From theory based policy evaluation to SMART Policy Design: Lessons learned from 20 ex-post evaluations of energy efficiency instruments

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Abstract
This article presents the results of an in-depth ex-post analysis of 20 energy efficiency policy instruments applied across different sectors and countries. Within the AID-EE[1] project, we reconstructed and analysed the implementation process of energy efficiency policy instruments with the aim to identify key factors behind successes and failures. The analysis was performed using a uniform methodology called "theory based policy evaluation". With this method the whole implementation process is assessed with the aim to identify: (i) the main hurdles in each step of the implementation process, (ii) key success factors for different types of instruments and (iii) the key indicators that need to be monitored to enable a sound evaluation of the energy efficiency instruments.

Our analysis shows that:

- Energy efficiency policies often lack quantitative targets and clear timeframes;
- Often policy instruments have multiple and/or unclear objectives;
- The need for monitoring information does often not have priority in the design phase;
- For most instruments, monitoring information is collected on a regular basis. However, this information is often insufficient to determine the impact on energy saving, cost-effectiveness and target achievement of an instrument;
- Monitoring and verification of actual energy savings have a relatively low priority for most of the analyzed instruments.
- There is no such thing as the 'best' policy instrument. However, typical circumstances in which to apply different types of instruments and generic characteristics that determine success or failure can be identified.

Based on the assessments and the experience from applying theory based policy evaluation ex-post, we suggest that this should already be used in the policy formulation and design phase of instruments. We conclude that making policy theory an integral and mandated part of the policy process would facilitate more efficient and effective energy efficiency instruments.

Introduction
While an increasing number of energy efficiency policy instruments are being introduced in Europe and elsewhere, only few of the instruments are evaluated systematically. Evaluations are often hard to compare due to the diversity in methods and indicators used. Furthermore, methods currently applied in ex-post policy evaluation are mostly focussed on 'final effects', i.e. energy savings and cost-effectiveness of policies, although hard to quantify. Little research is focussed on bringing policy evaluation methods on an equal footing and on systematically assessing successes and failures of energy efficiency policies. Efforts made so far include:

1. Active Implementation of the Directive on Energy Efficiency (AID-EE)

- The SAVE project entitled "A European Ex-post evaluation guidebook for Demand Side Management (DSM) and Energy Efficiency (EE) Service Programmes" (SRC 2001), which provides general guidelines for ex-post evaluation of DSM and EE Services. These guidelines were tested for a number of DSM and EE Service programmes in the European Union.
- The Evaluation guidebook "Evaluating Energy Efficiency Policy Measures & DSM Programmes" (IEA 2005) published by IEA DSM IA (Task 1). They provide guidance for systematically evaluating the implementation process of energy efficiency policy instruments. The developed method was applied for various types of instruments implemented in IEA countries.

Within the EU funded project "Active Implementation of the European Directive on Energy Efficiency" (AID-EE), executed by Ecofys, Lund University, Politecnico di Milano and Wuppertal Institute, we developed a generic framework for ex-post evaluations (Joosen, Harmelink 2006). The method is based on the 'theory based policy evaluation'. The method is designed to systematically assess all steps of the policy implementation process with the aim to determine final effects such as target achievement, energy savings impact and cost-effectiveness, as well as success and failure factors. By developing this method, we aim to contribute to the further development and harmonisation of ex-post policy evaluation methods and to creating comparable evaluation outcomes. Within the project, the method was applied to evaluate 20 energy efficiency policy instruments applied across Europe, Japan and the USA (Ecofys et al 2007).

This paper starts with an overview of methods applied in ex-post policy evaluation, followed by a description of the 'theory based policy evaluation' method and the practical approach developed within the AID-EE project. Next, overall findings are presented of the 20 case studies with respect to target achievement, energy savings impact, cost-effectiveness and typical success factors per instrument. This paper does not provide the detailed results from the various case studies. These can be found on the project website www.aid-ee.org and are also presented in other papers (Harmsen et al 2007) (Bongardt et al 2007). Finally, conclusions and a discussion are presented on the practical application of the method for policy makers.

Methods Applied in Ex-post Policy Evaluation

A variety of methods are applied in ex-post evaluation of policy instruments. One is the assessment of aggregate 'top-down' indicators on energy consumption per sector or end-user. Based on statistics, a hypothetical baseline is constructed assuming energy efficiency stays unchanged from the base year (frozen energy efficiency) or is adjusted for autonomous efficiency improvements. The actual energy use is subtracted from this amount and the difference is defined as the amount of energy saved. This method generally does not provide much insight in the impact of individual policies due to the aggregated level.

Another approach is econometric modelling of the impact 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 of a sector. Through statistical methods, the impact of the analysed policy instruments can be estimated. These methods, however, do not provide insight in 'why' an instrument performed or did not perform as expected and what could be done to improve it.

A third approach is detailed bottom-up policy evaluation which focuses on determining the 'final effects' of policy instruments. A bottom-up calculation method means that energy savings obtained through the implementation of a specific type of energy efficiency improvement measure (e.g. a CFL) are determined in GJ or kWh that can be attributed to specific energy efficiency policy instruments. A combination of top-down and bottom-up evaluation methods will be the officially applied methods to evaluate the EU Energy End-use Efficiency and Energy Services Directive (ES-Directive) (EC, 2006).

A fourth approach complementary to all three, but particularly to bottom-up impact evaluation is using policy theory. The general principle is that a likely theory is drawn up on how the policy instrument should achieve its targeted impact in terms of energy efficiency improvement. Several terms are used for this kind of approach, including, logic model analysis (Megdal, 2005), realistic evaluation theory (SRC, 2001) and programme theory (IEA, 2005). The advantage of this approach is that insight can be gained on the full implementation process, including explanatory factors behind the impact. A potential drawback is that a lot of detailed bottom-up information is needed.

Applied Methodology: Theory Based Policy Evaluation

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 in Rossi et al (2004). The application of the method for evaluating energy efficiency policies has been limited. One example comes from California where the method has been used to design, evaluate and adapt 'market transformation' programmes in the field of energy efficiency (Blumstein et al, 2000). In the Netherlands, the method was applied to evaluate energy efficiency policies applied in the built environment (Joosen et al, 2004) and to perform a mid-term evaluation of the Reduction Plan on Non-CO_2 greenhouse gases (Harmelink et al, 2006).

Theory-based policy evaluation establishes a plausible theory on how a policy instrument (or a package of instruments) is expected to result in energy efficiency improvements. The basic idea is to unravel the whole policy 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 impact and cost-effectiveness'.

PRACTICAL FRAMEWORK TO EVALUATE POLICY INSTRUMENTS

Within the framework of the AID-EE project the theory based policy evaluation method was translated into a practical 6 step approach which was applied to evaluate the 20 case studies. An earlier version was described in Harmelink et al (2005). The approach applies the following steps to evaluate individual instruments or packages of instruments:

1. In the first step the policy instrument or policy package is characterised. This includes, among others, a description of targets, the period the policy instrument was active, target groups, policy implementing agents, available budget, available information on the initially expected energy savings impact and cost-effectiveness of the instrument.
2. In the second step, a policy theory is drawn up. A policy theory includes all the assumptions on the way the policy instruments should reach its targeted impact. A policy theory can be either explicit or implicit. In the ideal case an explicit theory is available. This means that the policy makers have clearly described how they think the policy instrument is going to work, prior to its implementation. Often the theory is largely implicit and such a description is lacking. In this case, the evaluator has to try to reconstruct the policy 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 relationship, including the relationship with other policy instruments.
3. In the third step, the policy theory is translated to concrete and preferably quantitative indicators. This means that for each assumed cause-impact relation an indicator is drawn up to "measure" whether the cause-impact relation actually took place and to "measure" whether 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 impact and cost-effectiveness.
4. In the fourth step, the cause-impact relations and the indicators are visually reflected in a flowchart. Examples of such flowcharts are presented in Harmelink et al (2005).
5. In the fifth step, the policy theory is verified and if necessary adjusted. In step 2 the policy theory was drawn up with the help of available (official) documents or experiences with similar instruments. 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, (i) available information is gathered and analysed to draw up the indicators, (ii) conclusions are drawn on the energy savings impact and cost-effectiveness of the policy instrument using the formulas and indicators, (iii) analyses are made on the success and failure factors attributed to the analysed instruments and (iv) recommendations are formulated to improve the energy savings impact and cost-effectiveness.

Characteristics of the selected instruments

A great variety of policy instruments are in place in EU Member States, on the EU-level, and in countries outside the EU to stimulate energy efficiency improvement in different sectors. Within the project we aimed for a representative selection of instruments to evaluate, i.e. the selected instruments should be a good representation of the great variety of different types of policy instruments applied in the different sectors to improve energy efficiency. The following criteria were applied for selecting the 20 case studies:

1. Selected instruments should be aimed at achieving substantial energy savings and/or be aimed at market implementation of energy efficient technologies at the national level;
2. Selected instruments should be aimed at the implementation of energy end-use efficiency improvement measures (i.e. we excluded e.g. CHP policies);
3. Selected instruments should be applied in sectors that are covered under the ES-Directive;
4. Accurate break down of selected instruments among different sectors,
5. Accurate break down of selected instruments among different types of instruments, i.e. the total package of selected instruments should be good representation of the existing variety of implemented instruments;
6. Some monitoring data should be available.

Table 1 presents the instruments, which were selected as case studies in the AID-EE project. The instruments are grouped by type of instrument: regulation, financial, informative, voluntary agreements and procurement. It must however be noted that most instruments come in a package (e.g. regulation which is linked to information campaigns and financial incentives) so that it is not always easy to clearly put the instruments in a specific category. Hence, the categorisation is somewhat arbitrary. This also implies that we did not only assess individual instrument but in most cases packages of instruments.

Results

This section presents the overall findings of the 20 case studies with respect to data availability, targets and target achievement, impact on energy savings, cost-effectiveness and typical success factors per instrument.

DATA AVAILABILITY

Figure 1 shows the extent to which it was possible to assess the energy savings impact, the target achievement, critical indicators determined in the policy theories developed for the instruments, the side effects and the costs. The main observation from the case studies is that most instruments lack a comprehensive monitoring system. The availability and quality of monitoring data turned out to be much lower than expected at the start of the project. Data to assess target achievement and energy savings impact were available for roughly half of the evaluated instruments. Quantitative information on indicators that could explain success or failure is hardly available. For 17 of the evaluated instruments, figures on government costs were available. Information on costs for end-users and society were only available for a small number of the evaluated instruments.

Table 1 Overview of the analyzed instruments

	Instrument	Targeted Sector	Country
Regulation	Stepwise increase of the Energy Performance Standard for new buildings • Including subsidies for demonstration projects	Households and Services	Netherlands
	Energy Efficiency building regulation • Mandatory and recommended measures to improve the energy efficiency of new and renovated buildings • Particular focus on gas- and oil-heated buildings	Households	Italy / Carugate (province of Milan)
	Energy Efficiency Commitment (EEC) • Obligation on gas and electricity suppliers to achieve mandatory targets for energy savings in the residential sector • This is a framework for large financial and information actions operated by the energy suppliers towards the target groups	Households	United Kingdom
	Rational use of energy public service obligation • Obligation on electricity grid companies to save energy at the end-use level (domestic and non-domestic) • Stimulating action (financial support) + sensitizing and informing action towards target groups	Households, Services and industry	Belgium/Flanders
	Top Runner • Compulsory energy performance standards for a variety of products (domestic appliances, lighting, air conditioners, cars etc.)	Households, Services, Transport	Japan
	Energy labelling of domestic appliances • Including a rebate	Households	Netherlands
	Obligation on having an energy manager • To guarantee that companies which have an energy use above 10000 toe/year (industrial, tertiary sector) or above 1000 toe/year (public sector) employ an expert who deals with the analysis of energy flows, promotes energy efficiency measures etc.	Services and Industry	Italy
Financial	KfW soft loan program • Reduced interest rates for energy savings investments to modernize buildings	Mainly households	Germany
	Energy investment deduction scheme • Fiscal instrument, which allows companies to deduct part of their investment costs in energy efficiency equipment from the profit tax	Services and Industry	Netherlands
Informative	Local Energy Advice Program • Enable every municipality in Sweden to employ an energy adviser • The task of the energy adviser is to give objective advice on energy savings and renewable energy to households and local companies and organizations	Households and Services	Sweden
	Energy audit program • Subsidies to companies and organizations to carry out energy audits for their buildings and processes. • Closely linked to the Finnish voluntary agreement scheme	Services and Industry	Finland
	Industrial energy efficiency network • Identification and realization of industrial energy savings potentials • Network members can obtain grants to analyze the potential for energy savings and benchmark their performance against other companies	Industry	Norway
	Energy concept for trade and industry sectors • Concerted development of concrete and sector-specific measures for energy savings in small and medium sized enterprises	Services and Industry	Germany / North Rhine Westphalia
	Individual Advice Services • To increase awareness and give advice to small and medium-sized enterprises on energy savings options	Services and industry	Germany / North Rhine Westphalia
	Eco-driving • Information campaign on the concept of eco-driving (energy efficient driving) including , training of drivers, eco-driving as part of the drivers' curriculum, in-car devices	Transport	Netherlands
	Federal Energy Management Program (FEMP) • Variety of instruments to improve the energy efficiency of federal agencies • Governance by example: setting an example for other building owners and consumers, providing a market entry-point for new technologies and applying the federal buying power to expand and focus demand for energy efficiency products.	Public services in the federal sector	United States
Voluntary agreement	Voluntary agreements on energy efficiency in trade and industry • Part of the Danish Green tax package (green taxes, subsidies and VA-scheme)	Services and industry	Denmark
	ACEA agreement • Voluntary agreement with the European car manufacturers to make cars more efficient	Transport	Europe
Procurement	Energy+ • Co-operative procurement program of energy agencies and research institutes to stimulate the market for EE domestic cold appliances	Households	Europe
	BELOK: • Procurement program for commercial buildings for the development of energy efficient systems and products	Services	Sweden

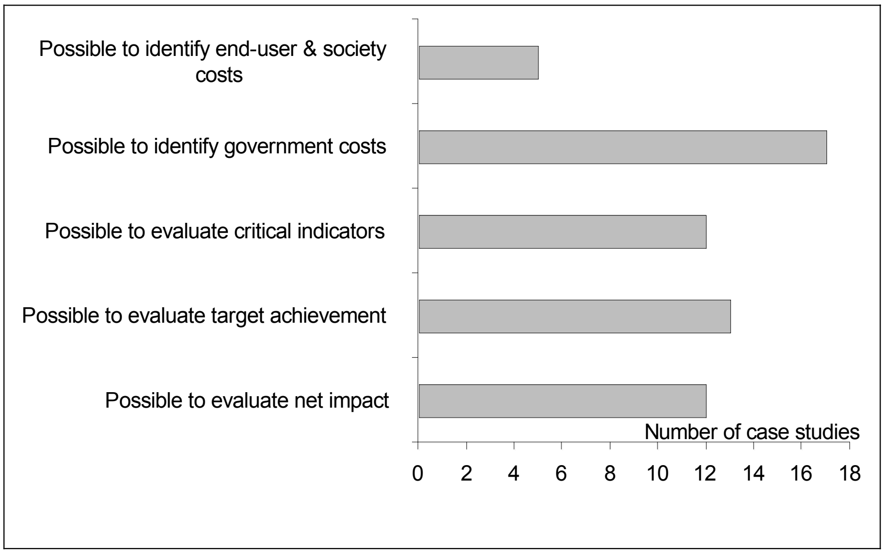

Figure 1: Availability of monitoring information for the different case studies.

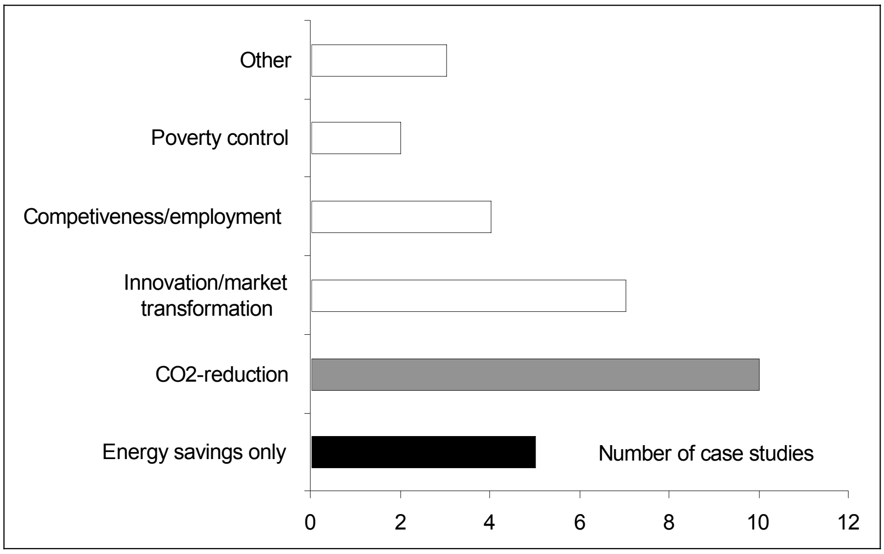

Figure 2: Type of target set for the different case studies.

TARGETS AND TARGET ACHIEVEMENT

A target was defined as a specific, either quantitative or qualitative objective that has been set at the time the policy instrument was introduced. Target achievement was defined as the extent to which a policy instrument achieved its stated targets. Figure 2 shows that from the selected case studies only 5 instruments focus on energy savings only and do not explicitly seem to have other objectives. Energy savings policies and CO_2 emission reduction policies can often not be separated. In 7 case studies, CO_2 emission reduction is the primary objective and it is mentioned as additional objective in 3 case studies. Market transformation is an important additional objective in 7 case studies.

Table 2 presents an overview of some of the characteristics of the evaluated policy instruments with respect to the targets set (quantitative or qualitative), the evaluated period and target achievement. In general, for regulatory instruments and voluntary agreements quantified targets are set, whereas this quantification lacks for most of the informative instruments. Six of the evaluated instruments reached their target. We also observed that for most instruments quantitative targets are set for the targeted end-year and generally not for intermediate years.

IMPACT ON ENERGY SAVINGS

The impact (**i**n the literature also referred to as effectiveness) of a policy instrument was defined as the extent, to which a policy instrument made a difference compared to the situation without a policy instrument (business as usual). Business as usual is defined as the development of energy consumption/demand in absence of the evaluated (package of) policy instrument(s). In figures 3 and 4, the energy saving impact is presented as annual energy efficiency improvements in the evaluated period. The impact was corrected for free rider effects. Other dynamic side effects like rebound effects and spill-over effects were not taken into account due to lack of data. Total energy use of the targeted sector was taken from the European Energy and Transport Trends 2030 (EC, 2003).

Table 2: Evaluated period, target and target achievement for the 20 case studies.

	Instrument	Evaluated period	Target	Target achievement
Regulation	Energy performance standard for buildings (NLD)	1996-2004		
	Building regulation (ITA)	2003-2005		oooooo
	Energy Efficiency Commitment (UK)	2002-2005		
	Mandatory targets on energy consumption (BEL)	2003-2004		
	Top Runner (JAP)	1999-2005		
	Labeling of domestic appliances (NLD) (+ rebate)	1995-2004		xxxxxx
	Obligation on having an energy manager (ITA)	1999-2003		oooooo
Finan-cial	Soft loans for building modernization (GER)	1996-2004		
	Energy investment deduction scheme (NLD)	1997-2004		oooooo
Informative	Local Energy Advice (SWE)	1998-2004		oooooo
	Energy audits program (FIN) (+ subsidy) **Public** services	1992-2004		
	Energy audits program (FIN) (+ subsidy) **Private** services	1992-2004		
	Energy audits program (FIN) (+ subsidy) **Industry** services	1992-2004		xxxxxx
	Industrial energy efficiency network (NOR)	1996-2004		oooooo
	Energy concept for industry sectors (GER)	1996-2003		oooooo
	Individual Advice Services (GER)	1990-2005		oooooo
	Eco-driving (NLD)	2000-2004		
	FEMP (USA)	1985-2004		xxxxxx
VA	Voluntary agreements on energy efficiency (DEN) (+ subsidies)	1996-2003		xxxxxx
	ACEA covenant (EUR)	1998-2003		xxxxxx
Procur ement	Energy+ (EUR)	1999-2004		oooooo
	BELOK (SWE)	2001-2005		
	Qualitative target or no target exists			
	Quantitative target			
	Target has been achieved or overachieved.			
	Target has not been achieved.			
xxxx	Target year has not been reached yet; unclear whether target achievement is on track.			
ooooo	Due to a lack of a quantified target, target achievement cannot be assessed.			

$$impact(\%)_{evaluated\_period} = \frac{total\_energy\_savings\_impact\,*_{end\_year\_evaluation}\,(PJ)}{period(years) * total\_energy\_use\_targeted\_sector_{end\_year\_evaluation}\,(PJ)}$$

* Total energy savings impact corrected for free rider effects

Figure 3 shows the calculated annual energy efficiency improvement with a breakdown by different types of instruments. Figure 3 does not show clear differences in savings for the different types of instrument. One should note that for some instruments, such as the Danish VA-scheme, Dutch labelling and Finnish audit programme, the results are given for the policy package and not for individual instruments. This might explain why the energy audit and the labelling scheme (both including financial incentives) have a higher improvement rate than the other mainly informative instruments. Furthermore in some sectors and countries there was relatively much "low hanging fruit," i.e., highly cost-effective measures that are not implemented due to various barriers. In such cases, high energy efficiency improvement rates may be possible. Some instruments focus on just a small part of the sector, which makes the energy efficiency improvement rate at sector level rather small. An example is an energy performance standard for new buildings which only slowly penetrates since the demolition rate in most countries is rather low.

Figure 4 shows the calculated annual energy efficiency improvement with a breakdown by different sectors. The transport sector shows the lowest improvement rates. It can also be observed that there are almost no instruments in place that exclusively focus on the service sector. All instruments that target the service sector also address either industry or households. Instruments that exclusively focus on the service sector are rare. As the Flemish and many US commercial sector programmes show, it is not more difficult to achieve savings in the service sector than elsewhere.

It must be noted that data on the energy saving impact of instruments are surrounded by relatively high uncertainties because of limited availability of data. Due to lack of monitoring data, several assumptions had to be made on "real-life" performance of energy savings measures (actual energy effi-

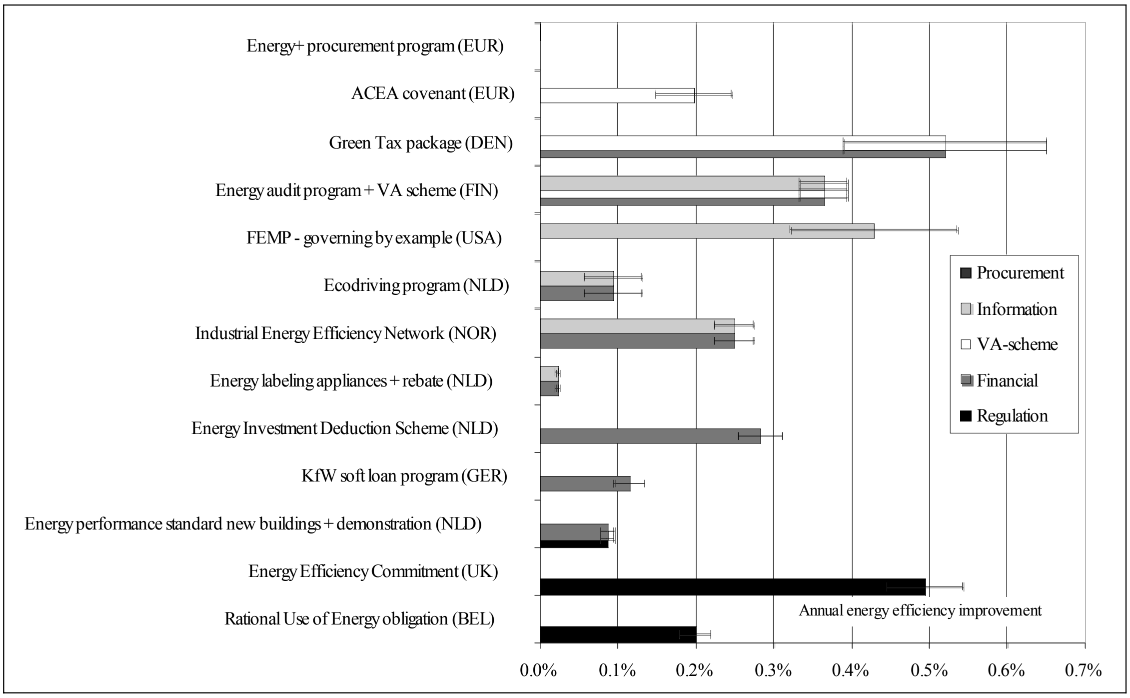

Figure 3 Annual energy efficiency improvements on the sector level per (type of) instrument in the evaluated period (see table 2 for the evaluated period).

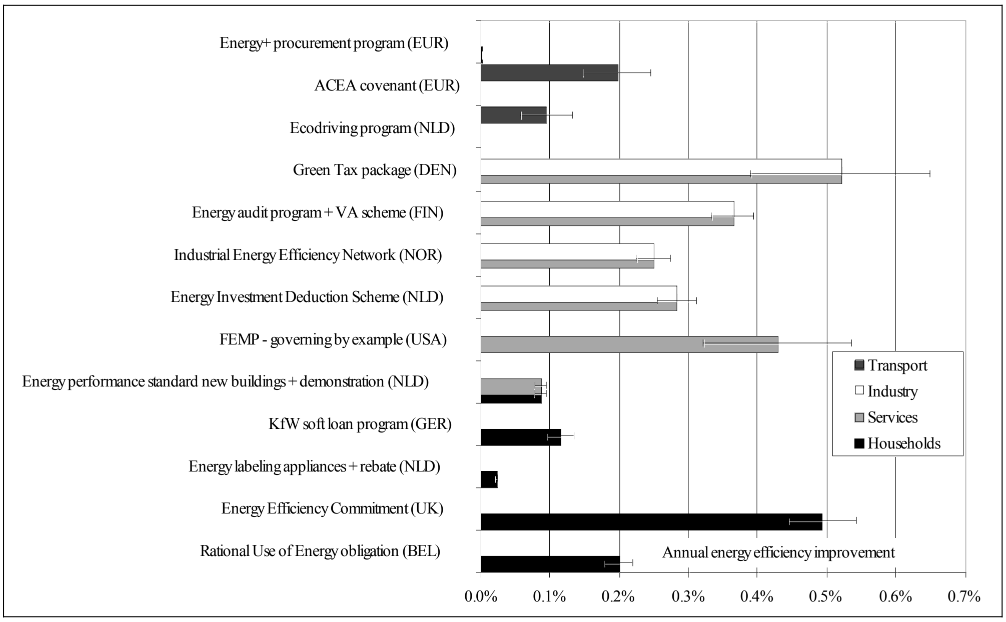

Figure 4 Annual energy efficiency improvements per instrument and sector in the evaluated period.

ciency performance, operational hours, use of buildings and appliances etc.). Furthermore for financial instruments data on the amount of free riders is often limited or lacking.

Most instruments in policy packages are reinforcing each other; however, empirical evidence for this is weak. Most evaluated instruments are part of a policy package (see table 1). Often these links are intended and meant to increase the impact of the whole package with respect to energy savings. In general, it is difficult to determine the isolated impact of a single instrument in a policy package. Informative instruments, which are generally implemented to support other instruments, constitute a good example. Their isolated impact is generally small or even zero. However, our analysis shows that both regulatory and financial instruments as well as voluntary agreements would not be so effective without informing target groups on their obligations, financial benefits etc. Literature on the reinforcing or mitigating effect of policy instruments is scarce and quantitative results are mostly lacking. Boonekamp (2005) developed a method to analyse the interaction between two instruments. This method was further elaborated by Michelsen (2005) for policy instruments providing incentives for the procurement of energy efficient cold appliances and complemented with empirical evidence by interviewing experts.

COST-EFFECTIVENESS

Cost-effectiveness (in literature also referred to as efficiency) refers to the relationship between the energy savings impact and the amount of money needed to achieve this impact. Three different perspectives can be distinguished when discussing the costs and costs-effectiveness of energy efficiency policies.

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, additional 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-specific depreciation periods (see Table 3), (ii) adjusting the annualised investment 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.

$$costs - eff_{end\_user} = \frac{\alpha * investments + cost_{annual} - Benefits_{annual}}{\Delta energy\_saving\_impact_{annual}}$$

Where:

Cost-eff = cost-effectiveness for the end-user (euros/GJ)

α*Investments = annual capital costs (euros) applying a *sector specific discount rate*

$Cost_{annual}$ = annual operation and maintenance costs

$Benefits_{annual}$ = annual benefits, mainly savings on energy costs but also O&M

$\Delta Energy\_savings\_impact_{annual}$ = annual saved (primary) energy

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 %.

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

Where:

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

α*Investments = annual capital costs applying a social discount rate

$Cost_{annual}$ = annual operation and maintenance costs

$Benefits_{annual}$ = annual benefits mainly savings on energy costs, but also O&M costs of the reference technology

$\Delta Energy\_savings\_impact\_corr_{1}$ = annual saved (primary) energy corrected for free-rider and spill-over effects

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 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. On the other hand, the government will achieve extra savings from reduced unemployed benefits, and extra tax revenues from the spending of the increased net income of the consumers and companies who benefit from energy efficiency improvements. 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 its once-only spending), and (ii) dividing depreciated costs by the energy savings impact corrected for side effects like free riders and rebound effects

Table 3 Default sector specific discount rates and depreciation period the different cost calculations

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

Sector	Discount rate (%)
Government perspective	*4%*
End-user perspective	
Households	8%
Agriculture	8%
Services	15%
Industry	15%
Transport	15%
Society perspective	*4%*

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

Where:

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

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

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

Data limitations and uncertainties

In the case studies we have tried to determine the cost-effectiveness for the three perspectives. However, due to limitations it was impossible to make a useful comparison of the cost-effectiveness from the perspective of the end-user and society. Figure 5 provides an overview of the calculated cost-effectiveness from the government perspective for the case studies for which sufficient data were available. The uncertainty in government's cost-effectiveness figures is relatively high (see error bars in Figure 5). This is due to uncertainties in the net energy savings impact assessment but also due to uncertainties in actual cost data.

SUCCESS FACTORS

Our analysis showed that there is no such thing as the "best" policy instrument. The impact that can be achieved with energy policies depends more on the design of an instrument and the way it is implemented than on the type of instrument. From our case studies we have, however, been able to derive a list of typical circumstances in which to apply specific types of instruments (see table 4). We have also identified a set of characteristics that typically determine the success of an instrument. It must be noted that we only looked at the success factors in a qualitative way, i.e. we did not analyse the relative contribution of each of the factors to the overall energy savings impact.

Conclusions and Discussion

Evaluation of 20 energy efficiency policy instruments applied across Europe, the USA and Japan has shown that:

- Energy efficiency policies often lack quantitative targets and clear timeframes;
- Often policy instruments have multiple and/or unclear objectives;
- The need for monitoring information does often not have priority in the design phase;

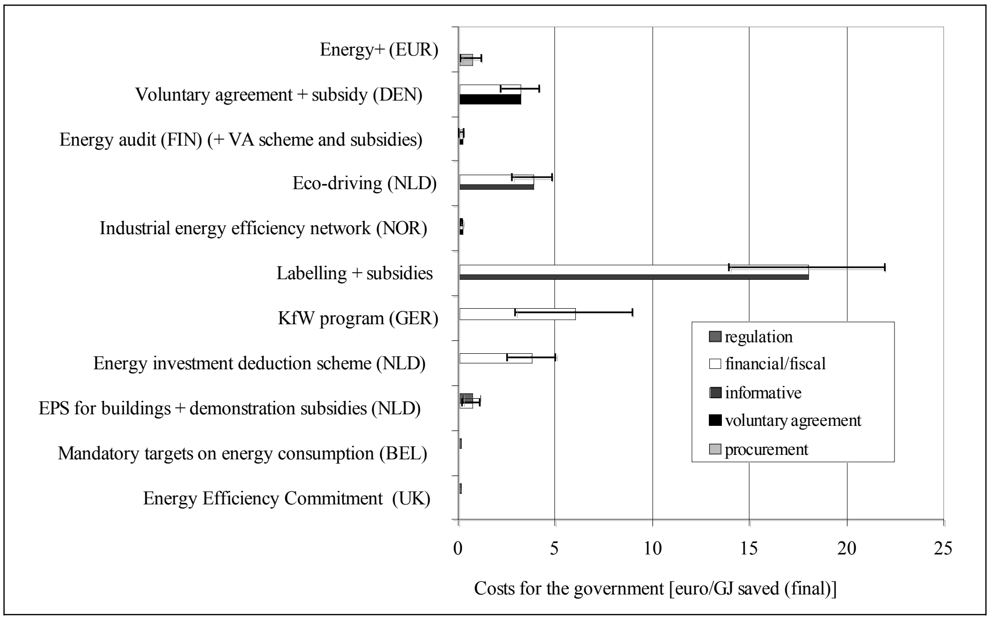

Figure 5 Cost-effectiveness from the government perspective (euro/GJ)

Table 4: Typical circumstances in which to apply different types of instruments and characteristics that determine the success of the instrument

Type of instrument	Typical circumstances in which to apply this instrument	Characteristics that typically determine the success
Energy performance standards for buildings, cars or appliances	• When dealing with a target group which is: • unwilling to act (e.g., voluntary agreement of producers not fulfilled) or • difficult to address (e.g., land-lord – tenant problem) • When aiming at removing the worst products or services from the market with regard to energy consumption	• Is the standard well-justified? E.g. through life-cycle cost studies. • Is the target group well prepared for the standard? E.g. through information campaigns, demonstration projects, feasibility studies, training programs etc. • Is the target group sufficiently skilled to apply the standard? • Is there resistance among the target group to apply the standard? • Are there sufficient resources (knowledge, capacity, time, budget, priority) in place to enforce the legislation? • Are there penalties in place for non-compliance? • Are the penalties at a sufficiently high level to stimulate meeting the standard? • Is the standard timely adjusted to technology progress?
Mandatory targets/tradable certificates for (demand-side) energy savings for energy companies	• When aiming at energy savings in the households or services sector, i.e. large target groups being difficult to address by energy efficiency services. • When knowledge, financial and institutional barriers play a role. • As an alternative or complement to an energy saving fund	• Is the target clearly set beyond business-as-usual? • Is measurement and verification of savings possible at low cost, e.g. by standardization of energy saving measures? • Is the cost-recovery mechanism (energy companies' costs passed to end-users) clear and transparent? • Are there penalties in case of non-compliance (or are there other incentives in place to prevent non-compliance)? • Are penalties set at such a level that target achievement is stimulated? • Are financial incentives needed to stimulate households and companies to implement EE measures • Is the market for tradable certificates transparent and reliable? • Is there undesired overlap with other instruments?
Labelling of appliances, cars, buildings	• When there is a knowledge / information barrier • When dealing with large consumer or service sector groups • When dealing with rather uniform technologies • Whenthere are large differences in energy performance between similar units	• Is it planned to adjust the label to technology progress and market transformation? • Is the label well-justified by respective life-cycle cost studies? • Is the target group timely and sufficiently informed? E.g. through information campaigns. • Is the label clear and transparent? • Are there complementary incentives (eco-tax, subsidy, tax exemptions) for stimulating action?
Financial / fiscal instruments such as soft loans, subsidy schemes, investment deduction schemes, rebates	• When there is a financial barrier in place. • When an informative instrument (e.g. energy audit) needs financial incentives to attract the target group	• Is the target group aware of the existence of the instrument? • Is the financial support sufficient to attract new investments or to carry out energy audits? • Is the annual budget for the instrument linked to the target? • Is the procedure for getting financial support sufficiently known by the target group and simple enough? • Is it clear for the target group which technologies are eligible for financial support? • Is the list of technologies regularly updated to limit free riders? • Is the instrument implemented for a long time period to ensure security for investors?
Energy tax / energy tax exemption	• When dealing with large target groups • When aiming to internalize external costs	• Is the target group well informed on existence and planned future development of the energy tax? • Is use of tax income properly justified and marketed to market actors? • To what extent does the energy tax take account of global or European-wide competition aspects (e.g., by tax exemptions for large industries)? • To what extent are energy tax exemptions used as an incentive for implementing EE measures (e.g. in a voluntary agreement scheme)
Information / knowledge transfer / education / training	• When there is a knowledge barrier • When dealing with large target groups	• Is the information well linked to the customer type within the target group? • Is the information clearly linked to other instruments (regulation, financial/fiscal, voluntary agreement, etc.)?

Energy audits	• When there is a knowledge barrier for buildings and production facilities	• Is the target group well-informed about existence of instrument? • Is the target group well-informed about benefits and costs of instrument and of energy-saving measures identified (e.g., through demonstration projects)? • Is the energy audit targeting all relevant energy end uses? • Is the energy audit producing an estimate of energy cost savings and investments for the recommended measures? • Is the energy audit scheme linked to financial incentive, soft loan, voluntary agreement, and/or energy performance contracting schemes?
Voluntary agreements to save energy (industry, services sector) or improve energy efficiency (e.g. cars or appliances)	• When dealing with a small number of actors with which you need to negotiate or a strongly organized sector • When there is much relatively cheap saving potential (low hanging fruit)	• Is the target group motivated to participate in the voluntary agreement? • Is the target set beyond business-as-usual? • Are there penalties in case of non-compliance (or are there other incentives in place to prevent non-compliance, e.g. a rebate on energy tax, or is there a regulatory threat in case of non-compliance)? • Is there a good monitoring system in place? • Are supporting instruments in place (such as audits, energy monitoring systems, demonstration projects, financial incentives)?
Co-operative procurement programme	• When there are sufficient possibilities to bundle large buyers of EE technologies • When there is a limited number of market actors supplying EE technologies • When potentials for further development and market transformation of new technologies are large enough.	• Is the programme management qualified and engaged? Can the buyers and suppliers group be motivated in principle? Is the buyers group involved in the programme set up? • Is the buyers group sufficiently sized? Are the results of the programme well documented to facilitate market deployment? Is the programme well tuned with other policies (energy efficiency standards, labelling, research & development)?

- For most instruments monitoring information is collected on a regular basis. However, this information is often insufficient to determine the impact on energy saving, cost-effectiveness and target achievement of an instrument;
- Monitoring and verification of actual energy savings have a relatively low priority for most of the analyzed instruments.
- There is not such thing as the 'best' policy instrument. However, typical circumstances in which to apply different types of instruments and generic characteristics that determine success or failure can be identified.

The instruments were evaluated by applying a practical framework based on theory based policy evaluation. With the development of this framework, we aimed to contribute to a further harmonisation of evaluation processes and create comparable evaluation outcomes among the case studies. This paper shows that the theory based policy evaluation method has several benefits over other ex-post evaluation methods as:

- The whole policy implementation process is evaluated and the focus is not just on the final impacts (i.e. realized energy savings).
- Through the development of indicators for each step in the implementation process, the "successes and failures" can be determined to the greatest extent possible.
- By applying this approach we not only learn whether policies are successful or not, but also why they succeeded or failed and how they can be improved.

Practical applicability of the method for policy makers was tested in seven national workshops that were organised within the framework of the AID-EE project (see www.aid-ee.org). These workshops showed that the method can also be a useful tool in the design phase of new policy instrument as it forces policies makers to think about:

- The whole implementation process;
- The relationship and possible overlap with instruments already in place;
- The crucial indicators that need to be monitored;
- SMART objectives for the new policies. In which SMART stands for (i) **S**pecific: be as concrete as possible: what should be achieved with the instrument?; (ii) **M**easurable: targets should be quantified; qualitative targets cannot be measured at a later stage; (iii) **A**mbitious: Does the target go beyond business as usual? (iv) **R**ealistic and Acceptable: Is the target achievable in the given timeframe, with the budget available? Is the target accepted by the target group? (v) **T**ime framed: Are targets set for a specific year? Are intermediate targets set in order to be able to monitor target progress?

We experienced a number of practical problems that in real cases often make it difficult to exactly follow all steps of the developed methodology.

- Lack of monitoring data is the most common problem. This is also one of the most striking issues that currently need to be dealt with in the further implementation of the

ES Directive. In order to enable monitoring of the targeted verifiable savings under the Directive, Member States will have to improve their monitoring and verifications systems significantly. The best way to handle this is to identify monitoring needs already in the design of the policy instrument and include monitoring from the outset.

- Lack of time and resources. The lack of time and resources often mean that compromises have to be made regarding data collection. This means that decisions have to be made regarding what the focus of the evaluation should be.
- Policy theory is not clear. Often, the policy theory is only implicit and the policy makers may only have a vague idea of how the policy instrument is meant to work. This means that the evaluators will have to reconstruct the policy theory themselves, which brings with it a risk of misinterpretation. Sometimes, there might be different opinions of what the policy theory looks like. In such cases, it is especially important to double check the policy theory with other evaluators and with various respondents.
- Difficult to determine cause-effect relations. The cause-effect relations are not always clear-cut for a policy instrument. Sometimes there are parallel actions that lead to the same effect. Sometimes one action can have several effects. Sometimes, there are various exogenous developments influencing the impact. And sometimes, there are long-lasting impacts of actions implemented. This means that the evaluator has to be creative when identifying and visually depicting the cause-effect relation in the policy theory.
- Difficult to identify the most significant success and failure factors**.** For a useful evaluation it is vital that the most significant success and failure factors are actually identified. This is not always easy since respondents can have differing views and since each interview situation can give different results. It is therefore important to try to double check the results as much as possible. This can be done by using several respondents, by letting respondents comment on results, by checking answers by respondents against data from other sources and by discussing the results within the evaluation team.

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