Evaluating energy policy instruments using outcome indicators

Lena Neij
International Institute for Industrial Environmental Economics
Lund University
P.O. Box 196, 221 00 Lund
Sweden
Lena.Neij@iiiee.lu.se

Kerstin Åstrand
Department of Environmental and Energy System Studies
Lund University
Gerdagatan 13, 223 62 Lund
Sweden
Kerstin.Astrand@miljo.lth.se

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Abstract

The aim of this discussion paper is to suggest a framework for the evaluation of policy instruments designed to affect development and dissemination of new energy technologies, e.g energy efficiency technologies. The proposed evaluation approach is based on the analysis of policy outcome as a complement to the more conventional impact assessments, e.g. saved energy and emission reductions. With the suggested evaluation approach policy instruments are analysed based on selected *outcome indicators*. Outcome indicators allow analysis of the *outcome scope*, i.e. describing changes in the socio-technical energy system. The different phases of an outcome-based evaluation process are presented and the advantages and disadvantages of the proposed approach are discussed. Disadvantages associated with the approach are for example complexity, possible high cost and the requirement of qualified evaluators. Despite these shortcomings, it is argued that evaluations using outcome indicators have several advantages compared to more traditional evaluations focused on impact assessment. The main argument is that the information of the continuous performance of policy instruments and their effects on the introduction and dissemination of new energy technologies, provided by this evaluation approach, is essential for an improved adoption and implementation of energy and climate policy.

Introduction

A core issue for climate policy is the design, implementation and evaluation of policy instruments[1] that have an effect on *technical change* in the energy field; e.g. development and dissemination of new energy technologies for more energy efficient end-use. The commitments to the Kyoto Protocol have especially enhanced the interest of processes and methods used for evaluation. Evaluations are important for verification of the results but also for enhanced understanding of ongoing policy processes and technical change.

Evaluations for verification of the results of policy instruments are often focused on *effectiveness*, which conventionally have been measured in terms of impact, i.e. saved energy and reduced emissions. Nonetheless, the conventional evaluations, analysing impact, does not provide any information on *how* the policy instruments do, or do not, affect an ongoing policy processes and the process of technical change. To capture the process of technical change, traditional evaluation approaches need to be further developed.

The aim of this theoretical paper is to present an alternative framework for the evaluation of energy policy instruments and technical change. This approach focuses on the *outcome* of policy instruments, i.e. changes in the system caused by the policy instruments, rather than the final im-

1. In this paper both "policy instruments" and "policy programmes" are mentioned. Here, a "policy instrument" is a technique for governance, whereas "policy programmes" can include one or combinations of several instruments.

pact achieved in terms of e.g. emission reductions and energy savings. It is proposed that the changes in outcome should be analysed applying *outcome indicators* and an *outcome scope*, i.e. describing changes in outcome in the socio-technical energy system. The socio-technical system will be different for each energy-efficient technology embraced by the policy instruments, which means that different outcomes indicators will be used for different technologies and their socio-technical system, see text below. The objective of the suggested framework is to improve and complement conventional evaluation methods analysing policy instrument effectiveness.

The work presented in the paper is part of research in progress, conducted by the authors.

Evaluation of outcome

The model in Figure 1 shows the important role of feedback between public policy programmes and the society (unbroken line). The model demonstrates how problems, needs, and issues, defined by the society, are the base for the outline of public policy programmes. At programme level political decision makers set up goals for the programme; *objectives*, and decide on *input*, e.g. resources (e.g. financial, human, time) and guidelines shaping the policy instrument. The *output* refers to what comes out of the governmental administration, such as e.g. of subsidies, audits and trained personal (see e.g. Vedung, 1998,). In the model, *outcome*, describes the response to policy interventions by actors and organisations and changes in the socio-technical system. Such changes may, in turn, have an *impact* on the society and environment, such as saved energy and reduced emissions. *Evaluation*s (broken lines) can result in knowledge that redefines problems and needs, which in turn may lead to modified policy decisions and improved policy instruments.

As mentioned earlier, evaluations of energy policy instruments have to a large extent been focused on the effectiveness measured through assessment of the aggregated impact on the environment and society – i.e. to what degree the impact meets the objective of the policy programme. A crucial problem is that evaluations of impact do not provide any information on how the policy instruments do, or do not, affect the process of technical change. Moreover, the final effect of policy instruments, which will be the result of several changes in the energy systems referred to as outcome, may take considerable time. Due to this, the evaluation of effectiveness, as well as the understanding of policy intervention, will improve if the evaluation also takes into account the outcome and the changes in the socio-technical system affected by the policy programme.

Evaluation with outcome indicators based on a socio-technical systems approach

As described above, the authors propose the evaluation of outcome to improve and complement evaluations of technical change. However, introduction and dissemination of new energy efficient technologies is a complex process that is not limited to changes in technology only. In system analysis, it is argued that technology cannot be separated from its social context; there is a "seamless web" that keeps technology and society together, to use a metaphor by Bijker, Hughes and Pinch (1987). This means that technological change involves changes in the entire *socio-technical system*, i.e, the technological system, actors (i.e. organisations, authorities and individuals), institutions[2] and the economic and political framework of the system. For this reason, evaluations of policy programmes, implemented for stimulation of techni-

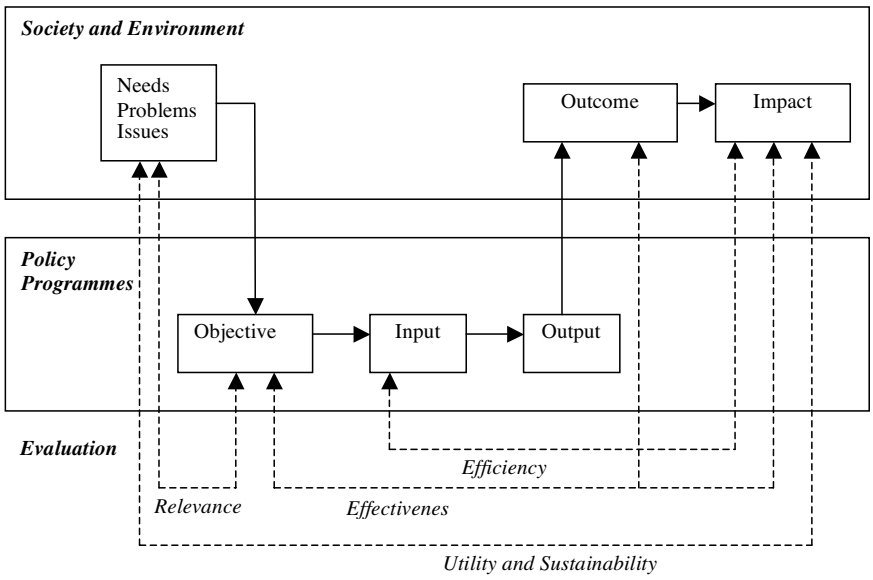

Figure 1. *Schematic model of a public policy process and evaluation. (The figure is an adaptation of a framework originally developed by the EEA, 2001).*

2. Institutions are here described in a broad way referring to informal conventions, formal constitutions and organisational structures, such as established practice, rules, laws and regulations, common habits and routines.

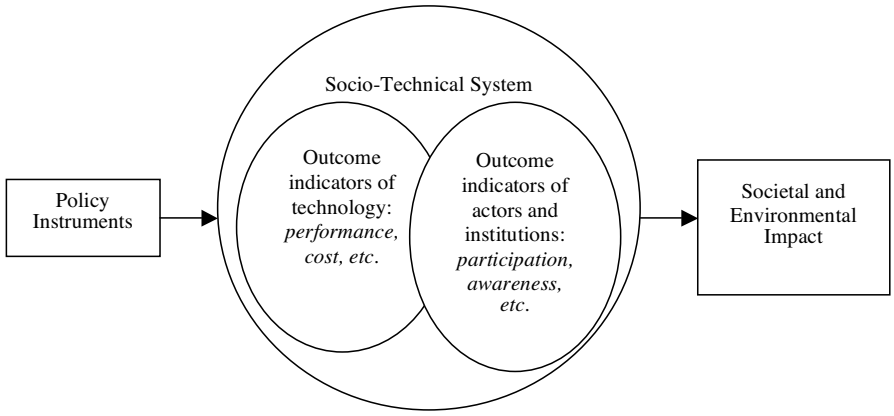

Figure 2. *Schematic figure of outcome indicators used to monitor changes in a socio-technical system.*

cal change need to address changes, i.e. outcome, in the entire socio-technical system.

To capture the changes in outcome the use of "outcome indicators" is suggested, which relates to evaluation parameters that describe changes of core issues in a socio-technical system, i.e. central aspects of a system that are vital for a technical change process. Based on the definition of a socio-technical system given above, such vital issues should at least address changes in the technological system, actors, institutions and the economic and political framework of the system. Examples of outcome indicators used for analysing changes in the technology system are: the technology concepts applied, the efficiency of the technology and cost. Outcome indicators used for the analysis of actors and institutions describe for example, participation and changes in knowledge, behaviour and awareness, see Figure 2.[3] The outcome indictors tell us where changes have been observed, what type of changes have occurred and about non-changes in the socio-technical system.

The use of parameters that can be referred to as "outcome indicators" was introduced in the 1990s and often referred to as market transformation indicators (see for example Prahl and Schlegel (1993), Feldman (1994-1996), Rosenberg (1995) and Neij (2001). In contrast to the previous use of outcome indicators we suggest that the indicators should not only provide information about changes of isolated effects, they should also provide information about the *outcome scope*, i.e. changes in the entire socio-technical system. The evaluations of isolated effects are not sufficient if the width of policy interventions is to be understood. An evaluation considering outcome scope may reveal that e.g. the design of the policy instruments is too limited and does not cover essential parts of the socio-technical system, e.g. essential technology concepts, infrastructure, actors or organisations. It is also possible that the policy instruments address the relevant parts of the socio-technical system but still do not result in the intended effects.

Another important aspect of the outcome evaluation approach is that it allows the evaluation to take *institutional change* into account, i.e. established practice, rules, laws and regulations as well as common habits and routines. Especially, it is of great interest to evaluate, to what extent institutions, related to governmental authorities and their activities, have changed and how this process of change has interacted with the development and dissemination of new technologies.

Which outcome indicators to select for the evolution of policy programme outcome depends on the kind of technology the policy programmes focus on. Each technology relates to a specific socio-technical system with its own characteristics. Since socio-technical energy systems are dynamic and may change in a direction that was not foreseen, the actual outcome indicators selected for an evaluation may very well have to be change over time. If the outcome indicators do not address relevant issues, there is a risk that the success or failure of policy instrument can not be fully understood.

In summary, evaluations based on the use of outcome indicators is a tool that can provide in-depth information which improves the understanding of how to bring about technical change, how to redesign an ongoing policy programme and how to design future policy instruments for the introduction and dissemination of new energy technologies.

The process of outcome evaluation

A systematic evaluation approach is often divided into the processes of *planning*, *monitoring* and *assessment* (Vedung, 1994, 1998; Weiss, 1998; Rossi et al., 1999; SRC et al., 2002). When applying a focus on outcome, outcome indicators need to be considered in each of the phases, as illustrated in Figure 3. In this section an evaluation framework is suggested in which outcome indicators are built into the evaluation process.

The *planning* process of evaluations, based on the use of outcome indicators, involves issues such as system characterisation, the identification of relevant outcome indicators and the estimation of pre-programme values of the selected

3. Additional types of outcome indicators can be used to analyse changes in the market, e.g. changes in product availability, the market share of the product, the provision of codes and standards, the percentage of eligible facilities that participate in the programme, the number of manufacturers entering the market, the number of manufacturers brining new models into production. The indicators could also be business oriented and describe changes in promotional practice, business strategies, offered ser.ice, changes in stocks and distribution practices.

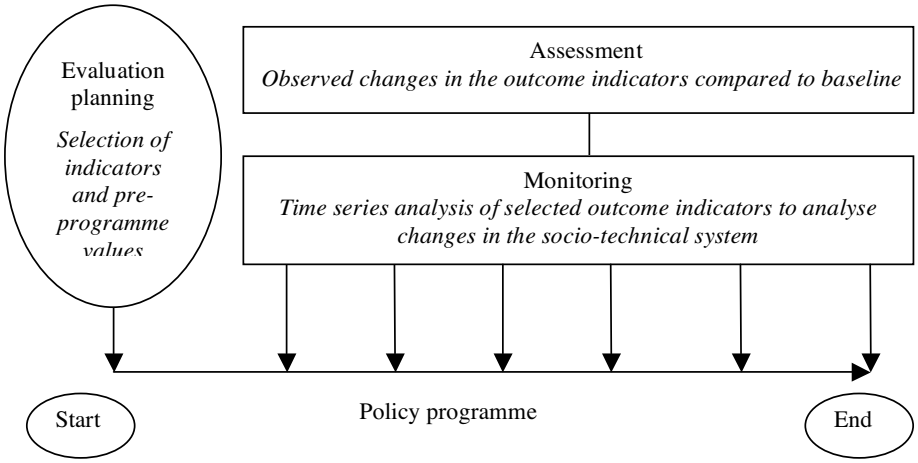

Figure 3. *Schematic figure of the structure of evaluation based on outcome indicators.*

outcome indicators. When identifying the indicators, characterisation of the socio-technical system is important since the process of technical change may be different for different types of energy technologies. When planning evaluations each socio-technical system must be seen as unique. Moreover, the selection of outcome indicators should reflect the individual characteristics of each energy system and consider items such as the dynamics of technology development, possible clusters of technologies, compatibility, risks associated with technical change, critical development of actors, etc. The selection of the outcome indicators should also take into account the availability and quality of data and relevant collection methods.

The planning process also concerns trend analysis of the selected outcome indicators, the development of a *baseline*, estimation of the potential outcome of the programme and definition of the goal of the project. The development of the baseline is of major importance and must to be central in the evaluation process; the baseline, which shows the autonomous change in the outcome indicators of the socio-technical system, will make it possible to analyse the actual effect of the policy instruments. An initial baseline, based on the selected outcome indicators, should be developed in the planning phase. However, the baseline may also be corrected over time due to changes in initial assumptions in any important underlying parameter (e.g. economic growth and effects due to other measures).

The *monitoring* process includes the systematic analysis of changes in the chosen outcome indicators, describing changes in technology, actors and institutions over time. The scope and frequency of the monitoring process will have a cost. Moreover, the monitoring process also has a *time* aspect that will be different for different technology systems; longer turnover effects may result in a slower process of technical change. A specific monitoring method will be required for each outcome indicator. Methods for the analysis of changes in actors' behaviour may include interviews, consumers billing records, consumer surveys, end-use metering, short-term monitoring, etc. Methods for the analysis of technology and market development may also include interviews as well as market surveys, site visits, manufacturers' sales reports, product catalogues, price lists, product reports, etc. The methods used will depend on the socio-technical system and the outcome indicators selected.

The *assessment* phase, which is built on the results of the monitoring phase, includes the evaluation of the observed changes in the selected outcome indicators in relation to a baseline. The changes in the outcome indicators in the assessment phase will describe the important changes in outcome scope. These results can then be used to improve the understanding the success and failure regarding the impact of the programme; e.g. achieved energy savings and reduced emissions.

The proposed evaluation framework provides information about the continuous performance of policy programmes and their combined effects on the introduction and dissemination of new energy technologies. This information is essential for an improved adaptation and implementation of energy and climate policy.

Empirical experiences from evaluating outcome scope

The experience from applying parameters that can be considered to be outcome indicators and outcome scope in energy programme evaluations is limited. In this paper we would like to highlight two evaluations that have been based on outcome indicators and to some extent also outcome scope.[4] The first case is the evaluation of energy efficiency and the Technology procurement programme in Sweden (see Neij, 2001). The second case applying outcome scope is the evaluation of wind energy policy in Sweden for the development and dissemination of wind energy and wind turbines. For this case outcome indicators and an outcome scope has been applied evaluating the programme. (Due to the focus on energy efficiency of this conference we will not go into details with this evaluation. For further information see Åstrand and Neij (2004)).

4. For a more comprehensive discussion see Neij and Astrand (2005).

In the case of energy efficiency and technology procurement, parameters identified as outcome indicators were used for evaluation already in the 1990s (see Neij, 2001). The Technology procurement programme aimed for stimulation of development and commercialisation of new products for efficient energy end-use, *such as combined refrigerator-freezers, HF-lighting systems, energy efficient windows. The out*come indicators were used to monitor the process of technical change continuously during the programme period. The first evaluations used parameters that described improved technological performance and price reduction. Over the years the parameters were expanded to include sales data, market share, changes in manufacturers' assortment, and change in knowledge, attitudes and behaviour of important actors (Neij, 2001). The outcome indicators to some extent illustrated the outcome scope of the policy programme, i.e. how the combination of policy instruments, based on technology procurement and complementing instruments, approached, committed and integrated several actors in the technical change process. The overall benefit with the outcome approach in these evaluations was that it could be shown that the policy programme initiated and supported technology change. The outcome indicators also showed failure in the process of technical change. This knowledge was used by policy-makers to redesign or terminate policy intervention. For example, in the programme of new air-handling units the outcome indicators provided information that indicated failure which resulted in the termination of further policy intervention.

Concluding discussion

The authors of this paper have presented a framework for the evaluation of policy instruments and their effect on technical change. The framework is based on the analysis of outcome rather than impact. The reason to this is to improve the understanding of the process of technical change and the effects, and non-effects, caused by the policy instruments.

The method is based on the monitoring and assessment of selected outcome indicators that describe changes in scope of the socio-technical system of a certain technology. This use of outcome indicators captures the complexity of development and dissemination of new energy technologies. The traditional evaluations of impact, based on aggregated final results, do not provide enough relevant information on changes in the socio-technical system. The outcome indicators tell us where changes have been observed, what type of changes do occur and help us to analyse the effects of the policy instruments.

The method suggested provide several advantages, however the authors also recognise some difficulties using this method. Like many other evaluation methods, this method cannot be used to single out the effects of individual policy instruments. The use of outcome indicators can be complex and the indicators chosen need to be simple, responsive to changes, reliable and representative. Moreover, the data collection and documentation requires national resources, which can be costly in the short-run. The use of outcome indicators also demands the input of qualified evaluators and administration. However, in the long-run these costs may very well pay off in terms of greater efficiency of the design of the policy programmes.

Despite the shortcomings, the benefits of using outcome indicators could be considerable. The use of outcome indicators is of interest for further policy intervention and is a method that should be further applied, developed, discussed and analysed.

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Appendix 2: Sample Energy Policies. Appendix 3: ENERGY STAR Energy Tracking & Benchmarking Tools. Appendix 4: Normalizing Data.Â Assessing performance is the periodic process of evaluating energy use for all major facilities and functions in the organization and establishing a baseline for measuring future results of efficiency efforts. Key aspects include: Data Collection and Management.Â Evaluating energy performance requires good information on how, when, and where energy is being used. Collecting and tracking this information is necessary for establishing baselines and managing energy use. Organizations of all sizes have established systems for gathering and tracking energy use data. Nonexperimental instruments used in prior evaluations. 6. Binary outcome models. Exogenous treatment. Binary outcome with binary endogenous regressor. The model and assumptions. Linear probability model.Â 11. Using economic models to evaluate policies. Structural versus reduced-form approaches. Modeling the effects of policies.Â The student is expected to characterize the problem, goals of the policy and key indicators, data, treatment, possible outcomes, a method of estimation, and the anticipated results of the estimation. 7.1 Structure of the Essay: 1) Consider a research problem that is relevant to evaluation of policy or impact. assessment. Describe the reform (policy), its period, area (country, region), units, targets and key indicators. Energy efficiency indicators can be very useful tools to evaluate energy efficiency, monitor changes, develop and assess policies, facilitate comparisons and construct demand projections. However, a fundamental requirement for all these analyses is the availability of data, which proved to be the biggest obstacle in this study.Â Within APEC, the deliberations of the APEC Energy Working Group (EWG) and APEC Energy Ministers meetings, have expressed a desire to promote the importance of energy efficiency policies and measures, and to develop ways of assisting individual economies to increase economic efficiency through the wiser use of energy. Evaluating regulatory management tools and programmes. By Claudio Radaelli and Oliver Fritsch. Expert Paper No. 2, July 2012.Â The focus is on policy instruments and oversight activities that (a) cover the production and implementation of regulation across sectors rather than disciplining individual domains, (b) enhance governmental capacity to provide high-quality regulation (e.g. consultation, access to regulation, transparency), and (c) are neutral in relation to the total level of regulatory activity.Â The report finds that there are many indicators used for large-scale descriptions and comparisons. More often than not, these indicators do not provide information useful to policymakers in order to change the regulatory reform instruments they control. Energy Efficiency Indicators - Analysis and key findings. A report by the International Energy Agency.Â Globally, energy use and economic development have been decoupling, with gross domestic product (GDP) more than doubling between 1990 and 2018, whereas total energy supply (TES) grew by 59%. Global decoupling trends. World GDP and TES trends, 1990-2018. Open. The amount of energy used to generate a unit of GDP, also called energy intensity of the economy (TES/â€ŒGDP) decreased globally by 36% between 1990 and 2018, with large regional variations. In non-OECD this fall has been greater.