From Targets to Impacts: Eight Steps for Evaluating Energy Efficiency Policies

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ABSTRACT

Germany's energy system is currently undergoing a massive transformation. Besides a shift towards renewable energy, energy efficiency is playing a key part in the transformation towards a green energy economy. This is reflected in ambitious energy efficiency targets; the reduction of primary energy consumption by 20% by 2020 and 50% by 2050 (both compared to a 2008 baseline). In order to achieve these targets, the German government introduced new energy efficiency policies. Many of them are funded through the Energy Efficiency Fund (EEF), which is financed by the German government and revenues from the European emissions trading scheme. The EEF overall, and all its individual policies, will be subjected to an independent evaluation process. In order to ensure a homogenous evaluation, the evaluators (the authors of this paper) developed a common evaluation approach. For successful monitoring of energy efficiency policies financed with Federal funds, German law demands monitoring in three areas: (1) target achievement (2) effectiveness and (3) efficiency (cost effectiveness). The evaluation system outlines objectives, indicators and methods. Based on these legal and methodological foundations, we derive an eight-step evaluation approach. This paper describes this approach and outlines how the approach is applied to a specific program that provides funding for energy management systems in companies.

Background and Introduction

The German Energy Transition

In 2010 and 2011, Germany initiated a far-reaching transformation of its energy system, labeled "Energiewende" meaning "energy transition." Alongside intensifying the use of renewable energy, a second key pillar of the Energiewende is reducing energy consumption by increasing energy efficiency. Energy efficiency (EE) is seen as a low-cost and reliable complement to the intensified use of renewable energy and a key pillar of the energy transition in Germany. In 2010, the targets and actions of the energy transition were introduced in the "Energy Concept" program (BMWi and BMU 2010). This program includes ambitious energy efficiency and greenhouse gas (GHG) reduction targets requiring a reduction of primary energy consumption of 20% by 2020 and 50% by 2050 (compared to the base year 2008). The GHG emission reduction target amounts to 40% in 2020 and 80-95% in 2050 (both compared to the 1990 Kyoto Protocol target base year).

For the first time, the German Federal Government set up a monitoring process to track the energy transition on a continuous basis. The key document of the monitoring process, "Energy of the Future," is a yearly monitoring report (BMWi 2015), which quantitatively analyzes Germany's progress toward its targets. The process also includes an independent commission of four well-known energy experts, who provide a scientific opinion on the annual Monitoring Report. (Expert Commission on the Energy of the Future Monitoring Process, 2015). This monitoring process strongly increased attention on improving the Evaluation, Measurement and Verification (EM&V) processes in Germany, especially with regard to energy efficiency.

The Climate Action Program 2020

The demand for improved energy efficiency EM&V was enhanced by the introduction of a set of new energy efficiency and climate policies in December 2014. Since the monitoring process identified a remaining shortfall in meeting the primary 2020 target by around 10 to 13% (Fraunhofer ISI et al. 2014), the German Federal Ministry for the Environment, Nature Conservation, Buildings and Nuclear Safety presented the"Climate Action Programme 2020" in early December 2014 (BMUB 2014). At the same time, the German Federal Ministry for Economic Affairs and Energy (BMWi) presented the "National Action Plan on Energy Efficiency" (NAPE) (BMWi 2014). Both programs include new and further developed policy measures to increase energy efficiency in buildings, industry, services and transport (Ringel et al. 2016; Schlomann et al. 2016). Again, the Federal Government committed itself to the regular monitoring of the success of the roughly 100 policy measures listed in the Climate Action Programme 2020 and NAPE. This is done by a "Climate Action Report," which for the first time was published in 2015 (BMUB 2015). It includes a detailed description of implementation progress and the latest emission trends including anticipated reductions.

The Energy Efficiency Fund

In order to establish a solid foundation for these regular monitoring processes, the most important and impactful energy efficiency policies are separately evaluated by external and independent energy efficiency experts. Many of these policies are financed by the Energy Efficiency Fund (EEF), which is supported by governmental spending and revenues from the European emissions trading scheme. In order to ensure a homogeneous evaluation, the evaluators, who are the authors of this paper, were asked to develop EM&V rules and guidance. The guidance paper was finalized in March 2017 (Heinrich et al. 2017). It is initially intended for internal use only by the Ministry for Economic Affairs and Energy and the external evaluators. In this paper, the EM&V approach developed for the EFF is being made publicly available for the first time.

In the following, we describe the legal foundations and the methodological concepts we have developed for the evaluation of the EFF and its policies. In addition, we outline an eight-step evaluation approach and apply the approach to an individual program, the funding of energy management systems (EMS) in companies. We conclude with some thoughts on the medium- and long-term perspective of energy efficiency in Germany.

Legal foundations for the evaluation of the EFF

The Energy Efficiency Fund (EEF) was established in 2011 with the aim of further exploiting existing energy savings potential in multiple sectors (e.g., private consumers, industry, municipalities). Initial funding equaled EUR 90 million[1] in 2011, and rose to EUR 306 million in 2015. The target groups to be addressed, and the orientation of the individual EE policies to be financed by the EEF, have already been outlined in the German federal government's Energy Concept. At the moment, 23 EE policies and programs are directly financed by the EEF (Heinrich et al. 2017). Among them are

- National funding schemes for the uptake of organizational concepts (energy audits and energy management systems) and the implementation of energy efficient technological solutions (cross-cutting technologies as well as process technologies) in companies.
- Energy advice programs for private households and small and medium enterprises.
- The National Runner Initiative, which bundles measures for speeding up the market penetration of high-quality services and products (top runners) that contribute to reducing electricity consumption.
- An innovative pilot program using smart plugs, terminals or meters for the search of most cost-effective energy-saving technologies and business models. (Blohm 2016).
- A national energy efficiency label for existing heating installations to motivate building owners to replace old, inefficient heating systems and to raise the replacement rate.

In addition, there are other new energy efficiency policy measures in the NAPE, which are financed from other Federal budgets, but will also be evaluated in a similar way as the measures from the EEF (BMWi 2014, Ringel et al. 2016, Schlomann et al. 2016).

[1] 1 EUR = 1.06 USD

The necessity of a thorough evaluation of all energy efficiency policies financed from Federal budgets directly results from Germany's Basic Law, which refers to the regulations of the Federal Budget Code (Bundeshaushaltsordnung – BHO). According to Article 7, measurable BHO goals, indicators are to be mapped as an approach for the cost-effectiveness analysis of funding programs in order to make the extent of target achievement, or the degree of target attainment, measurable. The successful monitoring of financial measures in general consists of three monitoring steps (1) target achievement (2) effectiveness and (3) efficiency.

The monitoring of the target achievement is a comparison of the originally planned objectives with the actually achieved target realization. The effectiveness check determines whether the measure was appropriate and causative. Lastly, the efficiency check is used to determine whether the implementation of the measure is cost effective. These regulatory stipulations form the starting point for the development of a general methodology for the evaluation of energy efficiency policies.

In their statement on the Fourth Monitoring Report of the Federal Government, the Expert Commission on the Energy of the Future Monitoring Process (2015) formulated a proposal for 10 principles for good energy efficiency monitoring. These principles also had to be taken into account for the development of the general guidance for energy efficiency policy evaluations. The expert commission identified the following characteristics of quality energy efficiency monitoring. Quality monitoring:

- identifies the most appropriate policies and programs for the relevant fields of action,
- adopts a suitable system of indicators,
- is based on a sufficiently reliable and up-to-date data ,
- has a suitable methodology to assess the effectiveness of instruments and measures, particularly taking into account endogenous and exogenous factors,
- distinguishes between direct and indirect effects,
- takes account of distributional effects,
- examines whether the effect of instruments is sustainable,
- reviews the efficiency of instruments and measures,
- can itself be implemented efficiently,
- is transparent and neutral.

Based on these binding specifications, we started to develop an evaluation system, which should serve as the overall methodological basis for the evaluation of all energy efficiency measures financed by the EFF and other financial energy efficiency policies from NAPE.

Methodological Approach: Development of the Evaluation System (Objectives, Indicators and Methods)

The evaluation system represents the overall methodological basis and procedures for the evaluation of the fund, or its policies and programs, on a uniform basis. Due to its diversity and heterogeneity, the evaluation system aims at pointing out and describing general approaches and actions, which can then be specified in detail according to the individual programs to be evaluated. The development of the system follows the already mentioned subdivision into objectives, indicators and methods.

Determining of Objectives

An evaluation should make its objectives clear in advance. In doing so, the selection of the objectives is not arbitrary, but depends on the subject of the evaluation. In addition, goals and indicators are closely related. Indicators are intended to provide information on whether, or to what extent, a goal is achieved. This means that targets must meet the same requirements as indicators. They should be comprehensible, accepted, relevant, representative and, as far as possible, measurable.

The objectives together form a target system. This is based on assumptions about effects and /or impact chains for the individual targets as well as their interaction with other programs. Therefore, the objectives and

the target system are the central elements of the evaluation. They are the basis for the implementation of the monitoring of target attainment, effectiveness and efficiency. It is only with the definition of the objectives that the scope of the evaluation can be assessed.

Against the background of the Energy Concept, where the EFF was established, the following key targets were defined for the EFF as a whole and its individual policies and programs:

- Contribution to the development of a highly energy-efficient economy
- Contribution to the achievement of climate protection targets
- Exploitation of the existing economic energy saving potentials
- Exploitation of the existing economic electricity saving potentials
- Decreasing the energy costs of all energy consumers (private households, companies, public institutions).

Definition of Indicators

Indicators are the key element of an evaluation system. The most important task of the indicators is to assess the EE policies and programs according to the three monitoring levels which are demanded by the Federal Budget Code BHO:

- **Target achievement monitoring** - is the first step. It is designed to examine the achievement of the originally defined objectives with regard to the degree of the target attainment (target vs actual comparison). The essential prerequisite is that clear and verifiable goals were defined before the beginning of the measures. To this end, the BHO recommends the definition of the objectives using SMART criteria (specific, measurable, agreed, realistic, timed) and a clear target hierarchy. This monitoring does not take into account the use of resources.
- **Effectiveness monitoring -** is designed to investigate the causality of the measure for the achievement of the target. On this basis, conclusions can be drawn about the suitability of a measure. Here too, the amount of resources used does not matter. In general, a distinction must be made between intentional and unintended effects. The basis for the analysis should be impact chains which logically represent the connection between intervention and the effect or target achievement enabling an empirical-causal-analytic impact research. In particular, the scientific advisory board of the BMWi (2013) calls for the use of the latest scientific findings and methods to achieve objective results and assessments. In particular, it proposes the comparison of treatment and comparison groups, randomized field trials or quasi-experimental evaluation methods.
- **Efficiency Monitoring**-- analyzes whether the use of resources for a measure overall is economical in relationship to the achievement of the main objectives. The implementation efficiency is closely related to whether the measure is efficient in terms of its resource consumption (cost effectiveness). Ultimately, the management of the funding budget is the focus of the investigation.

In our evaluation system, we distinguish between quantitative and qualitative indicators for the different levels of monitoring. Quantitative indicators are the preferred variant. They are mainly applied to the measurement of the resulting energy, GHG emissions and cost savings of a measure. The starting point is the new annual saving. From the annual savings, further summary values can be calculated: cumulative annual savings, cumulative savings over a specific evaluation period, or cumulative savings taking into account the lifetime of an energy efficiency measure (Figure 1). ^

Qualitative indicators are used when the determination of quantitative values is either impossible or only possible to a very limited extent. This is the case, for example, if the indicators are very complex for specific objectives; the indicators are only measure-specific; or if there are methodological reasons against a quantitative survey.

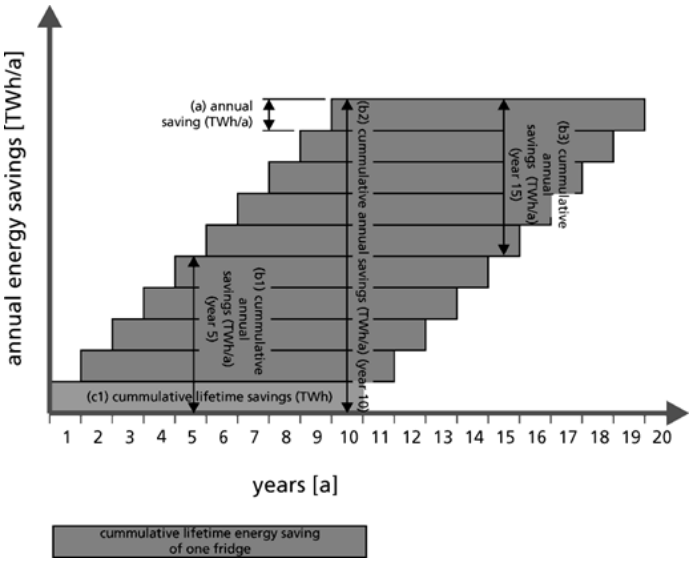

Figure 1. Possible accounting methods for energy savings over time. *Source:* Schlomann et al. 2015.

Suitable indicators have to be defined for all levels of monitoring:

(1) Indicators for target achievement (category A)

The indicators for the target achievement describe the degree of implementation of the objectives originally defined. It is essential to take into account that starting from the implementation of the measure to the recording of the effects is a multi-stage process.

(2) Indicators for effectiveness monitoring (category B)

The causality of the measures for the target achievement is relevant for the effectiveness monitoring. The indicators must therefore reflect the evaluation question as to the extent to which funded activities are responsible for certain values of the indicators and whether, for example, free-rider effects are overlapping with other measures (such as other funding programs) and influencing results. Consequently, the extent of the value of an indicator actually results from the measure itself or from other reasons analyzed.

(3) Indicators for efficiency (cost effectiveness) monitoring (category C)

On the basis of the indicators for the assessment of efficiency, the use of governmental funding is to be compared with the results obtained through the funding. According to Federal Budget Code BHO, it is necessary to respect the principles of efficiency and frugality in all administrative actions. For funding programs, in particular, the overall economic assessment explanations are relevant.

Table 1 summarizes the selected indicators for the different levels of monitoring in the evaluation system.

An extensive collection of information is required to identify the indicators presented above. Before showing possible data collection methods for a specific EE measure, we recommend for some factors to make joint and thus comparable framework assumptions. This is especially important if, as in the case of the EFF, more than one measure is evaluated. For the evaluation system developed here, we recommend standardized values at least for the following framework assumptions: energy costs, emission factors, primary energy factors, interest rates and lifespans as well as the duration of the actions.

Table 1. Overview of indicators for the different monitoring levels

Level of monitoring	Indicator
A. Target achievement monitoring Lead question: What is the actual degree of target attainment for planned targets?	
Contribution to an energy-efficient economy	Degree of the contribution of EFF (qualitative)
Contribution to the achievement of climate protection targets	THG-Minderung [t CO2-äq.] GHG reduction (t CO2eqv.)
Exploitation of energy savings potentials	Reduction of final energy consumption (MWh) Reduction of fuel and electricity consumption (MWh) Reduction of primary energy consumption (MWh)
Reduction of energy costs	Achieved energy cost saving (EUR)
B. Effectiveness monitoring Lead questions: Is the measure causative for the target achievement? Is it suitable for this? How do unintended effects, indirect effects and interactions appear?	
Disclosure of gross and net values for quantitative indicators via an adjustment of effects.	
C. Efficiency (cost effectiveness) monitoring Lead question: Is the use of the funding economical in regard to achieving the main targets (measure efficiency) and the resource consumption (execution efficiency)?	
Funding efficiency (view: funding body)	GHG-funding efficiency (t CO2eqv./EUR] Energy-funding efficiency (MWh/EUR]
Bureaucracy and execution (view: funding body)	Costs for measure execution per saved GHG (t CO2eqv./EUR) / per saved energy (EUR/MWh)
Bureaucracy and execution (view: funding body)	Costs for measure execution per funded case (EUR/case)
Leverage effect	Ratio triggered investment volume to funding volume

Methods for data collection and analysis

The third core area of the evaluation system is the data collection and analysis. The choice of the concrete methods cannot be generalized, but depends on the type of the EE measure to be evaluated and the data availability in the specific case. Figure 2 shows the broad spectrum of methods that are available for data collection and analysis.

Within the framework of the collection of data, three different ways of data generation are distinguished:

- primary statistical data collection, which is carried out specifically with regard to the specific question
- secondary statistical data collection, which uses existing data (e.g., data from publicly available statistics)
- tertiary statistics data collection, if the data are presented only in aggregated and compressed form (e.g., mean values)

With regard to data analysis, the central question is what effects the respective measures have in the relevant target groups. Here, the estimation of causal effects, that is, an unambiguous relationship between causes is paramount. The purpose of the analysis of data is therefore to investigate whether the cause leads to one or more effects on the target group and the degree of the effect. As highlighted in Figure 2, various statistical methods are available for this purpose (e.g., univariate, bivariate or multivariate analysis or the comparison of groups (see Figure 2). In principle, not all procedures are equally suitable for each of the measures to be evaluated. The selection of the method is decisively influenced by the research questions which are relevant for the respective measure and which data can be collected cost effectively.

An important methodological issue with regard to energy efficiency evaluation is the adjustment of energy saving indicators for effects not causatively linked to the measures. As a result, this may lead to an overestimation or underestimation of the measure impact (Eichhammer et al. 2008, Thomas et al. 2012, Schlomann et al. 2015). In the evaluation system, we therefore distinguish between gross and net effects. The gross effect should be determined in such a way as to cover the overall effect (impact) of the measure. The net effect is adjusted to give an overview of possible effects that have to be taken into account for the calculation of a measure's net effect

(see Table 2). Compared to the gross effects, the net effects are decisive for the assessment of the measures from the point of view of effectiveness

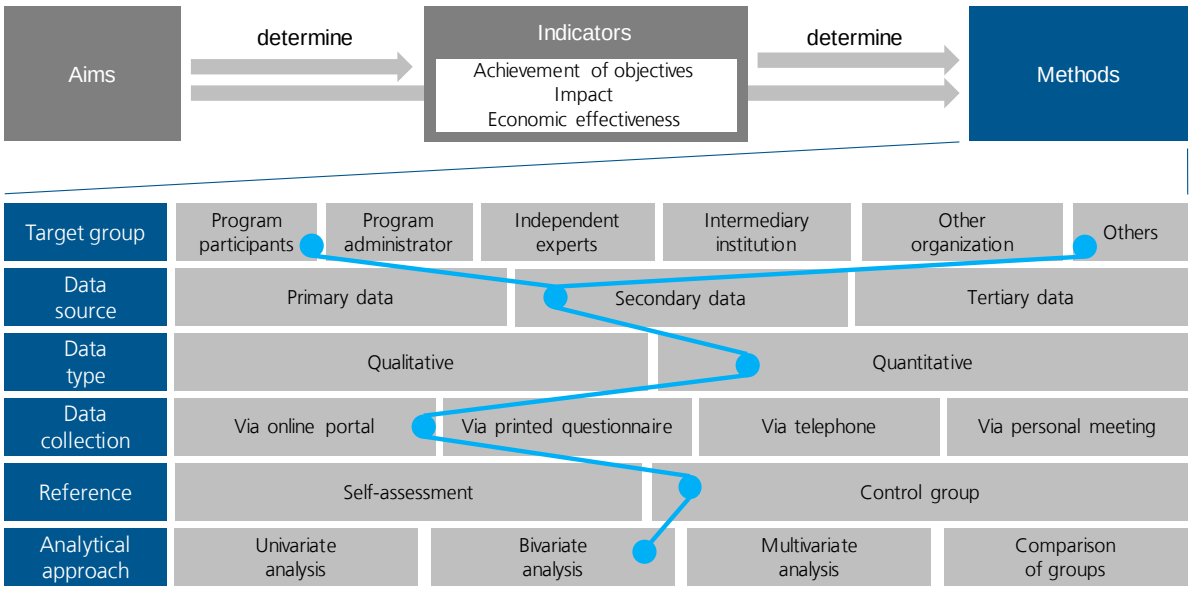

Figure 2. Overview of the broad spectrum of methods for data collection and analysis.

In addition to the adjustment of the effects of measures, the projection and backward extrapolating of indicators is a methodologically relevant area. Such a temporal projection is usually required if, due to different, mostly economic considerations, it is not possible to collect complete data sets for individual evaluation periods. Suitable methods are trend extrapolation, linear projection or a projection of central driving factors (e.g., the number of applications submitted in a program).

Table 2. Adjustment of effects

Impact / Effects		Description
	Gross impact	Impact before considering effects
-	Free-rider effects	Saving would have occurred without saving policy
+	Follow-on effects	Effects through not yet completely realized actions
-	Pull-forward effects	Effects through earlier implementation of actions
+/-	Structural effects	Effects through changes of central structure variables
+/-	Transfer effects	Effects through the transfer to third parties and other areas
+/-	Double-counting	Effects through interactions of measures
-	Rebound effects	Effects through additional consumption as a result of energy cost savings
=	**Net impact**	Impact after adjusting for effects

Results

Derivation of eight steps for evaluating EE policies

Based on the methodological consideration in the former section, we derived the following eight-step approach for the evaluation of EE policies:

(1) Characterization of the policy measure: What are its main characteristics (e.g., in terms of budget, target group)?
(2) Definition of framework conditions: What general parameters are used for the analysis (e.g., energy price assumptions, emission factors?)
(3) Review of the measure's targets: What types of targets have been defined (e.g., in terms of expected savings, size of the target group)?
(4) Translation of targets into indicators: Which indicators can be used to measure the achievement of targets (e.g., in terms of impact, economic performance)?
(5) Data collection: Which type of data is required for the indicators and how to obtain this data (e.g., by surveys, review of reports)?
(6) Data analysis: What methodology can be used to analyze the impact (e.g., descriptive or analytical methods)?
(7) Net impact estimation: Which side-effects need to be considered, or eliminated, for computing the net impact (e.g., free-rider, structural, distributional, economic or rebound effects)?
(8) Projection of impacts: In which way can the net impact be forecasted and backcasted?

Application of the eight-step approach

Finally, we will apply the eight-step approach to one specific program within the EFF, the financial support of the introduction of energy management systems (EMS) in companies. Energy management systems are an important tool to incentivize companies to systematically record and assess their energy efficiency potential, as well as to exploit them independently while considering cost effectiveness. These actions form a basis for the implementation of energy policy, energy targets and the establishment of processes and procedures to achieve program goals (International Standardization Organization 2011). The widespread promotion of EMS was already announced in the Energy Concept from 2010 (BMWi and BMU 2010). The main results of the evaluation are summarized below using the eight-step approach (Nabitz et al. 2016).

Step 1: Characterization of the policy measure.

Since July 2013, the Federal Ministry of Economics and Energy (BMWi) has been funding the initial certification of EMS according to ISO 50001 ((International Standardization Organization 2011) or an alternative system. This includes the procurement of measuring, metering and sensor technology for EMS as well as the acquisition of software. Additionally, since March 2015, both external consultations and expenditure on the training of employees to become energy managers have been eligible for funding.

Step 2: Definition of framework conditions.

All framework assumptions on energy prices, emissions, interest rates, product lifespans and duration of the action were taken from the methodological guidance (Heinrich et al. 2017) in order to ensure comparability with the evaluations of other measures of the EFF.

Step 3: Review of the measure's targets.

With regard to the objectives of the EMS program, the definition of two key targets can be extracted from the Energy Concept (BMWi and BMU 2010) and the explanations in the funding guidelines. The Energy Concept defines the funding of energy management systems adapted to operational requirements (especially for small and medium-sized companies) as a goal. This main objective is further substantiated in the funding guidelines.

Step 4: Translation of targets into indicators.

For the evaluation of the EMS program, all indicators proposed in the methodological guidance (Table 1) could be applied and calculated based on the data collected for the program.

Step 5: Data collection.

The evaluators were provided with a comprehensive data base of the application and funding statistics for 610 companies by the program implementer, the Federal Office for Economic Affairs and Export Control (BAFA). In addition, the evaluator carried out three different online surveys with funded and rejected applicants (Table 3).

Table 3. Data collection for the evaluation of the EMS program

No.	Database / Survey	Sample	Return rate
1.	BAFA application and funding statistics	n = 610	-
2.	Survey in companies already participating in the EMS program	n = 391	62%
3.	Survey in companies whose applications were refused by BAFA	n = 56	30%
4.	Survey in companies whose applications were canceled by BAFA	n = 45	47%

Decisive for the evaluation of the impact of the funding program are both the number of technical (and organizational) EE measures undertaken as well as the level of activity of the companies in the individual technology areas. To this end, the survey looked at both the number of EE measures identified and implemented as well as the activity within the following technology areas: electric drives, compressed air, pumps, process cold, process heating, building heating, building isolation, lighting, information and communication technologies.

Step 6: Data analysis.

For the analysis of data, the methods described in the methodological guidance were used (Figure 2). Due to the relative small samples (Table 3), only descriptive statistical methods were applied. For example, with regard to the adoption of EE measures, an average of 4.8 measures (median: three measures) per company participating in the program were implemented in the various technology sectors. The average rate of adoption (defined as implemented EE measures as a percentage of the total recommended EE measures) amounts to 53.3% (median = 50%).

Step 7: Net impact estimation.

In the evaluation of the EMS, both gross and net effects were taken into account (Table 3). However, a quantitative adjustment could only be made for the free-rider effect. Within the framework of the survey, the companies were asked whether they would have implemented the measures without the financial support. Based on these data, we estimated the free-rider effect. 68.7% of the companies that used the energy management system's funding stated that they would have introduced the system to the same extent at the current or a later date without the funding from the program.

Step 8: Projection of impacts.

The present evaluation was limited to the period 2013-2015. Therefore, no projection of results was made. But in principle, a projection of data is possible based on the survey results and statistics available from BAFA.

Summary of evaluation results

As mentioned above, all indicators proposed in the methodological guidelines for the different levels of monitoring could be calculated (Table 1). In Table 4, the main quantitative results of the evaluation are summarized for the target monitoring (category A) and the efficiency monitoring (category C). The effectiveness monitoring (category B) is implicitly made by an adjustment of effects.

In addition to these quantitative indicators, the general procedure of the funding program was evaluated in a qualitative way, using a scale of 1-5. The procedure was assessed very positively from the applicants' point of view. Over 50% of the applicants are "very satisfied" or "rather satisfied" with the administrative aspects of the program. Although a relatively large number of applications had to be refused or canceled, BAFA felt the program ran smoothly. The average application processing time were extremely low at 2 weeks. This is also reflected in the high satisfaction of the applicants.

Conclusion

In our paper, we presented methodological guidance for the evaluation of EE policies in Germany, which should be applied in the evaluation of all measures financed by the EFF and preferably for other new policies implemented during the last two years. The aim is to calculate key indicators in a homogenous way, so that the evaluation results are comparable and can be added. At the moment, only a few measures are already evaluated using the proposed methodology. We presented the results of the evaluation of the EMS program within the EFF. The available results are promising. We showed that all proposed indicators could be evaluated, many of them in a quantitative way. One of the most important methodological challenges will probably be the adjustment of the gross impact of a measure. In the EMS evaluation, it was only possible to collect data to determine quantitatively the free-rider effect.

With regard to the overarching monitoring process of the energy transition, the increasing evaluation of the most important EE policies according to a common methodology will considerably improve the database for this process. However, in spite of a substantial number of new EE policies implemented during the last two years, there is still a gap in reaching the national primary energy targets in 2020 and 2030. This assessment is based on the results of recent energy scenarios. As a result, there is an ongoing discussion of additional EE policies which may be needed to reach the ambitious medium- and long-term energy and climate targets in Germany and thereby also to contribute to the climate agreement reached at the climate conference in Paris.

In August 2016, the Federal Ministry of Economics and Energy launched a discussion paper on energy efficiency policy in Germany beyond 2020 (BMWi 2016). The Green paper asks how the existing range of instruments in energy-efficiency policy can be further developed and supplemented in order to enable Germany to reach its target of reducing primary energy consumption by 30% by 2030 and by 50% by 2050. The Green paper mentions options such as price-based instruments (e.g., energy charges and taxes) and volume-based instruments (e.g., energy utility obligations). In addition, a new Climate Action Plan 2050, which was submitted in November 2016 (BMUB 2016), also contains a set of strategic measures in order to further improve energy efficiency in all sectors and areas of action (e.g., buildings, private households, industry and services, transport). For the evaluation of these expected new policies in the field of energy efficiency, the methodological guidance developed in this paper will also hopefully be applied.

Acknowledgements

This paper is based on a research project funded by the Ministry for Economic Affairs and Energy (BMWi). We thank the representatives from the ministry for the support of the study and for the fruitful discussions during the work on the project. We also thank the three reviewers for their helpful comments and linguistic improvements as well as Katherine und Alexander Mahler for their support on the translation of the German report.

Table 4. Summary of indicators for the EMS funding program in Germany (evaluation period: 2013-2015)

Indicator	Unit	Accounting method	Gross impact	Effects	Net impact
A. Target achievement monitoring Lead question: What is the actual degree of target attainment for planned targets?					
Contribution to the achievement of climate protection targets	GHG reduction [t CO_2-eqv.]	New savings	43,430	29,836	13,594
		Period savings	130,290	89,508	40,782
		Lifetime savings	616,190	423,323	192,867
Exploitation of energy saving potentials	Reduction of energy consumption [MWh_{final} / $MWh_{primary}$]	New savings	102,770/ 189741	70,603/ 130,352	32,167/ 59389
		Period savings	308,307/ 569,222	211,809/ 391,058	96,501/ 178,167
		Lifetime savings	1,686,460/ 2,683,544	1,158,598/ 1,843,594	527,862/ 839,949
Reduction of fuel consumption	Reduction of energy consumption [MWh_{final} / $MWh_{primary}$][2]	New savings.	43,774/ 48,151	30,072/ 33,079	13,701/ 15,07
		Period savings	131,319/ 144,450	90,218/ 99,239	41,103/ 45,214
		Lifetime savings	1,049,200/ 1,154,120	720,800/ 792,880	328,399/ 361,239
Reduction of electricity consumption	Reduction of energy consumption [MWh_{final} / $MWh_{primary}$][3]	New savings	58,996/ 141,590	40,530/ 97,272	18,465/ 44,317
		Period savings	176,988/ 424,771	121,590/ 291,818	55,397/ 132,953
		Lifetime savings	637,260/ 1,529,424	437,797/ 1,050,714	199,462/ 478,709
Reduction of energy costs	Achieved energy cost reduction [EUR]	New savings.	-	-	-
		Period savings	7,792,950	5,353,757	2,439,193
		Lifetime savings	-	-	-
C: Efficiency monitoring Lead question: Is the use of the funding economical in regard to achieving the main targets (measure efficiency) and the resource consumption (execution efficiency)?					
Funding efficiency (view: funding body)	GHG-funding efficiency [t CO_2eqv../EUR]	Period savings	0.056	0,038	0,018
		Lifetime savings	0.264	0,181	0,083
Funding efficiency (view: funding body)	Energy funding efficiency [MWh/EUR]	Period savings	1.323	0,909	0,414
		Lifetime savings	7.235	4,970	2,265
Bureaucracy and execution (view: funding body)	Costs for measure execution per saved GHG [EUR/t CO_2-äq.]	Period savings	1.739	1,195	0,544
		Lifetime savings	0.366	0,251	0,115
Bureaucracy and execution (view: funding body)	Costs for measure execution per saved energy [EUR/MWh]	Period savings	7.322	5,030	2,292
		Lifetime savings	1.339	0,920	0,419
Bureaucracy and execution (view: funding body)	Costs for measure execution per funded case [EUR/case]	Period savings			169
Leverage effect	Ratio triggered investment volume to funding volume	Period savings			2.76

[2] Assumption: primary energy factor of 1.1

[3] Assumption: primary energy factor of 2.4

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