Implementation aspects of the EU Directive on energy end-use efficiency and energy services in Germany

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Keywords
energy efficiency improvement, ESD, energy savings target, energy policies, public sector, national action plan

Abstract
The EU Directive 2006/32/EC on energy end-use efficiency and energy services (ESD) became effective on 17 May 2006. Now the Member States have to develop strategies and policies for the national implementation of the Directive, which sets a national indicative energy savings target of 9 % for the ninth year of the Directive's application. This target is to be met using measures to improve energy efficiency. The Member States have to present their first energy efficiency action plan (EEAP) under the ESD by 30 June 2007, which must contain the national overall target for energy saving. According to the first provisional calculations of the national energy savings target under the ESD, the energy savings which have to be achieved in Germany in the ninth year of the Directive (2016) amount to 758 PJ of final energy. The target cannot only be achieved by new measures applied in the active period of the Directive (2008-2016), but measures taken since 1995 which still have an effect in 2016 ("early actions") may also be considered. According to a first rough estimate, early action can contribute substantially to achieving the ESD target value for Germany. Taking into account recent energy efficiency programmes of the Federal government, the main focus of new measures under the ESD will probably be on the building sector (existing and new buildings) and on electrical appliances. The transport sector could become a second area for energy efficiency measures under the ESD. For measuring the energy savings realised under the ESD in Germany, a national model has been developed which includes both bottom-up and top-down monitoring elements. Other important implementation aspects are also discussed such as the statistical data demands resulting from the ESD, the special requirements for the public sector, institutional embedding and cost aspects of transposing the ESD in Germany.

Introduction
In the wake of the European Climate Change Programme (ECCP), the European Commission proposed a Directive to the European Parliament and the Council of the European Union at the end of 2003 on improving energy efficiency and promoting energy services. The Directive on energy end-use efficiency and energy services (ESD) was finally passed by the European Parliament on 23 March 2006 and became effective on 17 May 2006[1]. During more than two years discussion of the Directive by the European Commission, the European Parliament and the Council of the European Union, negotiations concentrated on the following issues:

- A binding or non-binding target for the energy efficiency improvement under the ESD.
- The height of the savings target and the duration of application.
- Special requirements for the public sector.
- Measuring target achievement using top-down and/or bottom-up methods.

1. Directive 2006/32/EC of the European Parliament and of the Council of 5 April 2006 on energy end-use efficiency and energy services and repealing Council Directive 93/76/EEC. ABl. L 114 of 27.4.2006, p. 64

Table 1. Main contents of the Directive on energy end-use efficiency and energy services (ESD)

Subject	Content
Application	Providers of energy efficiency measures including distribution/retailing; final customers; military
Exceptions	Small suppliers/energy retail sales firms; EU-ETS installations; maritime bunker fuels
Status of the target	Non-binding target (energy saving indicative target)
General efficiency target	National energy saving indicative target: For the ninth year of the Directive's application: 9 % Intermediate target for the third year of application of the Directive
Calculation of the target:	Mean value of the annual domestic final energy consumption of all energy consumers covered by the Directive in the last five years before implementation of the Directive for which official data exist
Public sector	Not a higher target but simply an exemplary role for the public sector. Selection of at least two measures from the list in the ESD
Measurability of the target	Harmonised calculation model with a combination of top-down and bottom-up methods. At first, 20-30 % of the end-use energy demand under the ESD to be evaluated using bottom-up methods; "significantly higher percentage" from 2012
Early action	From 1995, in specific cases from 1991
Sectors affected	All final consumption sectors excluding those undertakings participating in greenhouse gas emission allowance trading and excluding defence-related parts of the armed forces' energy consumption

- Accounting for "early action", i.e. energy saving measures undertaken by countries prior to the active period of the Directive but which have an effect during the active period.

In the end, a compromise was achieved which managed to conciliate the previously diverging positions (Table 1).

Nevertheless, there are still some open questions with regard to the concrete transposition of the Directive in the individual Member States. Many of them have to be settled in the Committee set up under Article 16, which is to support the Commission in the further development of the ESD, some of them also on a national level (such as the statistical data demands resulting from the ESD and the institutional embedding of the reporting tasks). By 30 June 2007, the Member States have to present their first energy efficiency action plan (EEAP) under the ESD. The first action plan should show the national overall target for energy saving for the 9 year period as well as the intermediate target for the first three years and provide an overview of the country's strategy for achieving these targets.

This means that the Directive places high demands on the Member States concerning the national implementation of the Directive. In this paper, important implementation aspects of the ESD are discussed in relation to Germany. These are mainly based on a study of the statistical and methodological issues in the national implementation of the ESD carried out by Fraunhofer ISI on behalf of the German Federal Ministry of Economics and Technology (BMWi), which is the responsible ministry in charge of executing the ESD in Germany (Eichhammer et al. 2006). A basic national model for measuring the implementation of the ESD in Germany will be presented, which includes both bottom-up and top-down monitoring elements. A first set of concrete energy saving measures is also presented which can be envisaged for implementing the ESD in Germany.

Target definition under the ESD

The ESD basically establishes two things with regard to the target definition: a *target value*, which has to be achieved and a *rule* on how to calculate the energy savings which contribute to meeting the target.

According to Annex 1 ESD, the target is defined based on the final inland energy consumption of all the energy users affected by the ESD in the 5 year period for which the most recent "official data" are available. For Germany at present, this would be the period 2001-2005 if the summary tables of the energy balance (AGEB 2006) are taken as official statistics, which are preliminary for the last three years.[2] No corrections pertaining to annual climate fluctuations, structural or production changes are applied, i.e. the indicative target is calculated once and then remains unaffected by further economic, social or technical developments. This is a fundamental difference to the Kyoto target which is formulated as an absolute target. With this target definition, the ESD can result in substantial energy savings without reducing emissions because the savings could be overcompensated by the economic development or other factors (structural change, behavioural effects).

The following provisions of the ESD have to be taken into account when calculating an indicative energy saving target for Germany (Table 2):

- The ESD does not affect the total final energy use. According to Articles 2b and 2c, exceptions include undertakings which are subject to the European emissions trading scheme and that share of the armed forces' energy consumption which serves primarily defence purposes. As a result, the target definition has to be adjusted by this share of the fi-

2. Total final energy consumption in Germany in the year 2005 amounted to 9 173 PJ (AGEB 2006).

Table 2. Possible calculations of the indicative target for Germany within the scope of the ESD

	Electricity evaluated with	
Indicative target shown:	**1**	**2.5**
without correction for EU ETS and military	PJ	
1% additional saving per year	93	120
9% saving after 9 years	836	1078
Integral saving over 9 years assuming a linear target achievement	3760	4851
Corrected for EU ETS and military	PJ	
1% additional saving per year	84	111
9% saving after 9 years	**758**	**1001**
Integral saving over 9 years assuming a linear target achievement	3412	4503

Comments:

1) Calculated based on the summary tables of the energy balance 1990-2004 (State 11/05; AGEB 2006).

2) Fuels are converted from physical units to energy units using the conversion factors of the energy balance.

3) Corrections for EU ETS approximate based on undertakings (sectoral approach not corrected for the electricity use of the ETS companies). Energy balance rows 46: extraction of minerals, other mining, 48: paper industry, 52: glass and ceramics, 53: processing of minerals, 54: metal production. Electricity consumption for all sectors completely accounted for. Calculation based on the energy balance for the year 2002 as shares in total industrial energy consumption 2002.

4) Corrections for military under the assumption that the fuel consumption (12 PJ in 2004) is defence-related and thus not subject to the ESD, whereas the rest of the armed forces' energy use (6 PJ) concerns, e.g. buildings, and could thus fall under the ESD.

nal energy use. Especially the correction for the EU ETS is not an easy task. The main difficulty is that the ESD talks about "undertakings", whereas the EU ETS only mentions installations. Taking entire companies out of the energy consumption calculation is statistically difficult. Moreover, this would remove a significant share of the industrial final energy consumption from the ESD, particularly electricity applications which do not fall under the EU emissions trading scheme either. This would have a negative effect on carrying out efficiency measures in this field. For these reasons, it is recommended to define emissions trading more narrowly in the ESD. In the target calculated here for Germany, electricity use in companies is not deducted.

- When calculating the target, the energy sources can either be converted from physical units to energy units using the conversion factors given in Annex II of the Directive, or using national factors where reasonable. For electricity, the Directive allows a conversion coefficient of 1 (electricity evaluated as final energy), but a standard factor of 2.5 or a national weighting factor can also be used for electricity if justifiable. In the subsequent calculation of a target for Germany, national conversion factors are used for fuels in order to avoid deviations from the national energy balance. Electricity is evaluated with 1 or alternatively 2.5, but not with the national weighting factor. Choosing a factor of 2.5 means electricity is weighted higher both in the target value and in the savings. This can be used to express an energy efficiency policy which wants to put more emphasis on electricity savings.

Table 2 shows the target calculated in this way for energy savings in Germany. This value can be depicted in three ways:

- As a 1 % target, i.e. the annual additional average saving to be achieved.
- As a 9 % target, i.e. the annual saving which has accumulated after nine years.
- As an integral target over the nine years duration of the Directive under the assumption that the target achievement is linear.

The height of the target depends decisively on which factor is used to weight electricity. With a weighting of 1, it equals **758 PJ** – shown as accumulated savings which have to be achieved in Germany in the ninth year of the Directive (2016). If weighted with 2.5, which is also possible under the ESD, it amounts to around **1000 PJ**.

Top-down and bottom-up methods to calculate energy savings

The ESD permits both top-down and bottom-up calculation methods for measuring target achievement. These can be classified according to their degree of detail as follows:

1. The most detailed approach consists of autonomous **bottom-up data acquisition and analysis of the energy savings** in which data collection may be based on both measurements as well as expert estimations with or without local inspection. The advantage of this method is that many exogenous factors can be inherently excluded and thus, theoretically, greater accuracy achieved. In practice, free-rider effects and setting the baseline for measuring the energy saving play an important role in the accuracy of the concept. The potentially high costs of such a system are its major drawback.
2. A **combined top-down/bottom-up approach** which separates all exogenous factors statistically or by modelling. The advantage is the improved information content at still rela-

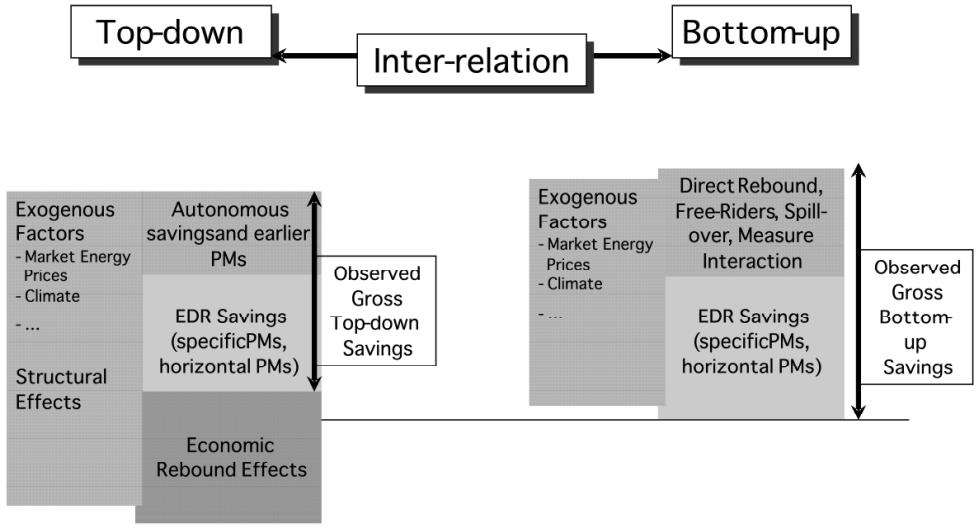

Figure 1: Structure of a combined top-down/bottom-up model for measuring the achieved energy savings

tively low additional costs. The drawback is that the data and method first have to be approved.

3. A **refined top-down approach** aims at separating as many exogenous factors as possible. Secondary statistics and statistical studies are enlisted to do so. The advantage is the improved information content at relatively low additional costs. The drawback is that the data and method first have to be approved. An example for this approach is the so-called "ODEX", which is a re-aggregated energy efficiency index summarizing the measured development of energy efficiency in a single indicator, but which is calculated on a detailed level of around 30 branches, sub-sectors or application purposes. The ODEX, which has already been developed EU-wide within the scope of the ODYSSEE-MURE project[3], is mentioned in the ESD as a possible top-down monitoring tool.
4. A **simple top-down approach** using aggregated energy intensities calculated only from available official statistics. The advantage of this approach is that no additional data surveys are necessary and the data are officially approved. The drawback is the poor separability of exogenous factors.

Figure 1 shows what the structure of such a combined top-down/bottom-up model required by the ESD could look like. The ideal objective of such a mixed system is to evaluate the energy savings under the ESD using both approaches. Ideally, this area should be the same size. In practice, however, there will be differences since the determination of "real" energy savings is made more difficult due to the influence of a variety of other factors and effects.

Statistical data demands resulting from the ESD

The availability of statistical data on energy consumption and activity data which determine the final energy consumption in the respective sectors forms the essential basis for defining the target and calculating the energy savings under the ESD. With regard to the basic approaches shown above for evaluating energy savings, the statistical data situation in Germany for monitoring within the scope of the ESD can be assessed as follows, assuming that the current state of energy statistics in Germany will at least be maintained.:

- If only a *simple top-down approach* is used to evaluate the energy savings based on highly aggregated energy intensities (macroeconomic or perhaps sectoral), the data required are basically available in the official energy and economic statistics (AGEB 2006; Statistical Office 2006; transport statistics from DIW Berlin/Ministry of Transport 2006). However, it should be noted that the figures for the last few years are often only provisional.
- If a *refined top-down approach* or a combined top-down/bottom-up approach is used, for example the ODEX mentioned in the ESD, the data requirements are much higher. Alongside the data available from official statistics, other data on a disaggregated level are necessary which are usually drawn from unofficial data sources or estimates. Therefore it would be necessary to first reach an agreement on the use of such non-official data for evaluating energy savings under the ESD. These higher requirements could be fulfilled to a large extent with the data available at present in Germany, i.e. costly additional data collection beyond those already planned[4] would not be urgently necessary. It would be useful, however, to target a greater harmonisation and networking of the energy consumption data available so far on a national level from official statistics and surveys. It would

3. http://www.odyssee-indicators.org

4. Especially the regular surveys in the household and tertiary sectors planned to supplement the energy statistics which began in 2001 (Görgen 2006) as well as, in future, the regular compilation at the shortest possible interval of an energy reference forecast for Germany.

Table 3. Energy consumption and employees in Germany's public sector (2001)

Public or semi-public domains	Electricity TWh	Fuels TWh	Employees 1,000
Office buildings[1)]	19.7	65.0	9,912
Hospitals	4.1	9.3	1,108
Schools	4.3	22.7	1,479
Swimming pools	4.2	10.1	66
Airports	1.2	1.2	34
Military	0.3	1.9	350
Street lighting	3.3	./.	./.
1) Incl. regional administrative bodies, social security as well as postal, telecom and rail services; this consumption group can be disaggregated in terms of the ESD.			

Source: Fraunhofer ISI et al. 2004

be helpful and would contribute to a continued improvement of the data situation if EU-level research projects on improving the data situation in the sectors affected by the ESD were better integrated into the national activities taken to improve energy statistics[5].

- The *purely bottom-up approach*, in contrast, is based on autonomous data collection which may entail high costs for setting up an original system of data acquisition. These costs have to be offset against the possible costs of improving the statistical database which might be necessary for the refined top-down and combined top-down/bottom-up approaches. Furthermore, there are different estimates about the level of costs involved. The data situation is much better in countries which have already constructed detailed bottom-up systems for monitoring energy saving measures (e.g. Denmark and Finland) or which have already introduced White Certificates or similar systems (the UK, Italy and France). Such a system does not yet exist in Germany.

The statistical data situation could also be improved for both top-down and bottom-up evaluation methods due to the obligation contained in Article 6, paragraph 1a of the ESD. This requires energy distributors, distribution system operators and/or retail energy sales companies to provide aggregated statistical information about their final customers on request once a year at the most to the authorities or agencies charged with implementing the ESD. How this obligation would be put into practice in Germany should be explored together with the companies affected.

The ESD addresses the **public sector** specifically and assigns it an exemplary role in improving energy efficiency (esp. Art. 5 (1) and 14 (2)). The Directive cites several aspects and concrete measures to realize these special demands, but also points out that the public sector has different administrative structures in the different Member States so that suitable measures will have to be determined on a national level. Nevertheless, the realization of energy efficiency measures in the public sector also implies specific data requirements for their monitoring.

To start with, it must be taken into account that the German public sector involves a huge variety of decision makers. The federal structure in Germany results in a large degree of autonomy of the states in their decisions and local authorities are responsible for regulating all local administration concerns under the right to autonomy guaranteed in the German Constitution. It must also be taken into account that there are a multitude of public buildings and institutions which make it difficult to compare savings and energy saving potentials, e.g. administrative buildings, schools, swimming pools, hospitals, libraries, museums, sports halls, conference halls, community housing developments, homes/hostels, nurseries, universities, supply and disposal establishments, street lighting and traffic lights. The exact definition and demarcation of the public sector within the ESD still has to be clarified. Alongside the sector "public administration, social security, defence" which can be clearly defined economically and assigned to the public sector (NACE 75, although the ESD only covers parts of the military), there are other areas which could be assigned completely or partly to the public sector (such as schools, universities, hospitals and local community services such as waste disposal and water supply etc.). In Germany, there are energy data on specific years for the areas mentioned available from past surveys conducted in the tertiary sector, which would, however, have to be specified regarding the ESD and harmonised with other data sources. The data situation on the stock and energy consumption of public properties is still insufficient, even if there have been several recent moves to improve these records in the past few years.

Design of a basic model for implementing the ESD in Germany

The ESD Directive creates a framework for evaluating energy efficiency measures in the EU Member States (esp. in Annex IV), which will probably be fleshed out by the Article 16 Committee over the next few months. At the same time, each EU country must reflect on its structure at national level since the individual Member States have to present their first energy efficiency action plan (EEAP) by June 2007 including a detailed model plan for measuring and verifying measures. The following **basic principles** could be taken as a basis for the energy efficiency monitoring system to be created in Germany:

- In order to overcome the accusation of bureaucratization, which was frequently made at the beginning of the ESD's development, the model should build on existing databases and methods/models as far as possible. The ESD also creates flexible possibilities in Annex IV for applying differ-

5. Within the EU programme "Intelligent Energy Europe", there are many projects on improving the database of energy consumption especially in the household and tertiary sectors (incl. public buildings). http://europa.eu.int/comm/energy/intelligent/index_en.html

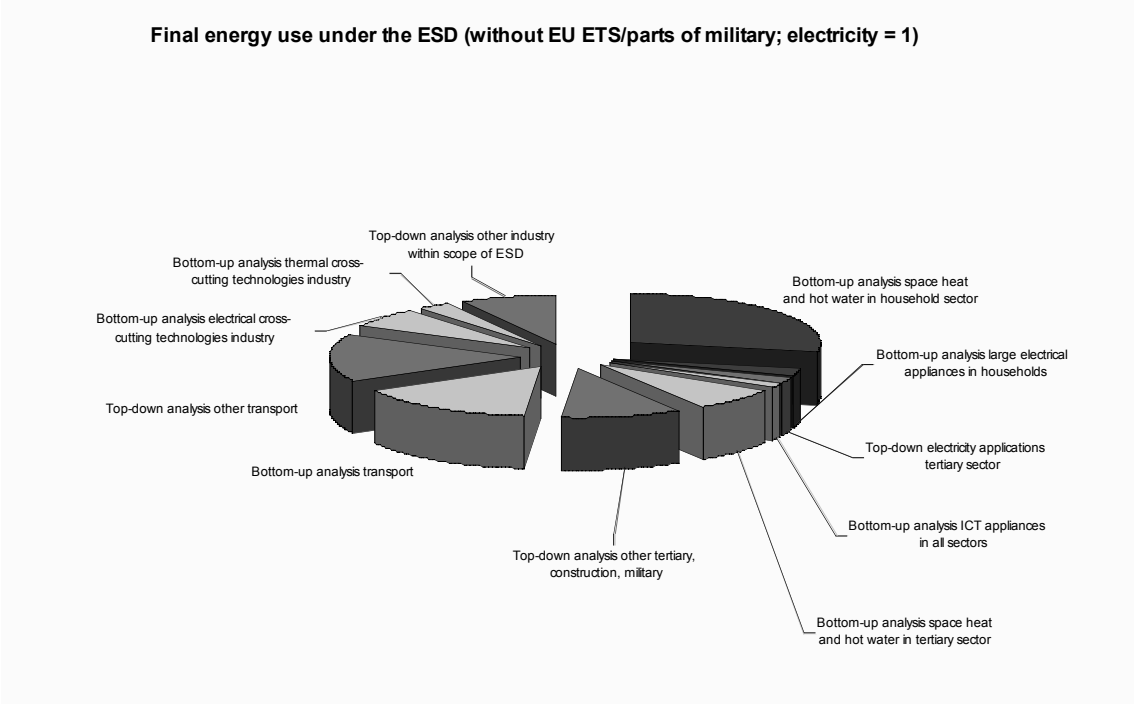

Figure 2. Bottom-up and top-down parts of the basic model for evaluation of the ESD in Germany

ent methods of evaluation depending on the measure concerned. In Germany, there is a long tradition of evaluating measures (ex-post, but often ex-ante) within the scope of research projects[6], which has to be made operational for the ESD.

- The evaluation methods selected should concentrate on revealing the policies and measures most relevant for implementing the ESD; i.e. the sector on which the measures focus should be given a better evaluation basis. This is a political issue. The household sector seems to have been given priority for starting the transposition of the ESD in most Member States (Bowie 2006).
- Preferably, measures should be considered which generate their own information base (audits, building certificates, labelling of electrical appliances etc.). The data acquisition necessary to evaluate the measures is then not just a theoretical exercise, but an integral part of the measures themselves.
- The introduction of the ESD forces a certain hierarchy in timing the introduction of bottom-up evaluation methods: in the first phase of the ESD up to 2011, the evaluation will concentrate on the sector for which the most complete bottom-up information is available. In the second half of the ESD, when higher percentages of bottom-up are required, other sectors might have to be tackled, too.
- From the viewpoint of the ESD, it is not absolutely necessary to separate the individual effects of measures. Of course, those responsible for a programme see this differently since they are primarily interested in the results of the respective programme. However, there may actually be a longer term necessity to provide evidence for the effects of individual measures from the perspective of the ESD as well, namely once White Certificates (energy efficiency certificates) have been introduced and are being traded throughout Europe (or nationally). Then, savings will be set against a direct monetary value which may lead to disputes between different parties each claiming a larger share of the saving. At present it does not seem likely that White Certificates will be introduced throughout Europe before the end of the first period of the ESD. However, there is also the short-term argument of traceability and accuracy which supports separating the effects of measures as much as possible.

Figure 2 shows what a national model for evaluating measures within the ESD could look like. To start with, those parts of the final energy consumption have to be identified which are described using bottom-up evaluation methods from today's viewpoint or from the perspective of the ESD. Already existing evaluation methods and possible necessary additions are shown for these parts of the pie with regard to the ESD. The remaining parts of final energy consumption have to be evaluated using top-down methods.

In Figure 2, the final energy consumption most easily covered using bottom-up evaluation methods in Germany is split up into seven domains:

1. Space heating and hot water in the household sector (including electrical).
2. Large electrical household appliances (refrigerators without freezer compartments, combined fridge/freezers, freezers, washing machines, dishwashers, driers, TVs, microwave ovens) and lighting.

6. E.g. IER/Prognos (2004), Policy scenarios I and III (1997, 2004) or Prognos/IER/WI (2002), which include partly ex-post evaluations of measures, but mainly ex-ante measures.

3. ICT appliances in all sectors.
4. Space heating and hot water in the tertiary sector (including electrical).
5. Transport.
6. Electrical cross-cutting technologies in industry (electrical motors, pumps, fans etc.).
7. Thermal cross-cutting technologies in industry (industrial steam generators < 20 MW; excluding industrial space heating).

Using these seven domains, it can be estimated how much of the final energy consumption affected by the ESD can be covered using bottom-up approaches based on the present state of data availability and existing evaluation methods and models in these areas:

1. For the first phase of the ESD, it makes sense to rely on the detailed bottom-up evaluation of *space heating measures in the household sector*. 28 % of the final energy use affected by the ESD can be covered in this way which meets the ESD's first phase requirement of covering at least 20-30 % by bottom-up analyses. Germany already has a bottom-up modelling approach in this area because of diverse evaluation studies made in the past based on a representative building inventory. This current state would have to be maintained and updated in the future for the monitoring planned in the ESD. It also makes sense to concentrate on space heating in the household sector because the most concrete measures exist here resulting from the coalition agreement in the autumn of 2005 to greatly extend the KfW support programmes.
2. If the domain of *large electrical household appliances* is added, which is also relatively well covered by bottom-up evaluations, this adds another 2.3 % (electricity x 1), which means the 30 % target is then exceeded. For the majority of appliances, this field is continuing to profit from the dynamics of energy labelling which was triggered by the EU Directive.
3. *ICT technologies* constitute another field which could contribute 1.5 % to bottom-up electricity savings. However, the prerequisite for this is the construction of relevant, regularly updated stock models complete with technical data and stock data. For this reason it might be more cost-effective to tackle the following two areas first.
4. The sub-sector of *space heating/hot water in the tertiary sector* could contribute up to 7.5 % points to increasing the share of bottom-up. However, so far, there has been no real bottom-up evaluation of measures in the tertiary sector, only top-down estimates restricted to a few measures. The top-down indicators developed up to now for the tertiary sector are a comparatively rough tool for assessing energy saving measures in this sector since the classification based on sub-sectors and application purposes is insufficient. It might be possible to use existing or extended models coordinated with ongoing and possible future surveys of energy consumption in the tertiary sector.
5. For the further development within the ESD, the *transport sector* is of primary importance. As a conservative estimate, almost 16 % of the savings in this sector could be covered by bottom-up. The type of measure involved mainly determines whether the evaluation is to be characterised as bottom-up or top-down. In this context, the question has to be asked: Which energy efficiency measures in the sense of the ESD can be expected in this sector in Germany in the future? The coalition agreement of 2005 is quite vague in this respect. If no further measures are going to be implemented, it does not make sense to have good bottom-up evaluation methods available but no measures to evaluate within the framework of the ESD. With the help of the transport sector, it would be possible to achieve almost 50 % bottom-up, which might be relevant for the second phase of the ESD.
6. *Industrial electrical cross-cutting technologies* (electrical motors, pumps, fans, compressed air) would be of particular significance if electricity were evaluated with 2.5. Even with a weighting of 1, they would contribute 4.5 % to bottom-up evaluation; with 2.5 they would be almost as relevant as the transport sector. Due to the fact that a relatively large share of the industrial sector is excluded from the ESD, they are also the field most suited to measures in the industrial sector under the ESD. There are corresponding bottom-up models currently being constructed for this sector, but the database for these needs further improvement.
7. The *industrial thermal cross-cutting technologies* (essentially industrial steam generators < 20 MW and industrial CHP) are currently being modelled in bottom-up structures. They could contribute 2.8 % to bottom-up evaluations. The quality of such bottom-up studies could be improved by a statistical evaluation of the data held at the safety standards authorities who are responsible for testing the systems.

In summary, it can be concluded that the first phase requirement of the ESD to cover at least 20-30 % of the final energy use affected by the ESD using bottom-up evaluation methods could be fulfilled in Germany solely by domain (1), space heat/hot water in households. If necessary, domain (2), large electrical household appliances, could be added since the necessary data and models are readily available here. From 2012 onwards, more than 60 % of the energy use affected by the ESD could be covered by bottom-up using *all* the domains mentioned. If bottom-up coverage of 50 % has to be achieved by 2012, besides domains (1) and (2), also (5), the transport sector, as well as (4), space heat/hot water in the tertiary sector, or (6), electrical industrial cross-cutting technologies, could be included. The remaining parts of final energy consumption would have to be evaluated using top-down methods.

Institutional embedding and cost aspects of transposing the ESD in Germany

Alongside the questions concerning statistics and methods, it must also be clarified which institution should take on the reporting task and under which conditions when transposing the ESD in Germany. There are a few basic options here:

- establishing a new authority along the lines of the German Emissions Trading Authority (DEHSt), which was established to transpose the Emissions Trading Directive of the EU and is affiliated to the Federal Environmental Agency;
- embedding the reporting obligations in already existing institutions like the Germany Energy Agency (dena), the Energy Balance Working Group (AGEB), the Federal Statistical Office or the Federal Network Agency[7], which is in charge of regulating the electricity/gas, postal, telecommunication and railway markets;
- or directly assigning the reporting duties to the Federal Ministry of Economics and Technology (BMWi) which is the ministry responsible for implementing the ESD in Germany.

However, there are reservations associated with both establishing a new organisation (the transposition of the ESD in Germany should be as efficient and unbureaucratic as possible) and embedding the ESD reporting in existing organisations (the institutions in question only cover specific parts of the reporting duties required by the ESD and are already overloaded with their current work). As a result, the most realistic solution remains the direct embedding of the reports in the responsible ministry. This task could be supported by involving external (ad-hoc) experts, for example in the form of research projects on specific issues within the ESD as well as by holding workshops and expert discussions. Within this framework, the other institutions cited above could also be involved in implementing the ESD in Germany. At least in the short term, i.e. for the first EEAP to be presented at the end of June 2007, there seems to be no realistic alternative to this solution as far as the experts participating in the debate are concerned. However, for the continued monitoring, it will be necessary to increase the personnel capacities of the BMWi in order to be able to adequately monitor the transposition of the ESD in Germany. In this case, additional personnel costs (about 2 positions) would be incurred as well as the costs for associated research projects contributing to implementing the ESD.

The costs for extending the bottom-up approaches to implement the national basic model suggested here could be in the range of 750-1050 kEuro per action plan or approx. 250-350 kEuro per year, if all the seven domains cited are to be covered in the medium to longer term using bottom-up methods. For the first EEAP in June 2007 it would be sufficient to operate with domains (1) and (2), space heat/hot water in households and electrical household appliances, maybe even only with (1). This can be achieved at much lower costs of about 100 k€ per EEAP for space heat/hot water and – depending on the scope of the stock model – of about 100-150 k€ for electrical appliances. For 2012 and after, it would be sensible, as mentioned above, to combine (1) and (2) with transport (5) and non-residential buildings (4) or the electrical cross-cutting technologies in industry (6) in order to reach a 50 % level of coverage with bottom-up evaluations. This could be done at a cost of approx. 500 kEuro per EEAP or approx. 170 kEuro per year. On top of this are the costs for the top-down analysis of the other parts of the final energy consumption covered by the ESD, which will probably be quite small.[8] It would still be sensible to explicitly include the public sector since this is assigned an exemplary role in the ESD. A first measure could be a survey of the regional administrative authorities on already conducted and planned energy efficiency measures. The costs for the design, realization and assessment of such a survey which could be done in written form are estimated at around 40 kEuro per EEAP.

Possible energy saving measures in Germany under the ESD

In Germany, the main responsibility for most energy policy issues at the federal level (incl. energy efficiency policy) lies with the Federal Ministry of Economics and Technology (BMWi) (www.bmwi.de). The BMWi is also in charge of the national implementation of the EU Directive on Energy End-Use Efficiency and Energy Services (ESD). But since the ESD covers a broad range of possible energy saving measures in all final energy consumption sectors, other Federal ministries are also affected by the Directive. The responsibility for renewable energies lies with the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) (www.bmu.de), which is also in charge of climate policy measures (which could also be energy saving measures). Energy issues related to transportation are the responsibility of the Federal Ministry of Transport, Building and Urban Affairs (BMVBS) (www.bmvbs.de), which also incorporates energy saving measures in buildings. Furthermore, the Federal Ministry of Education and Research (BMBF) (www.bmbf.de) is in charge of general research on energy efficiency.

When looking at the patterns of energy policies and measures in Germany over the last 15 years, i.e. the predominant measure type in an end-use sector covered by the ESD, this can be illustrated by diagrams in the form of a spider's web with the measure types forming the spokes of the web. The greater a country's preference for a certain measure type, the more the pattern will resemble the hands of a watch indicating the preference. The broader the policy in the sector, the more equally spread the measures on the different axes so that the pattern then resembles a pentagon or other polygons depending on the number of categories (see Figure 3 based on information from the MURE database on energy efficiency measures[9]). The resulting patterns are different for the final energy consumption sectors:

- Financial measures are by far the most dominant in the *residential sector* in Germany, especially the housing modernisation programmes of the KfW promotional bank. More than 50 % of the measures introduced from 1990 onwards are financial measures. Legislative measures are important, too, both legislative/normative measures (especially building regulations) and legislative/informative measures (especially mandatory labelling of household appliances, a meas-

7. http://www.bundesnetzagentur.de

8. This is especially valid if the ODEX is used as suggested in the ESD because the work and continuous updating of the ODEX are already being financed by the EU or paid for by the participating institutes.

9. http://www.mure2.com

ure triggered by the EU). All other measure types are at the lower end of preference in the residential sector.

- In the *transport sector*, the spider graph looks more equally spread. Most important are measures aiming at the transport infrastructure, followed by fiscal measures (different taxes on vehicles and fuels, levies for trucks on motorways) and information measures. But only a few measures refer directly to energy efficiency.
- In *industry*, there is a clear focus on cooperative measures like voluntary agreements and, more recently, new market-based instruments since the start of the European-wide Emissions Trading Scheme. Financial measures are important, too, though considerably less significant than in the residential sector.
- In the *tertiary sector*, the spider web is similar to the one for industry, but with a greater importance of financial and legislative/normative measures. This shows that the measures in the tertiary sector are a mix of industrial and household measures.

It is possible to get an idea about the additional energy saving measures which can be expected in Germany under the ESD by analysing the latest proposals concerning energy-saving measures and climate policy by the Federal government and the responsible Federal ministries.

In July 2005, the new *National Climate Protection Programme 2005* was published (BMU 2005), which is an update of the first programme dating from October 2000. The purpose of the present programme is to make sure that Germany will be able to comply with its commitments within the EU burden sharing agreement, i.e. to reduce its greenhouse gas emissions in the period 2008 – 2012 by 21 per cent compared to 1990 levels and thus provide a basis for further ambitious environmental policies after 2012. The update takes stock of the Federal Government's climate protection policies of the past 5 years and submits a set of concrete measures. Since the sectors energy and industry are covered by the new instrument "emissions trading", the Climate Protection Programme 2005 focuses on measures in the transport and private household sector. In private households, a CO_2 reduction potential of 5.3 Mt should be achieved through public relations campaigns, consultation and innovation, financial support measures and the introduction of the new Energy Savings Ordinance which also includes energy passes. In the transport sector, a CO_2 reduction of 10 Mt should be achieved by incentives to increase energy efficiency (e.g. tax reductions for low fuel cars, emission-related landing fees at German airports), technical improvements in vehicles, alternative fuels and public information campaigns promoting low emission driving habits. In energy terms, this means final energy savings of about 200 PJ, which are equivalent to one quarter of the German energy saving target under the ESD.

In November 2005, a coalition of Christian Democrats and Social Democrats was elected as the new German government. The *Coalition Agreement of 11 November 2005 (CDU/CSU/SPD 2005)* reconfirmed the energy efficiency target set in the National Strategy for Sustainable Development in 2002[10], namely

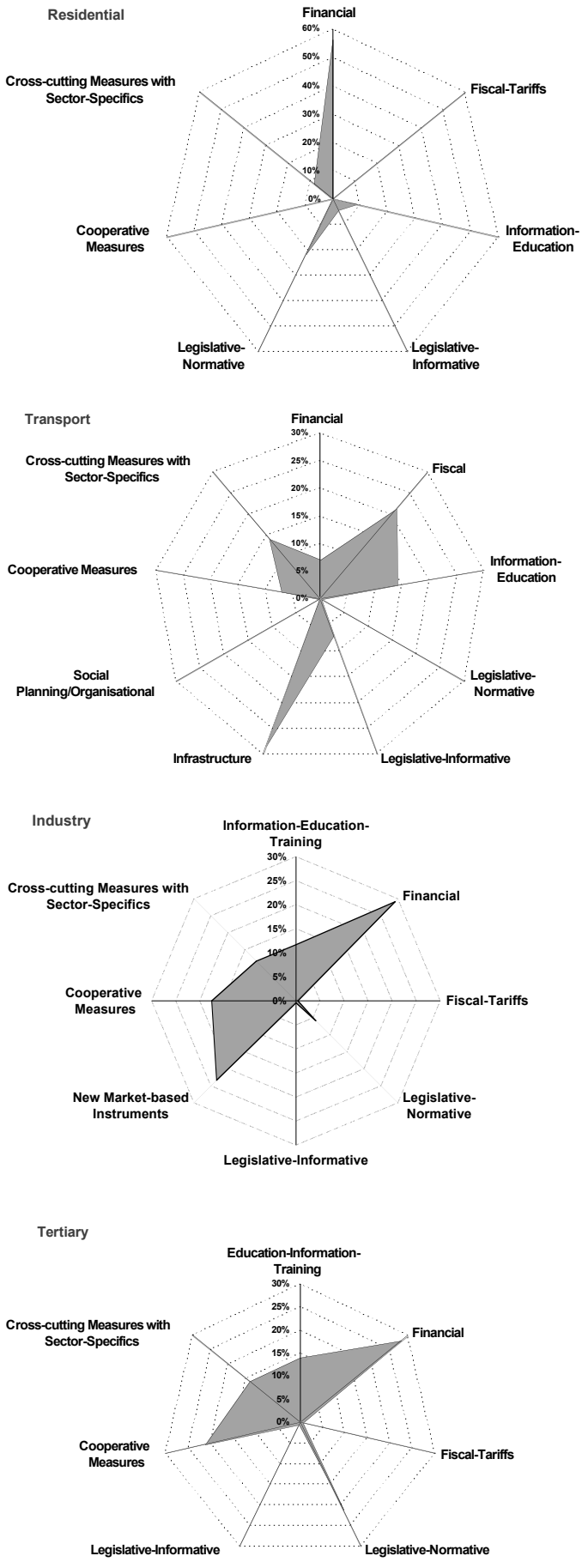

Figure 3. Patterns of policies and measures in Germany 1990-2006. Source: MURE database.

10. http://www.bundesregierung.de/Webs/Breg/DE/Politikthemen/Umwelt/Nachhaltige Entwicklung/nachhaltige-entwicklung.html

a doubling in energy productivity until 2020 compared to the reference year 1990. This means that energy efficiency continues to play an important role for the new government as well. Priority has been given to improving energy efficiency in existing buildings. As announced in the coalition agreement, public funding of the KfW programmes for the energetic restructuring of buildings has been increased to 1.5 thousand million Euro per year from February 2006. Support for European initiatives to improve the energy efficiency of electrical appliances and strengthening the dena campaigns on energy efficiency in buildings, electrical appliances and transport have also been mentioned.

In June 2006, the Federal Ministry of Economics and Technology published a "Proposal for a 10-Point-Programme for more energy efficiency in the end-use consumption sectors" (BMWi 2006). In this programme, possible measures to improve energy efficiency are specified in order to reach the target of doubling energy productivity by 2020. With regard to measures at the national level, the programme mainly comprises a revival or reinforcement of well-established measures and policies with a clear focus on financial measures:

- Improving energy efficiency in existing buildings with financial incentives and the rapid introduction of energy certificates for buildings.
- Promoting innovations in the field of end-use energy efficiency (with a focus on new and existing buildings) using the budget of the BMWi.
- A new KfW financial programme: the Market incentive programme for energy efficiency in industry and the tertiary sector.
- Upgrading the support programme of the BMWi for advice on energy conservation.
- Initiatives of the German Energy Agency (dena) to improve information, motivation and education in the field of energy efficiency. The *Bundesländer* (federal states) are asked to incorporate more energy efficiency aspects into the syllabuses at schools and universities.
- To improve the energy efficiency of electrical appliances, the BMWi will submit proposals for revising and improving the EU-wide energy labelling of appliances. One focus will be on the Japanese "Top runner" approach, which has already been mentioned in the coalition agreement.[11]
- With regard to activities triggered by the EU, the BMWi programme has announced a rapid implementation of the ESD in Germany.

Further energy efficiency measures are mentioned in a Working Paper for the "Energy Summit" of the Federal Government, energy utilities and other energy-related institutions which took place on 9 October 2006 (BMU/BMBF 2006). An "Action Programme Energy Efficiency" (APEE) is proposed in order to better exploit the existing energy saving potentials in the end-use sectors. The priorities are similar to the BMWi programme, with an additional focus on the transport sector (further reduction of the average fuel consumption of new cars by fiscal incentives and a further development of the voluntary agreement by the German automobile industry).

Taking into account these recent energy efficiency programmes of the Federal government and the ministries in charge of energy efficiency and similar policy areas, the main focus of measures in the German Energy Efficiency Action Plan (EEAP) under the ESD will probably be on the building sector (existing and new buildings) and perhaps also electrical appliances. The transport sector could become a second area for energy efficiency measures under the ESD, although the coordination between the different competent ministries is expected to be even more difficult in this sector than in other areas. Up to now, energy efficiency has not been the main target of transport policies in Germany.

When comparing the proposed measures to further improve energy efficiency in Germany with the current patterns of energy policy (Figure 3), it can be seen that they mainly represent a revival or reinforcement of well-established measures and policies with a clear focus on financial measures. Completely new and market-oriented instruments such as e.g. the introduction of White Certificates or the setting-up of an Energy Saving Trust have not been recommended at the political level so far, but only by research institutions.[12]

Conclusions

According to the first provisional calculations of the national energy savings target under the ESD, the energy savings which have to be achieved in Germany in the ninth year of the Directive (2016) amount to 758 PJ of final energy. Since the first Energy Efficiency Action Plan (EEAP), which will also provide an overview of the national strategy for meeting the target, will only be submitted at the end of June 2007, possible additional energy-saving measures in Germany can only be derived from the current proposals for energy-saving measures and climate policy made by the Federal government.

The energy-saving measures included in the current National Climate Protection Programme mainly concern the household and transport sectors. The total CO_2 reduction potential of these measures is estimated to be 15.3 Mt, which is equivalent to energy savings of about 200 PJ up to 2012, or one quarter of the energy savings target under the ESD.

The energy-saving measures proposed in 2006 by the Federal Ministry of Economics and Technology and for the "Energy Summit" of the Federal Government mainly refer to improving energy efficiency in buildings using financial incentives and the rapid introduction of energy certificates, to further improving the energy efficiency of electrical appliances and to financial incentive programmes for more energy savings in the industrial and commercial sectors. According to calculations within the German "Policy Scenarios for Climate Protection" (2004 and forthcoming), energy savings of about 190 PJ can be achieved by efficiency improvements in existing buildings triggered by financial incentives, and additional savings of about 40 PJ by

11. On 29 June 2006, BMWi and dena already organized a workshop on the top runner approach. www.initiative-energieeffizienz.de; www.bmwi.de

12. E.g. the proposed introduction of White Certificates in Germany by the Öko-Institut (Bürger/Wiegmann 2007) or the Energy Saving Fund for Germany suggested by the Wuppertal Institute (Irrek/Thomas 2006).

more energy-efficient electrical household appliances and a reduced standby consumption up to 2016. For the transport sector, the main proposal is to reduce the specific consumption of new cars using fiscal incentives and further development of the voluntary agreement with German car manufacturers. According to recent calculations of the Fraunhofer ISI within the Policy Scenarios, energy savings of 100 PJ at most could be realized up to 2016 by reducing the upper limits of CO_2 emissions of new cars to 130 g/km up to 2012 (and to 100 g/km up to 2030). In total, energy savings of about 300-330 PJ could be achieved up to 2016 by these measures in the residential and transport sectors, the sectors on which measures under the ESD will probably concentrate first. This amounts to about 40 % of the German energy savings target.

According to Annex 1, point 3 of the ESD, energy efficiency measures taken "not earlier than 1995" may be accounted for in the target achievement as "early action". This means that not all the energy savings under the ESD must be from applying new measures, but that energy efficiency measures implemented over the past ten years can also be considered. In Germany, a lot of important energy efficiency measures have been introduced since 1995, especially the eco-tax introduction in 1999, a new Energy Savings Ordinance in 2002 and substantial financial programmes to promote energy efficiency in residential buildings and in the industrial and commercial sectors. According to a first estimate of the Fraunhofer ISI (Eichhammer et al. 2006), early action can contribute "substantially or even significantly" to achieving the target value of the ESD for Germany. The percentage of the ESD's indicative target covered by early action ranges widely, however, from 20 to 70 %. This range is due to the fact that the quality criteria for evaluating the energy-saving measures, or conventions for dealing with free-rider and rebound effects as well as lifetime discounting or cross-sectoral measures such as the eco-tax are not fully defined in the Directive. This will be part of the work of the Committee planned in Article 16 of the ESD which will deal with the concrete form and harmonisation of the ESD's requirements. A realistic contribution of early action to the German ESD target could be a value of 45 % or 340 PJ. This value was calculated in a variant without discounting but which does consider the lifetimes of products with shorter lifetimes such as electrical appliances, eco-tax rebound effects in households and transport (50 % of the eco-tax effect is compensated by rebound effects), free-rider effects in financial-support programmes (20 %), measure overlaps and the autonomous development in electrical appliances.

Taking into account both a realistic value for early action and the possible contribution of already proposed savings measures, the remaining gap to the German energy savings target under the ESD is relatively small (about 100-150 PJ or 15-20 %). This gap can either be closed by further energy efficiency measures in the transport sector, by measures in the industrial and commercial sectors (though the industrial sector is partially excluded from the ESD) or by the introduction of fundamentally new instruments for Germany such as, e.g. White Certificates or the institutionalisation of an Energy Efficiency Fund.

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