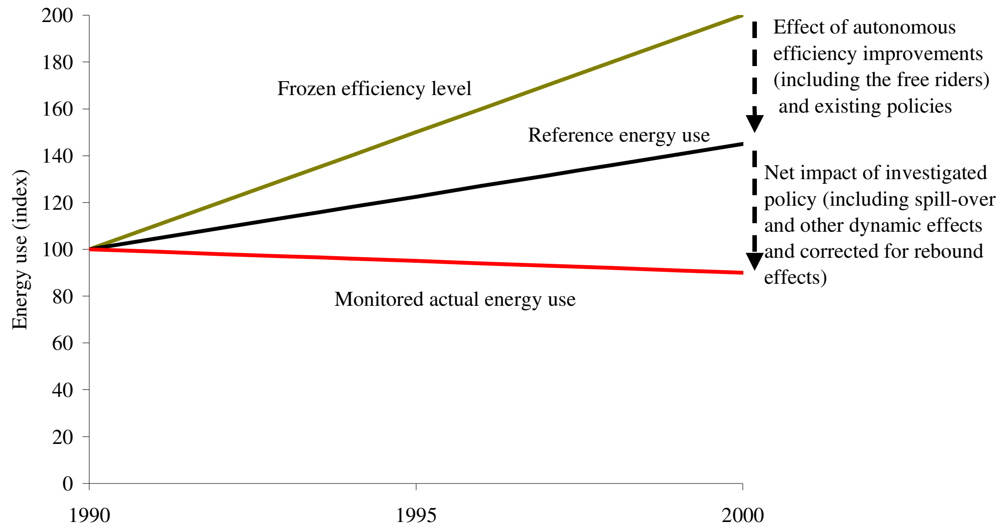

Figure 5 Outline of how annual reductions and the cumulative gross reductions are determined

The side effects mentioned in the paragraph are explained in more detail below. As already indicated relevant side effects (free riders, rebound and spill-over effect) will be taken into account as much as possible. Other side effects, such as persistence of the measure are not taken into consideration. Off course in case they turn out to be essential during the evaluation this will be reported.

4.1.1 Free riders

Free riders are defined as an entrepreneur or consumer who even without (financial or other) support of the policy instrument would have made the same investment at the same point in time but still benefits from the policy.

Several methods to determine the share of free riders in the group of investors can be distinguished:

1. By asking the person when he does his request for financial support if he also would invest in case no financial support was available. In this case the investor has to make an estimation of his own behaviour (*say-behaviour*)
2. Comparing the benefit of an investment including financial support with the used critical payback time by the investor (*homo-oeconomicus-behaviour*). Based on this information three groups investors can be distinguished:
    - Free riders: investment is also profitable without financial support, this means without support the used critical pay back time is already fulfilled.
    - "Rational": the investment is only profitable with financial support, this means only with support the used critical pay back time is fulfilled.

- “Irrational”: the investment is also with financial support not profitable, this means also including financial support the investment does not fulfil the used critical pay back time, in spite of this the entrepreneur or consumer invests in the technique.

It is important to realise that policy instruments based on financial support always bring along free riders, but that “free-rider effects” are also present in all other policy instruments, because there will always be energy users who would anyway have taken the energy efficiency measure that is stimulated by the instrument.

4.1.2 Rebound effect

The rebound effect, which can manifest itself in several ways, is the increased energy use caused by market actors trading some portion of their net cost reduction for other benefits. Three different forms of the rebound-effect can be distinguished: (1) increased use of the device (micro), (2) increased other energy use (meso) and a (3) shift in consumption patterns (macro).

4.1.3 Spill-over effect

The spill-over effect is defined as additional savings that go beyond the direct instrument effect. Spill-over effects are e.g. caused by changes in the product range of suppliers due to the implementation of an instrument leading to more end users buying efficient products during or after the instrument is in place, but without being directly affected by the specific policy instrument.

4.1.4 Persistence of savings

Some programme participants remove or never install the more efficient equipment promoted by a policy instrument or programme, or they discontinue the energy efficient behaviour for a variety of reasons. Persistence of energy savings has three components:

- Measure retention: is the energy efficiency measure still implementedafter the policy implementation is discontinued?
- Effective measure life: how long does the measure continue to function at its rated efficiency? For example, what about replacement investments in this context?
- Rate of technical degradation of performance: at what rate does the technical performance of the measure degrade?

4.2 Effectiveness

The effectiveness of a policy instrument refers to the net impact of a policy instrument (here: an energy efficiency policy instrument) in relation to the policy targets set. Here in particular: in relation to the total potential energy savings and CO_2 emission reductions that are available from the energy efficiency measures targeted by the instruments during the time the instruments are in place.

4.3 Cost-efficiency

Efficiency of policy instruments focuses on the costs and the cost-effectiveness of the policy instrument. The cost-efficiency of a policy instrument is defined as the ratio between costs and net benefits of an instrument and the amount of energy saved and expressed in euros per final energy saved (GJ). In addition the cost-efficiency can also be expressed in euros per CO_2 emission reduced (euros/ton CO_2). The cost-efficiency is determined in order to be able to make different instrument comparable. The cost-efficiency can be viewed from different perspectives: (1) the society as a whole, (2) the government, (3) other organisations (e.g. energy companies) and (4) end-users.

There is no standardized way to calculate the costs-efficiency of policy instruments. One possible method is the clearly defined Method Environmental Costs developed in the Netherlands three types of additional costs are distinguished (VROM, 1998)[6]. For the –end-user and society perspectives, the method described in (VROM, 1998) is more or less equivalent with the standard benefit-cost tests developed for the assessment of Demand-Side Management (DSM) programmes by energy companies in the USA in the eighties (CEC/CPUC 1987; Krause/Eto 1989).

4.3.1 End-user

The costs for the end-user provide an indication of the costs as experienced by the end-user responsible for the implementation of the energy efficiency measure. These costs are defined as all additional costs that have to be made by the end-user compared to the reference situation in case the evaluated energy efficiency policy instrument would not have been in place. Additional costs include additional investments, staff-costs, overhead costs minus cost savings (energy and energy taxes) and granted subsidies or fiscal profits. The cost-effectiveness for the end-users provides insight on the costs and benefits of the measure for the end-user and is calculated by (i) depreciating the additional investments made by the end-used over the lifetime of the technology using sector specific discount rates and technology spe-

[6] VROM (1998): Costs and benefits of environmental policies – Definitions and calculations methods (Kosten en baten van milieubeleid – Definities en berekeningemethoden). Publicatiereeks Milieustrategie1998/6, Den Hague.

cific depreciation periods (see Table 1 and Table 2), (ii) adjust the annualised investments costs with the annual additional costs of e.g. labour and non-energy inputs (iii) subtracting from this the annual savings (benefits) of e.g. labour, non-energy inputs but most importantly on energy cost and (iv) divide this number by the calculated physical energy savings in GJ as perceived by the end-user.

$$Cost-eff_{end\_user} = \frac{\alpha * Investments + Cost_{annual} - Benefits_{annual}}{\Delta Energy\_saving\_impact_{annual}}$$

Where:

Cost-eff	= cost-effectiveness for the end-user (euro/GJ)
α*Investments	= annual capital costs applying sector specific discount rates
$Cost_{annual}$	= annual operation and maintenance costs
$Benefits_{annual}$	= annual benefits mainly savings on energy costs
$\Delta Energy\_savings\_impact_{annual}$	= annual saved (primary) energy

Table 1 Default discount rates in sectors (VROM, 1998)

Sector	**Discount rate (%)**
Government	4%
Other organisations	4%
End-user	
Households	8%
Agriculture	8%
Services	15%
Industry	15%
Transport	15%
Society (as a whole)	4%

Table 2 Default depreciation period of energy saving measures (VROM, 1998)

Type of energy saving measure	**Depreciation period (years)**
Installations, appliances	10
Measures connected to buildings (e.g. insulation)	25

Table 3 Assessment of saved energy (VROM, 1998)

Cost-efficiency for	**Energy price**
Society as a whole	Shadow price, world market price of energy. Price without levies and taxes, because at national level costs for one sector (e.g. taxes for private companies) cancel out the benefits in another sector (tax proceeds of governmental authorities). Whether transport and distribution costs have to be taken into account depends on the considered time frame. For short time frames these are fixed and can be left out the calculations. In the AID-EE project it is assumed this is the default situation. For long term investments these costs can be avoided and have to be taken into consideration.
End-user	Average price for the end-user over the period the instrument was active. Actual price for end-user, so including levies and taxes.

4.3.2 Society

The main difference between cost-benefit analysis from a end-user perspective and cost-benefit from a social perspective is the time preference. The social perspective is translated into a discount rate that is generally much lower than cut-off discount rates used by end-users. In the case of cost-benefit analysis from the social perspective the discount rate is called the social discount rate. Such a social discount rate generally is derived from the cost of long-term capital. In industrialized countries typical discount rates used are 4 - 6%, in our analysis we used 4%. The costs for society are defined as all additional costs that have to be made by the society compared to the reference situation in case the evaluated energy efficiency measure would not have been in place. These include the same costs as mentioned for the end-user, however, excluding taxes and subsidies. Cost-effectiveness from the social perspective is mainly used to make energy efficiency measures comparable. The cost-effectiveness for the society is calculated by depreciating the once-only costs against a social discount of 4%.

$$\cos t - eff_{social} = \frac{\alpha * investments + \cos t_{annual} - benefits_{annual}}{\Delta energy\_saving\_impact\_corr}$$

Where:

Cost-eff = cost-effectiveness for the society (euro/GJ) α*Investments = annual capital costs applying a social discount rate

Costannual = annual operation and maintenance costs

Benefitsannual = annual benefits mainly savings on energy costs, but also O&M costs of the reference technology

ΔEnergy_savings_impact_corr= annual saved (primary) energy corrected for free-rider and spill-over effects

4.3.3 Analyzing cost-efficiency for end-user and the society

The cost-efficiency can also be expressed in euros per CO_2 emission reduced. However, analysing the results based on this indicator alone has as drawback that in case of a cost-effective measures (net costs below zero) it not always leads to the right conclusions (S. Thomas and C. Dudda, 2001)[7]. The example in Table 4 illustrates this problem. It is clear that measure 1 is preferred above measure 2 because of its higher net economic benefit and more CO_2 emission reduction. However, this conclusion cannot be drawn from the CO_2 emission reduction cost expressed in euros per ton CO_2 emission reduced. In this case measure 2 seems more favourable.

Table 4 Example comparison of results expressed in euro/ton CO_2 emission reduced can leed to wrong conclusions

	Measure 1	Measure 2
Net economic benefits (euros/MWh)	-10	-5
CO_2 emission reduction (ton CO_2/MWh)	1	0.2
CO_2 emission reduction costs (euros/ton CO_2)	-10	-25

Particularly due to difference in emission factors, a useful comparison between heat and electricity-based options is not possible with this concept. That is why the net economic effect or as a benefit-cost ratio, and the total CO_2 emission reduction should be presented as two indicators, not one.

4.3.4 Government

Costs for the government are defined as all expenditures that have been made by the government, which can be related to the implementation of the evaluated energy efficiency policies. Government expenditure includes budgets for subsidies, grants

[7] S.Thomas and C.Dudda, 2001: Critical comments on the use of the "Specific Costs of CO2 reductions" as a criterion for the selection of energy resources, Wuppertal Institute, 30 March 2001

for research and development, costs for monitoring and the administrative machinery. But this also includes reduced government income due to fiscal measures and lowered energy tax income. The cost-effectiveness for the government is calculated by (i) depreciating the total government expenditure using the social discount rate of 4% (by depreciating the cost for the government the fact is taken into account that the government is profiting several years from her once-only spending), and (ii) dividing depreciated costs by the energy savings impact corrected for side effects like free riders and rebound effects

$$Cost - eff_{government} = \frac{\alpha * Government\_\exp}{\Delta Energy\_saving\_impact\_corr}$$

Where:

Cost-eff = cost-effectiveness for the society (euro/GJ)

α*Government_exp = annual capital government expenditure applying a social discount rate

Δ Energy_savings_impact_$_{corr}$= annual saved (primary) corrected for free rider effects

In the analysis of the costs effectiveness for the government of various instruments it is important to see if set expectations are met, and comparison between similar instruments can be interesting (why is one subsidy scheme more cost-efficient than another etc.). However, the interpretation of the results between different types of instruments has to be done carefully, because the characteristics of the instrument already brings along certain costs for the government. For instance legal instrument will in general be less expensive for the government compared to costs for instruments based on financial support. However, the fact that certain instruments are cheap for the government does not necessarily mean that these instruments at the most cost-effective for the end-users.

4.3.5 Cost-efficiency for other organisations

Besides the government, instruments can be carried by other organisations. For instance there are important examples that stimulation of energy efficiency is initiated, financed and administratively arranged by energy companies or energy services companies. The cost-efficiency for other organisations can be calculated in the same way as for the government.

4.4 Uncertainty analysis

Experiences with other evaluations show that analysing the effect and effectiveness of policy instruments is surrounded by large uncertainties, because e.g. lack of good monitoring data assumption have to be made on the savings that can be attributed to a specific energy saving measures, the investments costs for the end-user and/or the average energy price paid by the end-user. These uncertainties have to be taken into account when estimating the net impact and cost-effectiveness of policy instruments. One possibility is to work with ranges, from minimal to maximal values. For instance using minimal and maximal values of energy savings and additional costs. It must be noted that cost-efficiency figured are extremely sensitive to the uncertainty margins in the factor that define the costs and the benefits, because the net costs are the (small) difference between (large) costs and benefits.

A full detailed uncertainty analysis is beyond the scope of the AID-EE project. Instead within this project the factors, which are responsible for the largest uncertainties, are indicated. Furthermore to what extent (in percentages) these factors affects the outcome of the analysis with respect to net impact and cost-effectiveness is presented.

5 Reporting format

5.1 Format report

The report format is outlined in Table 5.

Table 5 Outline format report per researched instrument

Index	Title	Description
1	Characterization of the instrument	Characterization of the researched policy instrument, including at least following items: 1. Targets, including relation to end-use sector and relation to national Kyoto target 2. Period the policy instrument was active 3. Actions, Specific technologies and/or energy efficiency measures 4. Target groups 5. National context 6. International context (optional) 7. Market failures (barriers) to overcome 8. Organisations, which are responsible for implementation and execution 9. Available budget and source of budget 10. Available information on initial expected effectiveness and cost-efficiency of the instrument 11. Side effects
2	**Policy theory**	
		The 6 steps of the theory based policy evaluations are guiding. Based upon already available sources a draft version of this chapter will be made. This draft version is used as basis for the interviews with policy makers. After the interviews the final version will be made.
2.1	Cause-impact relations, indicators and success and failure factors	Description of policymakers' assumptions on how the instrument will function. Definition of indicators to monitor the effect of the various steps in the process (per cause-impact relation) Definition of success and failure factors to monitor the learning experiences.
2.2	Interaction with other policies	Which instruments are strongly related to the policy instrument, where in the process (cause-impact chain) and

Index	Title	Description
		how do they effect the functioning of the researched instrument.
		Overall picture of relationships based upon policy theory (examples Figure 4 and Figure 3)
3	**Evaluation**	
		The outcome of each indicator is presented. Indicate if the outcome is as initially expected or not. Analyse the reasons why the result correspond to (in case of success) or differ (in case of failure) from the initially expected value. In other words go into the success and failure factors. Assess reliability and accuracy of results respectively error margins. The used sources of the data and the assumptions of the calculation have to be carefully documented here.
3.a	Indicator a	
3.p	Net impact	Is always one of the indicators
3.q	Effectiveness	Idem
3.r	Cost-efficiency	Idem
3.r.1	Society	Outcomes and basic assumptions for calculation of cost-efficiency for the society
3.r.2	Government	Outcomes and basic assumptions for calculation of cost-efficiency for the government
3.r.3	Other organisations	Outcomes and basic assumptions for calculation of cost-efficiency for other organisations (e.g. energy companies)
3.r.4	End-user	Outcomes and basic assumptions for calculation of cost-efficiency for the end-user
4.	**Conclusions**	
4.1	Net impact, effectiveness and cost-efficiency	Summary of the most important (quantitative) outcomes, net impact, effectiveness and cost-efficiency
4.2	Success and failure factors	Summary of the most important findings of the analysis why the instrument is successful or not.
4.3	Learning experiences	Summary of the most important lessons learnt for this specific instrument and (related) policies in the future.
	References - documents	See Annex I for format
	References - interviews	List of interviewed people

5.2 List of criteria which have to be checked

A list of criteria, which have to be checked during the evaluation, is shown in Table 6. Those criteria or factors that are perceived as important for the outcome of the instrument should be further analysed and evaluated. A format questionnaire will be made in Word and distributed to the partners within the AID-EE project. This format questionnaire will include also the guidelines for providing the necessary information for work package 5.

Table 6 Checklist of criteria

Issue	Criteria	Reason behind criteria
General energy-climate policy	• Basic assumptions (im- and explicit), • Characteristics • Impression of achieved effects • Conditions of success • Causes for failure • Unexpected fortune and disappointments • Impression of interaction between different instruments • Adjustment policy, why, where, when, who • Missed opportunities	To place instrument in a broader framework
Instrument itself		
Historical back-ground	• Initiation, why, who, when • Market failure (barrier) to overcome • Political support • Symbolic politics • Position and participation of stakeholders • Other relevant historic issues • Adjustments in between, why, which, where, when, who	Exact understanding circum-stances of putting the instru-ment in place.
Design of in-strument	• Clarity • Technical complexity • Basic assumptions of functioning (im- and explicit) • Validity of policy theory • Available ex ante evaluations, (who, where) • Especially (for work package 5) is needed: *The energy savings potential addressed	Understanding of important factors in the design of the in-strument.

Issue	Criteria	Reason behind criteria
	by the policy instrument in the region or country where it was applied to: - Absolute figure (TWh/yr, in the years x,y,z) - Relative figure, (energy consumption of the technology or organisational measure in relation to energy consumption of the reference case) **Coverage of the instrument (number of actors addressed) ***Support for and opposition against the instrument by political-administrative decision-makers, further stakeholders and the public	
Implementation of instrument	• Impression of introduction and implementation phase • Impression of market acceptance • Current stand of market development and market failure (barrier) to overcome, impression on degree of transformation of the markets for the targeted end-use technologies • Functioning as expected (good, bad) • Impression of achieved effects • Especially (for work package 5) is needed: *The effectiveness of the policy instrument: how much of the potentials can/could be realised in the years x,y,z? • Conditions for success • Causes for failure • Unexpected fortunes and disappointments • Impression of interaction with other instruments • Actions of implementing agency (capability, willingness, street-level bureaucracy) • Participation of stakeholders • Importance of networks and alliances	Understanding of success and failure factors in the implementation phase
Per instrument type		

Issue	Criteria	Reason behind criteria
Legal	• Market acceptation • Maintenance, how, who, when, • Sanctions	To see if and how possible resistance against legal obligations is overcome. To determine how powerful the instrument is in practice.
Financial support	• Inspection, combating of fraud • Indication of free riders	For the cost effectiveness these criteria are of importance
Voluntary	• Initiative: government and/or sector itself • Guarantee of additional effect compared to business as usual	To determine how powerful the instrument is in practice.
Certification	• Market acceptance	To see if and how possible resistance against obligations is overcome.

6 Selection of instruments

6.1 Introduction

A great variety of policy instruments were and are in place in the individual Member States, on the EU-level and countries outside the EU to simulate energy efficiency in different sectors. Firstly a long list of interesting policy instruments was drawn up per sector. Subsequently a selection from this long list was made using a list of criteria. The list of selection criteria is presented in Table 7. Finally approximately 20 policy instruments were selected that will be assessed on their effect and effectiveness in the following work packages.

In the AID-EE project the evaluation takes place on the level of an instrument applied in a specific country. This does not leave room for a full comparison of a particular type of instrument over different countries. However to see if the same success and fail factors exist in other countries as well, it was decided that each case study is reviewed by other project members for the situation of similar cases in their specific countries.

Table 7 (Provisional) Selection criteria

Selection criteria for instrument to be evaluated
Total package has good representation of sectors In the project plan the following distribution was indicated over the sectors: approximately 10 instruments in the household and service sector, 5 in the industry sector and 5 instruments outside the EU or currently applied in other sectors, or cross-cutting sectors.
Instrument has or had a substantial (potential) impact on energy efficiency in the EU. To estimate the impact issues like: share of the market aimed at, large scale investment are stimulate, available budget for carrying out the instrument etc.
Instrument must be applied in one of the countries were the consortium partners are located.
Instrument is implemented in several EU countries
Instrument is interesting for future implementation on the EU level
Total package is good representation of current variety of implemented instruments
Choice of instrument should not overlap with other project, unless there are

Selection criteria for instrument to be evaluated
very good reasons for further investigation
Good representation of the different stakeholders involvement
International as well as national instruments has to be covered (e.g. international policy on standby losses)
Some monitoring data for the instrument must be available.
It was furthermore decided to concentrate on DSM instruments and leave instruments specifically aimed at the increasing the implementation of CHP out (but CHP will be included when they are part of a voluntary agreement in the industry)

Annex I: References

It is important that from the start of the project the used information sources are correctly documented. This is necessary for the transparency of the research and in this way it is assured that questions in a later phase or even when the project is finished can easily be answered.

In the start references should be reported as footnotes. Footnotes can be easily transferred to end notes in the final report. In this project we use the same guidelines for in-text citations and List of references as the IPCC working group 3 for the Fourth Assessment Report.

In-text Citations

Guide	*Examples*
In-text citations put into parentheses, unless cited as part of the sentence	…. (Neilson, 1998) As provided by Greco *et al.* (1994)
"and" In between two authors	(Bugmann and Fischlin, 1995)
Three or more authors abbreviated by et al.	(Fischlin *et al.*, 1996)
Year separated from preceding author by comma	(Neilson, 1998)
Multiple citations separated by semi-colon	((Box, 1981; Emmanual *et al.*, 1985;Prentice *et al.*, 1992)
Preceding remark simply inserted before author as required	(e.g., Malanson *et al.*, 1992)
Subsequent remark added after year	(Neuberger and Cahir, 1969; see also Chapter 5 of this report)
If an author name forms part of sentence, put only year within parentheses	As provided by Greco et al. (1994)

List of literature
The style of referencing should be consistent within all report.

For a article, Journal:
Last name(s) and initial(s) of author(s) (include all names and initials and bold the first last name), year: Paper title (only first word initial cap), *Name of Journal* (initial caps and italicised, volume number (**bold**), inclusive page numbers

An example

Bertram, G., 1992: Tradable emission permits and the control of greenhouse gases. *Journal of Development Studies*, *28*(3), pp. 423-446

For a Book: Last name(s) and initial(s) of author(s) and/or editor(s) (include all names and initials, and bold the first last name), year: Chapter title (only first word initial cap), *Book Title* (initial caps and italicised), editor(s) if different from author(s) , publisher, place of publication, inclusive pages or total pages.

An example

Grubb, M., J.Sebenius, A.Magalhaes, and S.Subak, 1992: Sharing the burden. In *Confronting Climate Change: Risks, Implications and Responses*. I.M. Mintzer (ed.), Cambridge University Press, Cambridge, pp 305-322.