A EUROPEAN

EX-POST EVALUATION GUIDEBOOK

FOR

DSM AND EE SERVICE PROGRAMMES

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FOREWORD

This European Ex-post Evaluation Guidebook for DSM and EE Services Programmes is the combined result of two SAVE projects carried out in the period 1997-2001 (Phase I – Project No. 12488-96-12F1ED ISP DK, Phase II – Project No. XVII/4.1031/P/99-028).

The first phase of the project was completely financed by the European Commission's SAVE programme whereas Phase II was partially financed by the European Commission's SAVE programme and partially by the project team on a fifty/fifty basis.

PHASE II PROJECT TEAM

The project team of Phase II represented a wide geographical area and various types of actors within the energy system:

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- Mr. Kalle Jöks, Regional Energy Centre of Viljandi, Estonia.

The project team represented a variety of organisations and countries, something, which will help ensure that knowledge of the existence of this guidebook is widely spread. For details on how to contact these organisations, please consult Appendix A of this report.

Although non-project team members provided valuable comments, the full responsibility for the outcome of the project resides with the project team.

PHASE I

Phase I was organised by JRC, Italy with SRC International, Denmark as technical co-ordinator.

The objective of Phase I was to establish an overview of the existing evaluation practices used, available methods, and what issues the new methodology should incorporate.

Phase I consisted of the following main tasks:

- Bibliographic research of existing methodologies evaluating DSM and EE services programmes and preparation of summaries of selected methodologies.

- Translation of selected parts of the Swedish Evaluation Guidebook, prepared by NUTEK in 1993, relevant to other European energy markets.

- Preparation of a comprehensive draft document on general ex-post evaluation methodology based on the bibliographic research and the Swedish Evaluation Guidebook.

- Preparation of a comprehensive draft standard reporting format linked to the developed ex-post evaluation methodology The format was to be used for reporting on DSM and EE programmes in a consistent and logical manner which allows comparison of programme and evaluation results (at intra-company, regional, national, and international level).

- Identification of organisations to participate in Phase II and a selection of evaluation experts who reviewed the findings on a continuous basis throughout the project period.

The outcome of Phase I was published January 1998. This publication supersedes the Phase I results.

PHASE II

The objective of Phase II was to test the drafted methodology in various environments in terms of programme objective, implementation method, and market structure. Participating organisations were requested to test the drafted methodology on a specific DSM or EE services programme. The programme could be a programme implemented by the participating organisation itself or others. The project team provided support and guidance to the participating organisations as they applied the evaluation methodology to their own programmes. The purpose was to provide hands-on experience to the participating organisations and obtain valuable feedback on the practicality of the draft guidebook. In this way, the guidebook has benefited from real-world experience of organisations carrying out evaluation for this final document to be as practical and useful as possible.

Phase II thus included:

- Testing of the draft European ex-post methodology using the comprehensive draft report prepared in Phase I and the standard reporting format.

- Reporting on the adequacy of the draft European ex-post evaluation methodology and the standard reporting format.

- Preparation of illustrative case examples. The mix of case studies was composed in such a way as to reflect particularly interesting aspects, which have not been addressed to a great detail by previous reports.

- Review and modification of draft methodology and preparation of the final project document on the European Ex-post Evaluation Guidebook.

- Presentation of the European Ex-post Evaluation Guidebook at the ECEEE Summer Study 2001 and other EE and evaluation fora to allow dissemination of the experience gained and the guidebook itself.

The present report constitutes the final European Ex-post Evaluation Guidebook.

CONTENTS

1 INTRODUCTION

1.1 WHY A EUROPEAN EX-POST EVALUATION GUIDEBOOK?

Numerous demand-side management (DSM) and energy efficiency (EE) services programmes have been carried out over the last two decades; some supported by the EU SAVE programme.

However, many utilities and energy agencies have carried out costly campaigns and made large investments in EE programmes with only limited assessment of their impact. In other words, without a clear idea of:

- How much energy is truly being saved;
- Where the saving is taking place and why;
- To which extent greenhouse gas emissions are being reduced;
- Whether programmes are being operated cost-effectively.

The introduction of competitive energy markets and limited resources forms a growing pressure to prove impacts and justify costs.

Some hope to use EE programmes and projects to persuade customers to remain with the local utility or to gain market shares and need methods for evaluating the cost-effectiveness of their efforts in the competitive market environment.

Energy service companies (ESCOs) – both utility subsidiaries and independent ESCOs – need evaluation expertise, to assure their customers that promised energy savings have indeed occurred and to limit their investment risk.

Finally, the growing pressure on local energy agencies to compete with private businesses for the EE activities creates a need for proof of impact and justification of costs, also within the public domain.

Development of an evaluation guidebook is thus a logical continuation of national and international efforts to meet CO_2 reduction targets and limit energy consumption.

1.2 GUIDEBOOK OBJECTIVES

The overall objective of the project was to disseminate evaluation theory and thus indirectly help reduce the overall CO_2 emissions and improve energy efficiency. Evaluation of implemented DSM and EE services programmes provides useful information and allows optimisation of the programme cost-efficiency. Pursuit of more cost-efficient programmes means increased value for money. If money can be saved or better employed this could help lead to a greater reduction of CO_2 emissions. Implementation of DSM and EE services programmes without serious evaluation of the achieved impact is increasingly hard to justify.

The immediate objective of this guidebook is to present a European ex-post evaluation methodology for DSM and EE services programmes. In spite of it being an ex-post methodology, it is also envisioned as a planning instrument for new DSM and EE programmes and many of the elements presented here may also be used for other types of evaluation.

Demand-side management (DSM) is an activity designed to influence the energy demand of consumers. It was developed to complement supply-side management. The term "DSM" originally referred to activities carried out by energy utilities or governments in a monopoly market to reduce energy production and delivery costs and energy consumption. The term "EE services" typically refers to the services required to specifically ensuring that conversion of energy at the customer's premises is as efficient as possible, given the technical and financial constraints. EE services can be carried out with the aim to increase income of the service provider as opposed to reducing energy production and delivery costs. EE services may for example be part of a customer retention programme or an ESCO project.

In the guidebook no clear distinction is made between DSM and EE services. Together they cover all attempts at manipulating the demand-side consumption and improve demand-side energy efficiency. Instead, a distinction between programme types is used (targeted information, market transformation, transmission & distribution, load management, customer retention, and ESCO).

No clear distinction is made between the terms "programme" and "project"; the term "programme" is used as a common term in most of the guidebook text.

Furthermore, the term "programme" is used in its widest meaning. It includes very small programmes (by some referred to as projects) to very large programmes.

Also, no terminological distinction is made between large-scale (national) programmes, which consists of several individual programmes/projects and a single programme. The main difference between the two, in terms of evaluation, is that the large-scale national programme may require evaluation of the priority given to the individual programmes (i.e., should the resources be distributed differently) and their influence on one another. The question of whether some of the existing programmes/projects should be excluded and new programmes/projects included in the national programme is a question which is also relevant for independent programmes (i.e., would another programme have been more cost-effective; should we choose another programme for the next period; etc.).

The guidebook aims to provide arguments, questions, and examples on EE evaluation. Sound evaluation is to a certain extent tailor-made and requires innovative and creative thinking. The guidebook provides examples that illustrate the methodologies that can be used.

The guidebook is a hands-on document, addressing evaluation needs in both captive and competitive energy markets. It describes available evaluation methods, their possible application, and a detailed, step-by-step description of **how to plan and implement** them.

The user of the guidebook should be able to plan and implement an evaluation with the guidebook as his/her main inspiration. The target readers/users are people who carry out actual evaluation and not theoretical experts. Given that the readers will have varying skills in the field of evaluation, some readers will find the guidebook more useful than others. Whether novice or a more experienced evaluator, it is, however, recommended that you read Section 2.5 and Chapter 3.

It is the hope of the project team that this guidebook may help increase the number of programmes being evaluated as well as the quality of the evaluations.

1.3 RECOMMENDATIONS

Recommendations from the authors and main points made in the guidebook are:

- **Do carry out evaluation**. The gained information from a good evaluation is vital for improvement of programme activities. **Use the results of the evaluation actively**.
- Take **care in formulating the objectives** of your evaluation. This facilitates the task, increases the credibility of results, and limits costs.
- **Start planning the evaluation as early as possible** in relation to programme design. A lot can be gained from planning the ex-post programme evaluation even before the programme is carried out. It is of course not necessary and, alas, far from normal practise in today's world. However, a significant amount of work can be saved and more reliable data can often be gathered at a lower cost by early planning.
- Arrange **good communication** between the various parties involved in and affected by the evaluation and be aware of the possible consequences of the evaluation results. Care should be taken to present the evaluation results so that they are immediately useful to the intended users.

1.4 GUIDEBOOK STRUCTURE

The challenge in developing a guidebook is to get the right balance between providing an overview and providing detailed "how to do it" information.

One of the main concerns in the preparation of this guidebook has been to **avoid duplication** of information, which can already be found in other texts while providing the reader with a document detailed enough to function as a guidebook. The guidebook thus concentrates on drawing attention to the issues and planning steps, which the evaluator must address to achieve a successful evaluation.

Evaluation starts with determining the framework for the evaluation, i.e., establishing why the EE programme was implemented and why there is an interest in evaluating the programme (**Chapter 2**). Although evaluation needs are not necessarily directly linked to the programme objectives, the focus of interest can vary depending on programme type. For example are the interests associated with a customer retention programme different from that associated with a market transformation programme, which could lead to a difference in evaluation objective. Attention has been given to clarifying this link.

The choice of evaluation method will depend on a multitude of factors including experience (staff), time, available budget, users of the evaluation results, and programme specific circumstances.

Chapter 3 presents the organisational planning aspects of the evaluation effort. It offers a step-by-step approach to evaluation spanning from definition of objectives to selecting evaluation strategy. It also briefly touches upon the issue of evaluation budget.

General guidelines for selecting an energy impact evaluation strategy are provided in **Chapter 4** while **Chapter 5** outlines specific evaluation concepts including how to estimate the baseline development, i.e., the development which could have been expected provided that the programme had not been implemented. **Chapter 6** demonstrates evaluation strategies for specific programme types. The programmes categories used are targeted information, market transformation, transmission & distribution, load management, customer retention, and ESCO.

Apart from evaluation of the energy impacts of a particular programme, evaluation of the project process can provide valuable information to the programme planner, based upon which project cost-effectiveness can be improved. Related key issues are presented in **Chapter 7**. The techniques presented here may also be relevant for market impact evaluations.

Chapter 8 gives an introduction to how to apply evaluation results.

An **index** has been included at the back of the guidebook to facilitate easy reference to the parts of the guidebook of particular interest to the individual reader.

The guidebook methodology has been tested by ten European experts on specific DSM and EE services programmes. The evaluation cases cover a variety of target groups, technologies and approaches and have been carried out by both experts and novices in utilities, research organisations and governmental organisations. **Appendix A** contains a short presentation of each of the evaluation case studies. The descriptions have been used to form illustrative examples, which have been placed in the main part of the guidebook ("grey boxes").

Appendix B contains information on further reading and lists relevant web sites and conferences, as well as provides summaries of selected evaluation methodology literature, which supplement the guidebook methodology. Bibliographic research was carried out to benefit optimally from existing methodologies and to avoid unnecessary repetition and overlapping between these and the European ex-post evaluation methodology. Summaries of the most relevant documents were prepared to provide the reader with easy access to this information. Furthermore, the summaries are intended used actively as a supplement to the main report and the reader is encouraged to exploit the opportunity. An overview of the summaries is presented in Exhibit 1-1.

Appendix C contains a summary of the work on a standard reporting format**{** XE "standard reporting format" **}** for DSM and EE services programmes and their evaluation. Also presented there are four examples of formats.

An important outcome of the project, which is not visible in the guidebook, is the **network** created between the involved experts/organisations – a network that will continue to operate in the future. Sparring with colleagues and experienced evaluators is an effective way to promote successful evaluation.

Exhibit 1-1: Overview of bibliographic summaries.

#	Title	Contents
1	Realistic Evaluation	New trend in evaluation. The evaluation should not focus alone on average/aggregated impact since great information exists in the detail.
2	Guidelines for Defining and Documenting Data on Costs of Possible Environmental Protection Measures	These guidelines establish a common framework and vocabulary for documenting and using data on costs.
3	Evaluation, Verification, and Performance Measurement of Energy Efficiency Programmes	Standard evaluation methods - process, market, and impact evaluations including various impact evaluation methods to address various programme and technology types.
4	Evaluating Energy-Efficiency Programmes in a Restructured Industry Environment	Methods aimed at evaluation in restructured markets including critical review of standard evaluation methods and extensive discussion of information programme and market transformation programme evaluations.
5	Market Transformation in a Changing Utility Environment	Methodological issues regarding market transformation programme evaluation.
6	European B/C Analysis Methodology - A Guidebook for B/C Evaluation of DSM and Energy Efficiency Services Programmes.	Guidebook for performing benefit/cost analyses of DSM and EE services programme including identification of benefit and cost trade-offs between the various perspectives in designing and evaluating DSM and EE services programmes
7	International Performance Measurement and Verification Protocol	Standard methods for measuring and verifying savings for energy services projects.
8	Evaluating Market Transformation Initiatives: Issues, Challenges, and State of the Art	Establishment of the purpose of evaluation efforts. Key issues and challenges in evaluation of market transformation programmes.

2 PURPOSE OF EVALUATION

2.1 WHY PROMOTE ENERGY EFFICIENCY?

EE activities can be classified into two basic types: **Public policy** EE sponsored or directed by governmental and other public sector organisations, and **business-related** EE sponsored or directed by energy firms. There are reasons to implement each type of activity, both in captive energy markets and in more competitive ones.

2.1.1 RATIONALE FOR PUBLIC POLICY EE ACTIVITY

Many EU countries have developed public policy strategies to implement DSM and EE programmes. These programmes have been implemented by governments and, to a lesser extent, utilities. However, most of these programmes have been developed in an era of government-owned or -regulated, captive, monopoly businesses.

Restructuring the electricity supply industry changes the relationship between customers, utilities and regulators. In a monopoly environment, the government can rely on an implicit social contract between government and utilities as the policy basis for using utilities to implement social policy. As the monopoly is withdrawn, altered or changed, the basis for using utilities weakens and may even vanish altogether. However, rationale for public policy EE activities remains.

A publication produced by the International Energy Agency summarised the effects of energy restructuring on the rationale for public policy EE activity, as shown below.[1]

Ample literature and public policy debate has shown the weaknesses of monopolistic electricity sector in relation to achieving an economically justified level of energy efficiency. Proponents of intervention have identified a number of **market failures** that cause consumers not to choose a level of energy efficiency that appears to be economically justified. These market failures include:

- Pay-back gap;
- Prices differ from marginal cost;
- Risk sheltering of the utility;
- Externalities
- Lack of information and high transactions costs;
- Disconnected decision-maker;

[1] Review of Existing Mechanisms for Promoting DSM and Energy Efficiency in New Electricity Business Environments, *The IEA DSM Implementing Agreement, A Report of Task IV — Development of Improved Methods for Integrating Demand-Side Options into Resource Planning and Government Policy (Subtask IV/6), Final Report - October 1996, pp. 33-37.*

- Lobby effect; and
- Consumer capital constraints.

These are a selection of the range of market failures that have been cited as a rationale for intervening in energy markets to encourage higher levels of energy efficiency. For further readings, please refer to the report “Methodologies for Evaluating Energy Efficiency Programmes in Central and Eastern Europe”, IEA, October 1996.

A number of the market failures identified above are directly linked to the existence of a monopoly in electricity supply and the type of regulation that has been applied to limit monopoly electricity utilities’ market power. With restructuring of the electricity sector to encourage (1) competition in generation and (2) full customer choice of their electric supplier, some of these market failures are either reduced or eliminated while others remain, and maybe new occur.

Therefore, a rationale to encourage DSM and energy efficiency still exists in a competitive market, though the nature of the market failures will have altered. Determining whether or not to intervene in the electricity market to encourage DSM and energy efficiency will undoubtedly be a political decision. In developing an effective policy for intervention, policy makers would be well-advised to be as specific as possible in identifying the market failures that the intervention is intended to influence, and to prioritise (to the extent possible) the competing objectives of intervention.

2.1.2 RATIONALE FOR BUSINESS-BASED EE ACTIVITY

Three primary entities have rationale for implementing business-based EE activity:

- **Retail energy marketers** – The motive will be customer retention or profit generation. While some suppliers may seek to be the absolute lowest-cost provider, many may offer a competitive price but try to compete on some other basis. Many analysts believe that an effective strategy is to combine provision of the energy commodity with other products and services, which might, as a package, provide specific customers with higher value overall and therefore help in retaining existing customers and attracting new ones.

- **Electricity distribution companies** (in competitive energy markets) – In addition to a possible role in some types of public policy EE initiatives, electricity distribution companies may also have a self interest in implementing geographically targeted DSM/EE activities that can delay or eliminate the need for costly transmission and distribution (T&D**{** XE "T&D" **}**) system upgrades, e.g., peak load reductions.

- **Energy services companies** (ESCOs) in both regulated and competitive energy markets – These have EE activities as their primary business. The services may include efficiency upgrades of facilities and energy-using equipment; design, construction and/or turnkey implementation of efficient energy-using equipment; and performance contracting. The primary rationale is a fee for service, to generate profit for the ESCO.

2.2 REASONS FOR EVALUATION

Evaluation assesses programme effectiveness (are immediate objectives met?) and/or programme efficiency (could the objectives have been met with a lower use of resources?).

There are three main reasons for evaluating EE programmes:

- To estimate programme **impacts**, including:
    - Energy demand related impacts (e.g., energy use, capacity demand, greenhouse gas emissions, or market barriers);
    - Business-related impacts (e.g., impact on customer retention rates, profit margins, or overall profitability);
    - Market reactions to the programme (e.g., profiles of market segments participating and not participating, effects on equipment manufacturers, suppliers and market channels);
    - Explanations behind programme impact estimates (i.e., how and why the programme's impacts were what they were).
- To determine how the **process{** XE "process" **}** of the programmes could be improved, including:
    - Efficiency of programme procedures, programme outreach and information processing;
    - Methods for streamlining the programme and improving cost-effectiveness;
    - Effectiveness of marketing strategies and promotional materials;
    - Participant satisfaction with the programme (some analysts consider this issue relevant in both process and impact evaluation).
- To meet **contractual requirements** – Some energy services companies engage in performance contracting work, in which at least some portion of payment for services provided is based on the performance of the installed energy efficient equipment. Evaluation (monitoring and verification) requirements are typically written into such contracts, and specify the item to be measured, the way in which the measurement will occur, the duration of the measurement, and the frequency of the measurement.

Historically, most evaluations have had as their central objective the assessment of the reduction of energy use or CO_2 emissions**{** XE "CO_2 emissions" **}**. Consequently, impact evaluations have received most of the attention. For EE projects implemented by energy service companies in the private market, this is the sole objective.

As programme objectives have shifted to transforming markets and overcoming market barriers to energy efficiency, the focus of the impact evaluation has shifted to a more approximate estimate of energy use and CO_2 impacts and a more detailed estimate of market-related impacts, supported by market evaluation data on key market indicators (see Section 3.3).

When programme sponsors have been concerned about cost-effectiveness and public perceptions, or when programme implementers have had to prove to regulators or company management that programme funds were spent prudently, process evaluations have also tended to play a key role. Process evaluations typically trace the flow of the programme from programme design to measure implementation, examining programme marketing, customer contact, participation processing, and programme monitoring.

2.3 RISKS AND BENEFITS

Decision-makers have two clear options with regard to evaluating their programmes:

- **Not to evaluate** the programme. The risks are that:
  - The programme may be implemented inefficiently because previous experience is not used to the full extent.
  - Financial and human resources may be wasted.
  - Individuals and organisations may make decisions based on incorrect information (e.g., believing that a programme is saving energy when it is not, believing that it is saving much more than it is, or believing that it is cost-effective).
  - The programme may cause unexpected, and possibly undesirable, effects in the market place.
  - Others may not accept claims that energy has been saved, or claims that energy has been saved in the amount reported.
- **To evaluate** the programme. If this is the choice, further decisions must be made as to the level of detail for the evaluation as well as the methodology to be used. Implications of this choice are as follows:
  - Resources will be spent.
  - Human resources will be tied up.
  - Decision-makers and programme managers will obtain a better and more complete understanding of the effectiveness and efficiency of the programme.

Furthermore, evaluation may be required by law or due to contractual obligations (e.g., the Danish Integrated Resource Planning Law).

2.4 ANSWERING PRACTICAL QUESTIONS

In practical terms, evaluation can address practical questions that decision-makers need answers to, such as the following questions.

2.4.1 IMPACT QUESTIONS

Question: How can I **prove** (to the government, citizens, the media, other countries, my manager, my customer) that this programme or project is having significant impacts (on energy use, CO_2 emissions, customer retention, profit margins)?

Question: How **accurate** are the programme's initial assumptions regarding specific impact parameters?

In designing EE programmes, values are estimated for a range of factors, and those values directly affect the programme's cost-effectiveness. If the evaluation shows that the values for these factors are really much higher or much lower than assumed in the design phase and that the programme is not cost-effective (from the point of view of the programme sponsor, the programme participant, or society) then funds can be shifted to other programme options or programmes. An evaluation can reveal key data regarding components such as:

- Number of hours the targeted piece of equipment is used daily — Typically, the more hours the targeted equipment is used, the more energy savings accrue.
- Level of use of the equipment — Especially for commercial/industrial energy-using equipment, sometimes equipment can be used at less than full capacity (oversized in anticipation of future growth or operated in parallel with similar equipment as a reliability measure), resulting is lower than expected energy savings.
- Actual efficiency of equipment being replaced and of the more efficient equipment promoted by the programme — Nameplate energy load ratings of equipment can be inaccurate, resulting in lower- or higher-than-expected energy savings.
- Percentage of programme participants who have removed, disconnected or are otherwise not using the programme measure.

Question: What changes in energy use are occurring specifically as a result of the programme, compared to changes that would have occurred without the programme (net impact)?

Question: Has the programme caused **reduced or increased energy use** among participants with regard to other equipment or behaviours? Has it affected how even those who did not participate use their energy?

Question: Are some participants **trading energy bill savings** for other benefits, such as an increased winter thermostat setting or extended work shifts to achieve greater production at the same energy cost? What effect is this behavioural change having on the programme's overall objectives (e.g., reducing greenhouse gas emissions versus positive public relations)?

Question: How is the programme **affecting markets**? For example:

- Are new retailers/vendors of the equipment promoted by the programme entering the market?
- Is the number of product lines (models) of the targeted product increasing?
- Is product availability increasing?
- What effect is the programme having on competition between similar efficient products?
- Is market share for efficient equipment increasing?
- Are standard stocking practices and ordering procedures changing to facilitate the purchase of the efficient equipment?
- Is the cost of similar products decreasing, due to elevated competition (e.g., the cost of all compact fluorescent lamps, due to a programme promoting certain models)?
- Is the subsidisation of efficient products and services having a harmful effect on certain manufacturers or energy service companies, by devaluing the product/service they are

offering? Is the programme having a positive or negative effect on the energy service industry in general?

Question: Is the programme **still needed**? For example:

- Are there signs that the equipment or practice being promoted is becoming standard in the market place? Is demand for it increasing? Do customers expect it? Is less efficient equipment difficult to find?

- What is the likelihood that codes or standards requiring the targeted equipment or practice will be enacted in legislation (possibly because the programme demonstrated the practical feasibility or benefits of the measure)?

- Are the programme costs much higher in value than the programme benefits? Could the public's or the company's resources yield more value if diverted into a different type of efficiency effort, or a different effort not related to energy efficiency?

Question: What **motivated** the target group to participate and implement energy efficiency (functional benefit, economic benefit, ecological benefit, aesthetic benefit, social benefit) (relates to the issue of self-selection, see Section 4.2) ?

2.4.2 PROCESS QUESTIONS

Question: To what extent are programme funds being **wasted** on activities to persuade individuals/businesses to take actions they will take even if no funds are spent?

- Exactly how is the programme marketed, who is involved and when?

- How is the participation process supposed to flow, from customer contact through measure implementation (or incentive payment, final inspection, if appropriate)?

Question: Can the same or greater impacts be achieved using a different **programme structure/design** with lower costs? For example:

- Why are expected impacts not occurring?

- Are undesirable effects from factors/forces external to the programme negatively affecting the programme? How? Can they be reduced in some way?

- Could the programme take advantage of synergies or economies of scale through joint efforts with other entities?

- Is programme marketing most influential with low-impact consumers?

- Would a different marketing message or different marketing channel result in a greater percentage of high-impact consumers[2]?

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[2] *Low-impact participants are those participants for whom the equipment or behaviour targeted by the programme results in less than average per-participant energy reduction. Perhaps they use energy-using equipment less often, for shorter periods of time, during off-peak times, have heating thermostats at lower settings, etc. Conversely, high-impact participants' use of the equipment or behaviour targeted by the programme results in more than average per-participant energy reduction.*

- Is some portion of the marketing or promotional effort ineffective? Could it be terminated, resulting in a lower cost per participant and lower cost per unit of impact?
- Would participants make the same efficiency improvements …
  - if they had access to low-interest loans rather than incentive payments?
  - if they could pay for the efficient product in instalments as part of their electric bill instead of receiving any financial incentive at all
  - if someone would mail a full-price efficient product to them rather than offering a rebate on the product when purchased from retailers?
  - if they could receive information from a source they trusted that the product really worked as claimed, rather than receiving a rebate to purchase the product?
- Is there unnecessary redundancy in the processing of programme records? How many individuals in how many locations handle programme forms? Should this activity be more centralised or more dispersed?

Question: Are programme **funds being spent wisely**? For example:

- Were programme implementation contractors selected based on personal relationships instead of best value?
- Are programme marketers given an incentive based on number of participants rather than overall energy savings resulting from the participants?
- Does in-house staff do significant field implementation work? Does this drive up cost? Would outside contractors be more cost-effective or provide a higher quality service?
- (Especially for programmes of utilities operating in captive markets) Is the utility responsible administering the programme limiting the range of efficiency improvements possible, due to mixed messages from management about saving energy versus selling energy? Does programme implementation result in only certain types of equipment being implemented (e.g., electric), when the programme was supposed to be designed to be fuel-blind?

2.4.3 CONTRACT REQUIREMENT QUESTIONS

Question: Is the agreed level of performance reached?

Question: Can the agreed level of comfort be reached at a lower cost?

Question: Is the client still satisfied with the energy service contract or could the client be interested in an alternative or additional service?

Question: Were the chosen contract indicators appropriate?

Question: What were the advantages and disadvantages of using a contract approach to EE activity?

The answers to questions such as these contribute to answering the **higher level question**, "Should we be implementing this programme or this type of programme?" They also address accountability concerns, both by providing information on how effective the programme actually is and by communicating to those involved in implementing the programme that management/the programme sponsor is concerned about cost-effectiveness and prudent use of funds.

2.5 WHAT IMPACT VERSUS WHY THIS IMPACT

Typically evaluations focus on what impact was achieved due to a certain programme rather than investigating what caused this impact. However, understanding of the latter is very important for improving programme effectiveness and efficiency as well as for reproducing a successful programme.

Much too often the theory behind an evaluation is implicit – it is not published and it may not exist. Without any theory, the results from an evaluation are somewhat like a "black box"*: An energy audit was done in 50 companies and X MWh was saved*. Why the X MWh were saved, or what was important for the result is not known. The evaluator might have an idea, e.g., that it was the focus on profitable projects that made the audits successful, but in reality the mechanisms behind the impact are not known or are not investigated. Problems occur when a programme is repeated in another context, e.g. in another location, with other staff, or with a reduced scope. Without theory it is difficult to know whether the changes are important for the success or not.

We wish to point to three things related to impact evaluation:

- Cause-impact relationship and programme/problem mechanisms;
- Context and timing dependence;
- Importance of variations.

2.5.1 REALISTIC EVALUATION THEORY

According to realistic evaluation theory:

> "Evaluators need to focus on how the causal mechanisms, which generate social and behavioural problems, are removed or countered through the alternative causal mechanisms introduced in a social programme. Realist evaluators seek to understand why a programme works through an understanding of the action of mechanisms. Mechanisms refer to the choices and capacities, which lead to regular patterns of social behaviour. Causal mechanisms are at work in generating those patterns of behaviour, which are deemed social problems and which are the rationale for a programme. Programmes are often prolonged social encounters and even the simplest initiative will offer subjects considerable compass for decision making. A key aspect of evaluation research design is thus to anticipate the diversity of potential programme mechanisms involved and a key analytic task is to discover whether they have disabled or circumvented the mechanisms responsible for the original problem." (Pawson & Tilley, 1997, page 216)

The term "problem" refers to the unwanted state of things, which the programme targets (e.g. unrealised cost-effective energy saving potentials in industry).

The great challenge of impact evaluations is (according to the realistic evaluation theory) to determine the **cause-impact relationship**. One task is to document that a change has taken place in the size of the problem or the character of the problem. Another and far more difficult task is to document that the change (or part of the change) happened due to a certain effort (i.e., the programme).

Often, it is the impact of a specific activity carried out at a given time and place, which we want to analyse. However, the outcome of such an analysis depends among other things on the **context{** XE "context" **}** and the **timing** of the evaluation. When repeating the activity, a larger or smaller amount of conditions will invariably have changed. The activity may for example be repeated in a different location, the implementers might have different qualifications or the extent and terms of the financial support might be different. If important parameters are modified, then it is natural to assume that it will affect the programme impact. It is therefore vital in a repetition or transfer of a programme to know, which parameters, i.e., **mechanisms{** XE "mechanisms" **}** influence the problem. The mechanisms describe the personal arguments for a given behaviour. Significant mechanisms should be included in the evaluation and be covered in the data collection. Furthermore, trustworthy arguments for the lack of significance of the excluded mechanisms must be formed.

The mechanisms of a problem or a programme can be described explicitly in a theory. The theories may describe the programme or they may cover the problem, which the programme is trying to address. **Programme theory{** XE "programme theory" **}** for a labelling system for the energy consumption of cars describes how this information influences the buyers. The **problem theory{** XE "problem theory" **}** describes what influences the buyers to choose an energy efficient car or not. Combining the theories with information about the context and timing of the programme, it becomes possible to assess why the impact occurred.

The programme impact most likely varies depending on the buyer's situation (and the general context and timing). Not all car buyers react in the same way to energy labelling. **What works for whom in which context** is more important than average impacts if you wish to learn from your activities. An evaluation that only establishes the total programme impact or average impact will therefore miss out on important information i.e., in which circumstances the programme is effective and in which it is not. **Variations{** XE "variations" **}** and context contain useful information, which can help improve the programme/problem theory and programme design.

A more extensive example of programme mechanisms and problem mechanisms is given in the following based on the Danish Campaign for Lower Clothes Washing Temperatures (see also Appendix A for more detail on the evaluation). An assessment of the relative importance of the different mechanisms and their interdependence would lead to the formulation of a complete programme theory and a problem theory for the clothes-washing programme. A description of the relative importance and the interdependence of the following mechanisms have, however, not been included in the following.

The mechanisms marked "time related" are particularly sensitive to the timing of the intervention.

Problem:

High electricity consumption for washing in residential households constitutes 4.5% of total household consumption. The 90°C clothes-washes make up 15% of the consumption for clothes washing, which is considered too high.

Applied Method:

Dissemination of information.

Message:

Clean washing is possible/best at 60ºC (as opposed to 90ºC).

Indirect Message:

It takes energy to wash clothes and this has an impact on the environment.

Programme Mechanisms (How does the message influence the washer):

- **Conscious acting** – The washer starts thinking about how she/he washes clothes and why.
- **Individual decision-making vs. tradition** – The washer consciously decides based on the present level of information available how to wash clothes instead of doing what her/his parent(s) did.
- **Social value** – Clothes washing becomes an area of social attention e.g. public media attention; men may show an interest in how the clothes are washed; clothes-washing becomes an acceptable subject of discussion at social gathering; etc.
- **Washing of clothes is linked to environmental concern** – Environmental protection is introduced as an issue in relation to clothes-washing (indirectly affected through the associated the energy use) as opposed to only hygiene and dirt/stains.
- **Peace of mind** – Washers get satisfaction knowing that fabric care (i.e., lower washing temperatures) is not opposed to hygiene.
- **Snowball effect** – The campaign opens up for taking in information already available for example on detergent packaging regarding adjusting the amount of detergent to the water hardness and the type of wash.
- **Male interference** – Assuming that washing of clothes is still very much a female task (traditional gender roles), it might be seen as male interference (i.e., programme provider = male) in a female territory to "dictate correct procedures".
- **Attitude to programme approach** – The washer's reaction to the programme message depends on the approach used.
- **Attitude to programme provider** – The washer's reaction to the programme message depends on the washer's attitude to the programme provider (e.g. is the provider perceived as trustworthy).
- Et cetera.

Problem Mechanisms (Who washes at 90ºC and why):

- **Number of households with washing machines** – Determines the size of the potential target group.
- **Number of persons per household** – Can the household fill the machine completely at each wash if they want to?
- **Weather and climate** (time related) – Weather determines how many clothes are worn, what clothes are worn and how often they are changed. In Northern Europe more white

clothes are worn during summer (and especially during hot summers) and more cotton/linen are used which lead to a higher usage of 90ºC washes to remove sweat and stains. Colder climates require larger pieces of garments and/or a greater number of garments, which may lead to more washing depending on the need for symbolic cleaning.

- **Fashion** (time related) – Decisive factors are fabrics (not all fabrics can be washed at 90ºC), some cannot be washed at all), cuts (a tight fit will invariably lead to a greater need for washing), and colours (not all colours are resistant to 90ºC washes). These factors may work for as well as against 90ºC washes.

- **Distribution of professions** – Some types of work is dirtier than other types. Some work requires clothes, which is dry-cleaned and not washed. Some work places handle the washing of work clothes for their employees.

- **Spare time activities** – The tendency in Western countries is that each spare time activity requires its particular outfit. With many activities per household this increases the wash load especially when combined with a need for symbolic cleaning.

- **Age distribution of population** – The need for clothes washing depends on the age of the wearers, i.e., the persons within the individual household.

- **Symbolic cleaning** – The frequency of clothes washing is high since one-day wear of clothes is the social standard; you should not be seen wearing the same clothes two days in a row (due to a hysteric attitude towards human smell).

- **Age distribution of washers** – Young people of today are trained to collect and use information from many sources while older generations are more bound by tradition i.e., doing what their parents recommended/did (use information provided by their parents irrespective of the change in context). Furthermore, the younger generation may be more prone to behavioural change as such (i.e., their worldview is not cemented).

- **Sex of washer** – There may be differences in the way women and men reason and act in relation to washing of clothes and adopting a message as the one in question.

- **Key decision-maker** – A domestic servant washing the clothes of his/her employer might not have freedom of choice regarding temperature or even have an interest in the matter.

- **Economic wealth of the households with washing machines** – A wealthy household is less likely to care about potential energy bill savings.

- **Awareness and sense of responsibility in sustainable development** (time related) – The number of people, who wish to act upon their environmental conscience, can be influenced by other issues on the political agenda at the time of the programme. The presence of other EE campaigns may for example indirectly increase the impact of the campaign while a large political crisis may crowd the public attention.

- **Personal/societal history** – A country exposed to an energy crisis could seriously tune people into energy efficiency including EE behaviour when washing clothes. The opposite is also possible: A generation which in the past became exposed to a disease epidemic, which could be limited/contained by washing clothes at 90ºC, is more likely to uphold "old" clothes washing habits.

- **Design of the electricity bill** – Visibility of the link between washing of clothes and the size of the electricity bill influences the impact of the message.

- **Price of electricity** – A low impact on the overall household budget can mean that the household is less prone to EE behaviour.

- **Contact with dissemination media** – The choice of media for dissemination of the programme message will determine who comes into contact with the message as well as how it is received.

- Et cetera.

2.5.2 REQUIRED EFFORT FOR PROGRAMME THEORY DEVELOPMENT

An in-depth analysis of the cause-impact relationship puts great demands on theory and analysis methods. A precise proof of the influence of both significant and less significant parameters also often requires a large data material. This may result in impossible or unreasonably expensive evaluations. Such evaluations cannot be carried out on discount budgets. Successful impact evaluations often cost a lot of money and require years and not weeks. In-depth impact evaluations are similar to research projects. Especially small programmes cannot justify these kind of intensive evaluations. A lot can, however, be gained by focusing the evaluation properly and documenting the programme context, timing, and variations clearly and explicitly for future reference. Such documentation is very useful when developing a new or revising an existing programme since it identifies the characteristics of a successful programme design and marketing strategy. It provides an understanding of why a programme would or would not work.

Marketing and advertisement companies have large experience in predicting consumer behaviour, which can be used in developing both programme and problem theory. Technical literature may also provide insights in mechanisms at work. Programme decision makers (e.g. programme management) and programme workers may be interviewed regarding what they perceive as interesting parameters. Another possibility is to interview the target group of the programme (e.g. using a focus group). The findings can then be analysed and refined by the evaluators.

3 EVALUATION PLANNING

This chapter presents a methodology for making initial decisions about programme evaluation strategies. The guidelines make suggestions regarding:

- How to determine the overall **level of effort** and **focus** of the evaluation.

- **Practical issues** to address, to provide the evaluation team with an idea of what level of effort might be required for various evaluation strategies, in light of the amount, type and quality of existing data resources.

- What **limitations** are there on the evaluation due to the timing of the decisions that the evaluation is supposed to support (e.g. how to time the evaluation to allow taking evaluation results into account in programme decision making)?

Please refer to Chapter 4 and 6 for specific impact evaluation examples.

Prior to selecting an appropriate evaluation strategy for an EE programme, one should consider the following issues:

- Primary programme objectives – Gain understanding of the programme, its objectives, and how it is supposed to operate.

- Key areas of uncertainty – Identify areas of uncertainty and the impact of making incorrect assumptions about these. Use programme understanding to list key issues to be examined and prioritise the list.

- Programme vintage.

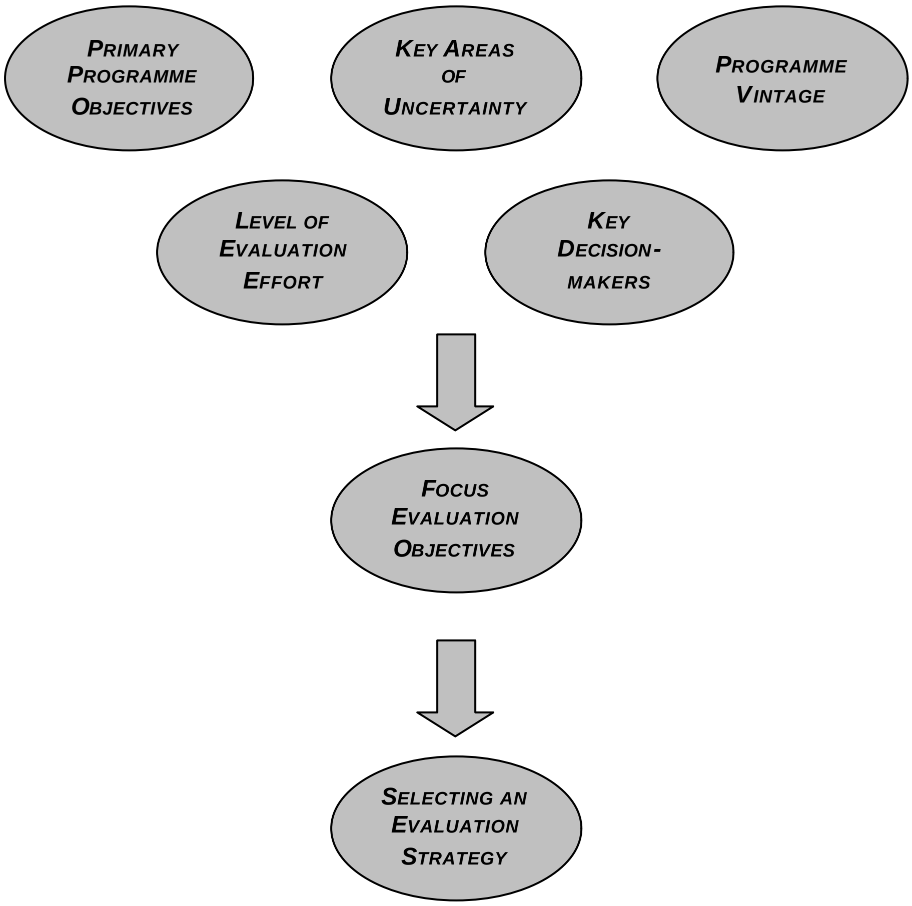
- Appropriate level of effort for the evaluation.

- Key decision-makers regarding the programme and the most important decisions to be made about the programme.

- Focus the evaluation.

Each of these important issues is discussed in more detail below.

Exhibit 3-1: Issues to consider prior to selecting an evaluation strategy.



3.1 CO-ORDINATION OF PROGRAMME AND EVALUATION

Ideally, the needs of the **evaluation should be incorporated early into programme design**. The advantages of doing this are:

- Evaluation costs can be estimated and included in the programme costs and the benefit/cost reflection of the programme thus providing a more complete picture of the resource consumption.

- Data needs are identified early in the process and thus allow for gathering these at the most convenient and cost-effective time in the programme process. For example, information on participants' background might be relevant in the evaluation and it little or no additional effort to include questions concerning participants' background in a programme questionnaire, which is to be distributed anyway. The cost of preparing an additional questionnaire after programme completion is thus avoided and the participants are not inconvenienced unnecessarily. Another example could be meters or metering, which are included as part of the DSM measure to ensure availability of metered data necessary for the evaluation.

- Areas of uncertainty are clearest at the time of formulating the programme.
- Planning the evaluation at an early stage helps keep programme objectives in clear view during design and implementation.
- Furthermore, it helps focus on how to measure/establish programme success - what are the indicators and what are the success criteria.

Naturally, a need for evaluation of a certain item might first appear after the completion of the programme, However, this is rarely the case if careful planning of both programme and evaluation has been carried out.

3.2 EVALUATION PLANNING PROCESS

Having decided to evaluate, the ex-post evaluation planning process should consist of the following actions:

- Decide who at the company is to have the **responsibility** for the evaluation.
- Determine the **purpose** of the evaluation - why do you want an evaluation, what is the goal of the evaluation, and which questions should the evaluation answer.
- What are the **mechanisms** at work in my case? Look at evaluations already done and literature about the relevant mechanisms (e.g. what is the reason people buy non-clean vehicles?)
- Decide whether the evaluation should be **divided** into several smaller studies or performed as one large study. The choice depends on:
  - Whether the evaluation simultaneously touches different areas such as economy, technology, or implementation.
  - Whether the buyer of the evaluation has special interests and opinions about arrangement and presentation of the evaluation of particular areas.
  - Whether the service to be evaluated is divided into several phases/stages.
- **Organise** the evaluation:
  - Decide who is to perform the analysis.
  - Decide who is going to use the results.
  - Contact external entities to be involved in the evaluation.
  - Arrange for good communication between the various parties involved.
  - Make sure that the person responsible for the DSM activity is in complete agreement with everyone involved about the structuring of the evaluation.
- Specify the **general form** of the evaluation (e.g. choice of method/strategy, see Chapter 4 for more detail on this issue).

- Plan the evaluation in **detail** (e.g. select measuring points). The evaluation could for example include profitability, energy efficiency, and how the co-operation worked. Regarding impact evaluations make sure to determine how to establish a baseline and discuss the uncertainty.

- **Implement** the evaluation.

- **Present the evaluation results** so that they are immediately useful to the company and other relevant parties.

Exhibit 3-2 presents an example of a ready-to-copy evaluation plan checklist**{** XE "evaluation plan checklist" **}**, which was prepared by NUTEK**{** XE "NUTEK" **}**, Sweden in 1993.

Exhibit 3-2: The NUTEK evaluation plan checklist.

Evaluation plan for

Project ………..

Project manager ………………………………………………………………………………………………..

Evaluation plan established by the project manager and ……………………………………………………….

…….

> This form is both a checklist over the establishment of an evaluation plan and a condensation of the plan itself.
>
> **Checklist**: The form is used as a checklist by point after point checking off and giving the date for each decision taken, and jotting down the salient points of each.
>
> **Evaluation plan**: In connection with small evaluations, this form can be the entire evaluation plan or at least the major part of it. With a larger evaluation, this form can be a shorter presentation of the evaluation plan and function as a sort of table of contents.

Step			Date
1	The evaluator is ……………………………………………………………………..		
	Decision taken:	❑	________
2	Goal: We wish to find out the following from the evaluation …………………………….		
	………………………………………………………………………………………………		
	………………………………………………………………………………………………		
	A more complete presentation is to be found in ………………………………………		
	………………………………………………………………………………………………		
	The goal has been discussed, decided, and written down:	❑	________
3	When to evaluate: The evaluation is part of the project plan for the energy service, and the plan is to be found in ………………………………………………………….		
	………………………………………………………………………………………………		
	The decision of when the evaluation shall take place has been taken:	❑	________

Step			**Date**
4	A division of the evaluation into part-studies has taken place Yes ❏ No ❏ A complete description of the part-studies may be found in ………………………….. ……………………………………………………………………………………………		
	A decision in this matter has been taken:	❏	________
5	The evaluation is organised as follows ………………………………………………….. …………………………………………………………………………………………… …………………………………………………………………………………………… A detailed organisation description is to be found in …………………………………… …………………………………………………………………………………………… ……………………………………………………………………………………………		
	The organisation has been decided on and written down:	❏	________
6	The specification of the evaluation in general ………………………………………….. …………………………………………………………………………………………… …………………………………………………………………………………………… …………………………………………………………………………………………… A complete description of the general specification can be found in ……………….. ……………………………………………………………………………………………		
	The specification has been discussed, decided, and written down:	❏	________
7	a) Detail planning done by ………………………………………………………………….. *The decision in the matter has been made:*	❏	________
	b) The detail plan is to be found in …………………………………………………….. *The decision in the matter has been made:*	❏	________
8	*Execution*	❏	________
9	The evaluation shall be presented as follows ………………………………………….. …………………………………………………………………………………………… …………………………………………………………………………………………… A more detailed description is to be found in …………………………………………… ……………………………………………………………………………………………		
	The presentation forms have been discussed and decided on:	❏	________

The NUTEK checklist may be expanded to fit your purposes. For example could names of the decision-maker of each step be added to the list. The main point is, that the checklist remains a checklist that provides an overview as supplement to the more detailed evaluation plan.

3.3 PRIMARY PROGRAMME OBJECTIVES

The primary programme objective may determine the primary objective of the evaluation effort. There are two basic categories of primary programme objectives:

- **Environmental/energy** resource objectives:
  - Reduce CO_2 emissions.
  - Meet future energy capacity needs.
  - Reduce energy imports.
  - Transform markets.
  - Overcome market barriers.
  - Promote general economic development.
  - Develop a strong EE service industry.
- **Business profitability** objectives:
  - Generate profit and increase profit margins.
  - Retain customers.
  - Generate positive public relations.

Typically, the **purpose** of the evaluation is to quantify, to the extent possible, how well the programme is accomplishing its primary objective. This quantification is somewhat easier for emissions, energy use, energy load, and business profitability objectives for which metrics are widely accepted and processes/measurement techniques are available for assessing those metrics.

It is a little more difficult to quantify success in achieving market change objectives, for three reasons:

- Markets involve the complex interaction of numerous forces, making causes of market change very difficult to establish.
- There are often no generally accepted and available metrics which indicate that a specific market has changed.
- Market change tends to happen very slowly, making it more challenging for evaluation to help guide programme implementation and to assess how well programmes are performing. The extended time frame for change also reduces certainty about exactly what is causing observed market changes, as more and more factors have time to influence the market.

As a result of the difficulties quantifying success in achieving market change objectives, evaluators typically collect data on a range of **market indicators** that provide evidence that a market is changing.

The following exhibit illustrates a typical relationship between the programme objective and the primary evaluation objective. To some extent the target group of the programme determines the areas of interest of the evaluation. Therefore these should also be identified.

Please note, that the evaluation efforts are not necessarily directly linked to the objectives of the programme in question.

All programmes can benefit to at least some degree from process evaluation activities, in which the efficiency of the programme and the nature of participating and non-participating consumers/businesses can be analysed, so that programme costs can be minimised and the amount of impact per unit of expenditure can be maximised.

Other examples of evaluation objectives not directly related to primary programme objectives are:

- Cross comparison of different programmes to establish which programmes are likely to continue in a competitive market.
- Understand or develop the programme tracking/monitoring system, so that participation can be documented (see below for more detail) and compile and analyse the usefulness of existing data resources of value to the programme evaluation.
- Determine whether opportunities exist for programme implementers to collect data of value to the evaluation less expensively and more efficiently than for evaluation researchers to do so. Determine the practicality of such data collection and its impact on both other activities implementers must perform and the validity of the evaluation results.
- Assess the energy savings engineering algorithms and the assumptions and supporting data behind them (see next section).

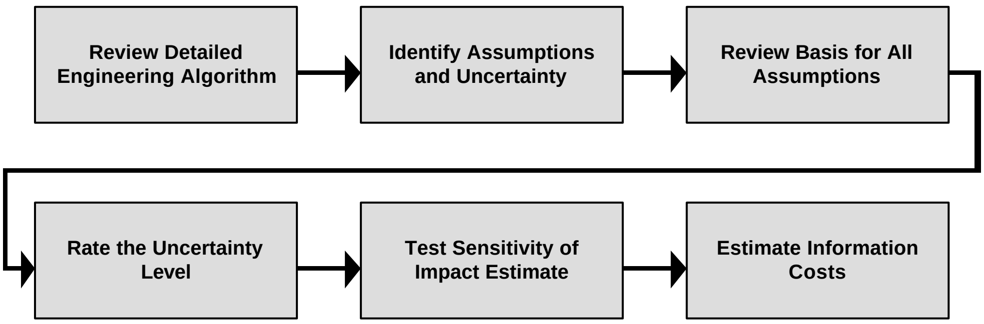
Exhibit 3-3: Relationship betweeen programme objectives and primary evaluation objective.

Primary Programme Objective	Primary Evaluation Objective
Reduce CO_2 emissions	Change in CO_2 emissions/change in amount of energy used
Meet future energy capacity needs and/or reduce energy imports	Change in energy use: - Amount of energy use (e.g., kWh) - Capacity of energy use (e.g., kW)
Transform markets/overcome market barriers	Change in market indicators — percentage of retailers stocking the energy efficient product, percentages of consumers and businesses aware of the product, product penetration, percentage of businesses engaging in the efficient practice, etc.
Promote general economic improvement	Change in market indicators — number of new business starts, level of retail sales for discretionary products, housing starts, etc.
Develop a strong EE services industry	Change in market indicators — number of ESCOs, annual revenues for ESCOs, percentage of businesses aware of ESCOs, percentage of businesses likely to contact an ESCO in the next year, etc.
Generate profits for sponsors/investors	Change in sales and profit margins
Retain customers	Change in retention rate, change in per-customer margin
Generate positive public relations	Change in market indicators — Awareness of firm among targeted customers, number of mentions in various media, percentage of positive mentions in various media, etc.

3.4 KEY AREAS OF UNCERTAINTY

One can always learn more about a programme through evaluation activities. However, the design and performance of an evaluation comes at a cost. To maximise the usefulness of evaluation results and minimise evaluation cost, decision-makers must determine how much uncertainty**{** XE "uncertainty" **}** they are willing to accept and when to require additional analysis and data collection to refine and confirm estimates. This includes asking the question: What are the consequences and the alternatives?

Exhibit 3-4: Course of action for review of programme plans.



We suggest the following course of action, when reviewing programme plans to develop an impact evaluation strategy:

- Review or develop a detailed engineering algorithm or set of algorithms for estimating programme impacts. Ideally, these algorithms are already included as part of the programme's tracking system, so that the tracking system can generate an estimate of the programme's (or each participant's) impacts. The algorithm should include all factors that may influence savings, such as free-ridership, spill-over, percentage of the load/capacity savings that is coincident with the utility's system peak (for utility load-reduction programmes), seasonal differences in hours of use, persistence, etc.

- Clearly identify all assumptions and areas of uncertainty in all programme plans.

- Review documentation for (or document) the basis for all assumptions. If a specific assumption is based on the results of previous evaluations, indicate the degree to which key programme conditions differ or are the same as the current programme (type and composition of participant population, year of data collection and analysis, economic environment, industry structure, etc.).

- Rate the uncertainty level around each term of the algorithm as high, medium or low, and document the logic of this rating.

- Test the sensitivity of the impact estimate - and its effect on programme cost-effectiveness - to changes in various terms of the engineering algorithm. It may not matter that there is great uncertainty in certain terms of the engineering equation, if wide variances in these terms have only an insignificant effect on the programme impact estimate and cost-effectiveness.

- Estimate the cost of obtaining information that would *significantly* reduce the uncertainty of the algorithm terms having high or medium uncertainty and for which the sensitivity analysis showed that variations produce a significant change in the impact estimate. It may be prohibitively expensive to significantly reduce the uncertainty around certain terms, for example, if it means a very large number of EE installations must be fully metered. However, it may be relatively inexpensive to address free-ridership issues when surveying programme participants.[3]

Having completed these steps, those responsible for the evaluation methodology have the information needed to make an **informed judgement** with regard to matching evaluation resources to the areas of greatest uncertainty and greatest possible effect on the evaluation's impact estimate.

Case Example: Evaluation of the Energy Efficiency Check

We realised that the goal of our evaluation was not compatible with the available information and resources. The initiating question of the evaluation was thus changed from "How much energy has been saved?" to "How many energy saving measures have been implemented due to the energy check?".

Norsk Enøk og Energi AS, Norway

Process evaluation may encompass one or more elements of the programme process from planning and design to delivery. It constitutes a type of administrative evaluation and final conclusion on the tracking and monitoring efforts carried out during the programme period.

Sometimes the process evaluation is split in two: An external and an internal part. The external process evaluation focuses on the part of the process involving external parties while the internal process evaluation focuses on the internal procedures. External process evaluation includes trade ally research (interviews, surveys, focus groups**{** XE "focus groups" **}**) and customer research (both participating and non-participating). The internal assessment includes review of programme database and tracking system, review of programme guidelines, status reports, and marketing material, as well as interviews / focus groups with programme staff.

Some of the uncertainties, which can be addressed by process evaluation, are:

- Objectives - Did the programme meet them? Have they changed? Why/Why not?

- Communications at all interface points (with trade intermediaries, customers, between utility and corporate staff) - Was it accurate, timely, and sufficient?

- Programme design process - Was it successful? How can it be improved?

- Programme data tracking (content and structure) - Quality? Is it accurate? Can it be streamlined? Does it support evaluation?

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[3] *A detailed description of a rigorous, quantitative way to use a similar evaluation planning approach appears in a 1993 paper on allocating evaluation resources: "A Framework for Strategic Evaluation Planning," by Kurt Kiefer, Wisconsin Power & Light Company, Proceedings of the 1993 International Energy Programme Evaluation Conference, Chicago, IL, USA, August 1993, CONF-930842, pp. 623-628. Other papers in the same volume also address this and similar topics, pp. 629-648.*

- Customer satisfaction - How satisfied are customers? How can satisfaction be increased?

- Programme delivery - Are there any bottlenecks? Are there adequate resources at each stage? How does actual delivery compare to planned delivery?

See also Section 2.4.2 on questions, which the evaluation may help answer.

3.5 PROGRAMME VINTAGE

Evaluation needs change as programmes mature. New programmes tend to need more exploratory research, while more mature ones require only very targeted studies about unresolved issues.

As a rule of thumb, an overview of the main evaluation needs by programme vintage**{** XE "programme vintage" **}** is presented in Exhibit 3-5.

Exhibit 3-5: Overview of evaluation needs by programme vintage.

First Year Programmes{ XE "first year programme" **}**
Review Tracking & Monitoring System
Conduct Interviews
Document Actual Operation
Determine Site to Meter and Install Meters
Second & Third Year{ XE "second & third year programme" **} and Pilot Programmes{** XE "pilot programme" **}**
(Review Tracking & Monitoring System)
(Conduct Interviews)
(Document Actual Operation)
(Determine Site to Meter and Install Meters)
Comprehensive Review of Tracking System
Comprehensive Impact Evaluation
Process Evaluation
Mature Programmes
Brief Interviews
Review & Update Programme Documents
Comprehensive Review of Tracking System
Limited Research to Remove Uncertainties
Estimate Programme Impact and Cost-effectiveness
Review Evaluation Results with Planners

3.5.1 FIRST YEAR OF PROGRAMME IMPLEMENTATION

- Review the programme tracking/monitoring system:
  - Ensure that it is accurately capturing key information needed to make implementation management decisions about the programme and to later evaluate the programme's impacts.
  - Conduct a cursory analysis of who is and is not participating in the programme (if programme managers have not already done this) and alert programme managers/implementation staff to unexpected findings.
  - Examine key performance indicators to identify participation or programme impact issues. Decide whether limited survey or focus group research is warranted to provide a basis for making mid-year refinements to the programme.
- Conduct interviews with programme planners, managers, and implementation staff:
  - Determine how the programme actually is being implemented (as opposed to how it was planned to operate).
  - Identify bottlenecks in the programme delivery process, procedural issues, and communications problems.
  - Review results of tracking system review.
- Document how the programme actually operates. Include a discussion of the programme process, including:
  - Development and design of the programme (the development process as well as the programme structure and impact engineering algorithms).
  - Marketing efforts.
  - Consumer/business contacts.
  - Participation processing.
  - Participant data collection.
  - EE measure implementation.
  - Other key activities/points of interaction (such as interactions with implementation contractors or other trade allies).
- Determine sites to meter, and install metering equipment (if appropriate and not already in place).

3.5.2 SECOND/THIRD YEAR OF PROGRAMME IMPLEMENTATION AND PILOT PROGRAMMES

- Perform any tasks listed above for **first programme year** that were not performed during first year.

- Conduct comprehensive review of the programme tracking/monitoring system:

  - Review accuracy of and trends in data.

  - Examine key performance indicators to identify participation or programme impact issues to be addressed in survey or focus group research.

  - Perform market evaluation analysis — Identify and profile participating and non-participating populations, segments of high and low impact, etc.

  - Design final sample design plan for participant and non-participant survey/metering research as appropriate. Select samples as appropriate.

- Conduct comprehensive **impact evaluation**:

  - Implement primary impact evaluation strategies, including survey research, secondary research if appropriate, and metering data collection, as well as any additional meter installations needed.

  - Analyse all data collected, to estimate programme impacts and values for specific impact parameters.

  - Conduct programme benefit/cost analysis.

  - Explore reasons for specific impact evaluation findings/results. Compare results to the programme's engineering algorithms, including assumptions behind specific algorithm parameters. Work with programme planners to resolve inconsistencies and anomalies.

- Conduct process evaluation:

  - Implement process evaluation strategies, including interviews with programme staff (unless performed recently), secondary research (if appropriate), and research with consumers targeted by the programme, both participating and non-participating.

  - Analyse data collected.

  - Report results to programme management in constructive manner.

3.5.3 MATURE PROGRAMMES

- Conduct brief interviews with programme staff, to identify programme changes.

- Review and update programme documentation.

- Conduct comprehensive review of the programme tracking/monitoring system:

  - Review accuracy of and trends in data.

  - Examine key performance indicators to identify participation or programme impact issues to be addressed in survey or focus group research.
  - Design final sample design plan for participant and non-participant survey/metering research as appropriate. Select samples as appropriate.
  - Perform market evaluation analysis — Identify participating and non-participating populations, segments of high and low impact, etc.

- Conduct limited, targeted research with targeted population, to resolve lingering uncertainties and verify implementation, as needed. Possible areas include:
  - Free-ridership, spill-over and persistence (which are apt to change over time).
  - Issues identified in performance indicator review and programme staff interviews.
  - Remaining market potential and ways to increase penetration (e.g., through programme redesign).
  - Selected impact parameters.
- Estimate programme impacts and cost-effectiveness.
- Review selected evaluation results with programme planners (as appropriate).

As the method described above indicates, one need not conduct a comprehensive evaluation of a programme every year it is being implemented. Instead, evaluation should be used as a tool for addressing areas of uncertainty at each point in a programme's life. Still, it is important to (1) conduct at least one comprehensive evaluation of every major programme and especially (2) conduct research in the market place, to know what is really happening in the programme.

3.6 DETERMINE THE GENERAL LEVEL OF EFFORT FOR THE EVALUATION

As discussed above, it is usually not feasible or cost-effective for every programme to receive the same level of analysis each year. At the same time, it is not possible to indicate which share the evaluation cost should make of the total programme cost. However, the following guidelines are offered as a rationale for determining the general level of effort for an evaluation of a specific programme:

More **comprehensive evaluations** are generally worthwhile to perform if a programme …

. . . is expected to yield very significant impacts and/or has cost a great deal to implement. It is only logical that, when significant resources are at stake, careful attention should be given to how a programme is operating and what its impact is.

. . . is a pilot programme. Pilot programmes serve as the trial stage for larger, more extensive, more costly programmes. Comprehensive evaluations of such programmes may result in significant cost savings or impact increases when full-scale programmes are later implemented.

. . . involves a new programme delivery approach or a new technology. For programmes that are significantly different from programmes implemented in the past, it is likely that important

lessons will need to be learned and that certain preconceptions of programme planners and implementers will be inaccurate. This is particularly true for entirely new types of programmes (e.g., market transformation programmes) or new technologies with which organisations may have no prior experience.

. . . *will receive a high degree of scrutiny.* This is self evident. The level of scrutiny is likely to increase if (1) the programme or its sponsor/implementing organisation are viewed with scepticism by entities having some political clout, (2) significant sums of money are at stake, or (3) significant public relations capital is at stake (possibly the case with regard to programmes targeted at reducing greenhouse gas emissions so that governments can meet international commitments).

Simpler, **less expensive evaluations** should be considered for less controversial, lower-impact, lower-cost, and/or more commonplace programmes.

Of course, the level of effort for the evaluation may be strongly determined by the overall level of funding available for the programme's design, implementation and evaluation. Those charged with developing and implementing EE programmes generally want as much of programme funding to go toward achieving programme impacts as possible, rather than precise measurement of what these impacts are. The uncertainty analysis described above may help decision-makers appreciate the value of addressing specific evaluation issues and the possible cost consequences of not doing so.

Exhibit 3-6: Rules of thumb regarding level of effort for the evaluation.

Comprehensive Evaluation	**Less Comprehensive Evaluation**
if	if
Significant Funding	Moderate/limited Funding
Significant Expected Impacts	Moderate/limited Expected Impacts
Pilot Programme	Well-known Delivery or Technology
New Delivery or Technology	Not Controversial
Subject to Scrutiny	

3.7 KEY DECISION-MAKERS

The**{** XE "key decision-makers" **}** individuals and organisations needing to make decisions about the programme help determine both the relative importance of various aspects of the evaluation and the level of rigor with which the evaluation must be performed. The evaluator must determine:

- Who must make decisions about the programme?
- What aspects of the programme will affect those decisions?

Remember also to establish **when** decision-makers must make their decisions. Important, comprehensive evaluation data may be of little use, if they come to decision-makers after key decisions have been made.

3.7.1 MANAGERS OF PUBLIC POLICY PROGRAMMES

Typically, the closer the decision-maker is to the individuals charged with programme implementation, the more **discretion** the decision-maker has regarding evaluation requirements and the more variability there is in the focus of evaluation activities.

Consider a programme manager at a utility, which is implementing an EE programme. The manager may have a great deal of experience in business or industry, or with regard to a specific technology, leading to a strong degree of comfort about the programme's assumptions for certain impact parameters such as the number of hours that certain equipment is used daily, or the type of equipment likely to be replaced by more efficient equipment. However, the manager may have some uncertainty about the efficiency of equipment that would be purchased in the absence of the programme or the effect of weather on equipment energy use. The manager would want the evaluation to focus minimal resources, if any, on the "understood" impact parameters and more resources on those about which there is greatest uncertainty. That is, the manager's decision-making needs would e.g. be met by an evaluation focused on the effect of weather on equipment use.

However, the manager's opinions may not be shared by others, especially those with less or a different type of experience in the market. Perhaps the manager had a strong experience that left an indelible impression several years in the past, and perhaps the industry or equipment has changed somewhat in the intervening years. The manager's perspective may be idiosyncratic, if not inaccurate.

If the **impetus for the programme** has come from within the organisation, this perspective may not be challenged for some time. The manager must merely convince upper management that the programme is achieving its objectives and, failing strong evidence to the contrary, upper management may not ask detailed enough questions or have sufficient technical/industry knowledge to become concerned that the manager's claims are not rigorously supported. After all, upper management may only be concerned with high-level questions such as "Should this programme be continued?" or "Should this programme be changed?"

3.7.2 OTHER DECISION-MAKERS ASSOCIATED WITH PUBLIC POLICY PROGRAMMES

On the other hand, decision-makers other than the programme manager may affect the nature of the evaluation:

- Perhaps the organisation is faced with a need to dramatically reduce costs and all possible cost-cutting opportunities are examined. Basic assumptions about the wisdom of implementing the programme may be challenged. Or, if the programme costs are large enough, other decision-makers may want to examine ways to improve programme cost-effectiveness, i.e., achieve the same or similar results by spending less.

- Perhaps some in upper management require strong documentation as a matter of policy or style. The evaluation may be required to produce data that confirm or refute the programme manager's assumptions.

- Perhaps the programme's impetus comes from an overseeing external source – government, regulators, etc. – which is either paying the programme manager's organisation to implement the programme or requiring it to do so. Decision-makers in these organisations may be responsible to a wide range of constituency, some of which may be hostile to the programme manager's organisation. Perhaps the decision-makers, themselves, are hostile to the organisation. In this scenario, the evaluation must be thorough enough and the evaluation results rigorous enough to withstand scrutiny by possibly hostile reviewers.

- Perhaps a government agency required the programme (or programmes like it) to be implemented with the intent of showing the rest of the international community that it is meeting its commitments to reduce greenhouse gas emissions. Now, decision-makers in other countries must be convinced of the validity of programme impact claims made by the implementing organisation. Typically, the requirement is for the evaluation to meet some sort of universal standard, most likely one that is both universally accepted in the academic community but practical enough (in terms of cost and data requirements) for all countries involved to meet.

Regardless of who the decision-makers are for public policy EE programmes, the evaluation team should confirm, from the beginning, what the primary programme objectives are with the decision-makers. It will also be helpful to obtain the decision-makers' initial assessment, if any, of the indicators for which specific changes would constitute the strongest evidence of programme-induced market change.

3.7.3 DECISION-MAKERS IN ENERGY SERVICES PROJECTS

Consider a similar process in the case of an energy services company proposing to implement an EE measure of some sort (lighting change-out, HVAC system upgrade, etc.) for a potential client. Decisions about how to estimate the energy impacts of specific EE measures may become much more simplified.

In this case there are two main decision-makers. The ESCO's management seeks a specific profit margin on the project and will price the project and any related evaluation (i.e., monitoring and verification) accordingly. Evaluation becomes a tool for increasing client comfort with the project. The client's management is likely to want to spend as little as possible to reap the financial rewards of the EE project, and knows that the evaluation (i.e., monitoring and verification) represents a cost that must be subtracted from the financial benefits it will receive.

Evaluation then becomes a method for **addressing risk**. What level of risk does the client feel is inherent in the project? Are engineering assumptions behind the pre-implementation estimate of the project's savings straightforward and generally accepted? How sophisticated are the client's technical staff? How comfortable are they with the impact estimate? Are they willing to take responsibility for savings estimate as long as the ESCO is held accountable for a specific level of implementation quality?

Perhaps the client understands the technology well enough so that no ongoing monitoring is necessary, but rather only verification that the measure is being installed competently. Or perhaps the client perceives some risk and, rather than requiring sophisticated monitoring and evaluation, prefers to off-load risk through a shared savings agreement based on some bottom-line indicators the client is confident will reflect the project's success. In this way both the ESCO and the client have a strong interest in the project yielding maximum savings.

Yet another scenario is one in which the client is a government body negotiating work to be done on a government-owned facility. This entity may be required to have monitoring and verification for the project follow widely accepted guidelines such as those appearing in the **International Performance Measurement & Verification Protocol** for energy services projects (see bibliographic summary in Appendix B). Whatever the case, in the ESCO project scenario, evaluation becomes another part of a contract between two parties, and whatever the two parties are willing to accept and agree to determines what is required.

Energy marketers implementing EE programmes as a strategy for generating profit, or for retaining existing customers/attracting new ones have a similar decision-making focus to that of ESCOs, because, in effect, they are functioning as ESCOs. Again, what is most important is customer satisfaction, and decisions about the rigor and cost of evaluation activities (monitoring and verification) are driven by what is required to maximise satisfaction and profit. The value of an evaluation to the energy marketer is in providing data related to customer retention, profit margins, profitability, market share, market position, and other competitive issues, rather than energy savings per se. Energy savings are only a mechanism for addressing these more important issues. As such, evaluation of energy impacts of specific projects (or of all projects within a specific time period) is secondary and a contractual issue primarily serving the needs of the marketer's client's decision-makers.

3.7.4 DECISION-MAKERS IN UTILITIES OPERATING LOAD MANAGEMENT PROGRAMMES

The key decision-makers with regard to programmes designed to delay or avoid the need for costly upgrades to T&D equipment include the programme manager, system planners, and, if the utility is subject to regulation, the regulating authority. For this type of programme, more than any other, decision-makers are likely to require compelling, easy-to-understand evidence of programme impacts, because the reliability of portions of the T&D system is at stake.

The central issue is whether the programme has **delayed the need for the planned upgrades** and, if so, for how long. Answering this question implies a careful analysis of the assumptions and analysis used by those planning the upgrades. As noted earlier, the very process of closely analysing these assumptions can sometimes result in significant cost savings and delayed implementation of upgrades. However, the evaluation will need to assemble strong evidence, with conservative assumptions, to support claims of any real energy savings. Data from measurements at the targeted transformer or substation level are likely to be considered the strongest source of impact evidence, and system planners and the evaluation team will need to work together to provide a reasoned estimate of the reliable impact of the programme.

3.8 FOCUS THE EVALUATION

Given all the possibilities and buts and ifs, it is easy to get side-tracked in the evaluation efforts. It is therefore important to focus**{** XE "focus" **}** before proceeding any further with the evaluation.

A simple method to breaking down the evaluation into manageable pieces is to go through the five steps below:

1) What is the **question**, which the evaluation seeks to answer (initiating evaluation question)?

2) What does the question **aim** to clarify?

3) What are the underlying **assumptions** (with respect to mechanisms)?

4) Which **indicators** will be used to answer the question?

5) What is the **approach** for establishing the indicator?

If it becomes difficult to answer the questions in step 2-5, then the first question is not specific enough. It may be necessary to use iterative thinking to arrive at a sufficiently specific initiating question. Step 3 relates the programme theory and the problem theory discussed above.

An example may illustrate the idea more clearly. We therefore consider a programme example. The programme objectives were to provide training in heating systems and EE improvement of such to energy managers in all industry. The training course and certificate were free of charge and only offered to employed energy managers. Direct mail was used to promote the course. A regional energy centre offered the programme and the training was outsourced to a specialised consulting company. The course was repeated four times in a row and lasted a week each time.

All elements of the programme may be subjected to evaluation and they are not all equally easy to evaluate. Some examples of **initiating evaluation questions** (Step 1) are presented below (by far not a complete list):

- Would others be interested in the course (and to a greater energy impact)?
- Was direct mail a good way to create interest?
- What energy savings were achieved due to the programme?
- What was the motivation of the energy managers to participate (were they planning to improve their systems anyway)?
- What is according to the energy managers the driving force in initiating improvement of the heating system efficiency?
- Which industrial branches did the participants represent?
- What impact does the promised certificate have on participation rate?
- Would it be more cost-effective to use regional energy centre staff as trainers?

Some of the questions may need to be divided into sub-questions to allow sound, structured evaluation (e.g. what is *good* training?). Careful choice of words is necessary to direct the evaluation in the wanted direction. Exhibit 3-7 shows an example, which illustrates that the same question may be asked for different reasons. The example should not be seen as “an absolute truth” – it only aims to hint at what might be of interest and to point out that focus and explicit, precise formulations are important.

Exhibit 3-7: Example of breakdown of an evaluation.

Question:	Did the consulting company fulfil its contract to our satisfaction?		
	Interpretation 1	**Interpretation 2**	**Interpretation 3**
Aim:	Form a basis for a decision on whether or not to employ this consulting firm again in this or other training courses.	Release payment for services rendered.	Did the contents and structure of the training course give new and useful skills to participants? (The exact skills wanted could be listed.)
Assumptions:	The consulting firm will perform in the same manner in similar and different training courses (including applied approach and choice of teacher).	Contract fulfilment can be measured in number of hours, subjects taught, and the staff's impression of the course.	▪ The participants have not been exposed to other ways of obtaining these skills during the course period and two months forward. ▪ If the skills are useful, companies will send additional people to the course. ▪ The participants will apply their skills no later than 2 months after the programme.
Indicator:	▪ List of subjects covered in the training. ▪ Participant small talk during breaks. ▪ The level of satisfaction of the participants including their suggestions for improvement at the end of the course and later. ▪ Number of energy managers, who have applied their newly acquired skills. ▪ Consultant's impression of the course.	▪ List of subjects covered in the training. ▪ Staff's impression of the course. ▪ Invoice from consulting company.	▪ List of subjects covered in the training. ▪ Number of energy managers, who have applied their newly acquired skills. ▪ Skills, which have been applied. ▪ Number of companies, which have sent other energy managers to the course.
Approach:	▪ Review subjects listed in course material. ▪ Interview staff that was present during training. ▪ Participant comments overheard by staff or expressed to staff. ▪ Review assessment forms completed by participants at the end of the course. ▪ Interview x% of the participants 2 months after completion of the course. ▪ Interview the teachers.	▪ Review subjects listed in course material. ▪ Interview staff that was present during training. ▪ Compare invoice with teacher presence during course and the amount of course material distributed.	▪ Review subjects listed in course material. ▪ Interview x% of the participants 2 months after completion of the course. ▪ Compare course lists to find "repeat" companies.

Case Example: Evaluation of a CFV Programme – Powershift

The evaluation of the PowerShift programme currently employs a number of performance indicators ranging from purely quantitative carbon and regulated atmospheric emission savings and cost-effectiveness indices to more qualitative and non-emission based indicators such as awareness, cost differentials and the development of refuelling infrastructure.

The Energy Saving Trust is required to report to Government annually on the total savings and policy cost per tonne of CO_2, total green house gas, CH_4, NO_x, and particulate matter. Both savings and policy cost are calculated on an annual and a lifetime basis. The policy cost equates to government funding and is effectively the total programme expenditure less partner and customer contributions. Emission factors used are sourced from the report of the alternative fuels group of the Cleaner Vehicles Task Force.

Other **prime indicators** monitored are:

- CFV sales per year;
- Total vehicle populations;
- Number of refuelling stations;
- Financial price premiums between CFVs and conventional equivalents;
- Residual values of vehicles.

The **secondary indicators** include, for example:

- Number of grant applications;
- Number of workshop delegates;
- Number of press articles;
- Number of hotline calls;
- Number of website visitors;
- Number of approved vehicle manufacturers;
- Number of approved converters;
- Number of fuel suppliers.

Indicators are monitored using market research involving vehicle manufacturers, converters, and fuel suppliers.

Energy Saving Trust, United Kingdom

3.9 REQUIRED BUDGET FOR EVALUATION

It is important to allocate sufficient budget{ XE "budget" }, staff and time to evaluate competently important programmes and projects. In general, evaluations planned early in the programme's life cycle yield more accurate and useful results at a lower cost than those planned and implemented after programme completion.

The appropriate size of the budget for evaluation varies significantly depending on the programme type, the programme objectives, and the evaluation objectives. Roughly estimated, a sound evaluation budget constitutes around 3-10% of the total programme costs.

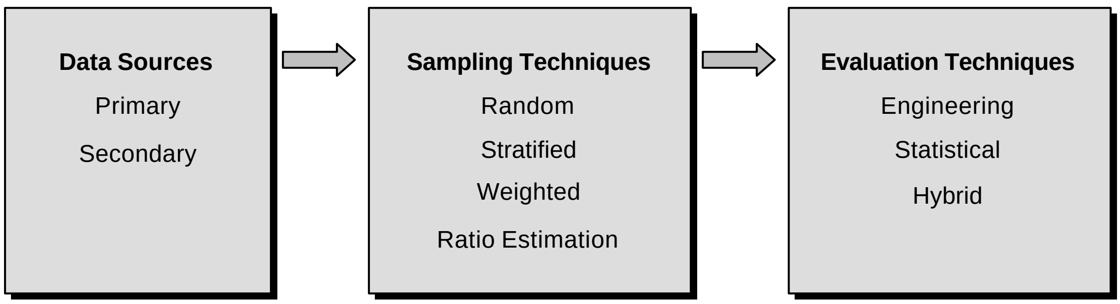
Some flexibility should be designed into the budget, particularly when planning new evaluations, as it may turn out certain components of the evaluation study may go over or under budget. Another point worth remembering is that it might be possible to combine the evaluation efforts of several programmes and/or projects and thus reduce both costs and effort.

4 OVERALL IMPACT EVALUATION STRATEGIES

This chapter provides:

- A listing of **resources** required for obtaining data needed in impact evaluation;
- Descriptions of **specific evaluation strategies** that can be used at various levels of effort, from simple and often quite imprecise methods, to highly complex, expensive and much more accurate methods;
- A discussion of the **strengths and weaknesses** of main evaluation strategies, including the types of programmes most appropriate to evaluate with them;
- A discussion of **programme cost-effectiveness**.

Exhibit 4-1: Impact evaluation strategies.



4.1 IMPACT EVALUATION DATA SOURCES

4.1.1 TRACKING AND MONITORING SYSTEMS

Tracking**{** XE "tracking" **}** and monitoring**{** XE "monitoring" **}** systems provide information for impact evaluations as well as process evaluations.

Tracking and monitoring are both a sort of "running" evaluations. Tracking refers to the recording of programme data while monitoring refers to the general surveillance of the programme management, which may lead to adjustments. Often no distinction is made between the two terms.

Tracking and monitoring systems collect programme data on a regular basis providing an ongoing reading of the programme performance useful for programme management and stakeholders. Tracking and monitoring data can thus be used to identify problem areas as well as areas in need for more thorough evaluation. Specific performance thresholds are established before commencing the programme implementation. Also specific evaluation steps to be carried out if threshold values are exceeded are identified prior to programme implementation.

The data collected through the tracking and monitoring systems is also very valuable to the ex-post evaluation of the programme. If the development of tracking and monitoring systems is co-ordinated with the evaluation planning, the total effort needed for data collection may be minimised.

Case Example: Energy Efficiency Standards of Performance

Energy Efficiency Standards of Performance (EESoP) were introduced in 1994 in England and Wales and a year later in Scotland. The promoted EE measures include low energy lamps, domestic appliances, insulation, heating systems, and combined power and heat installations. An essential part of EESoP scheme has been to monitor the EE programmes in three fundamental areas: Energy, customer satisfaction, and quality.

In order to compare the actual energy savings related to heating and insulation measures with predicted savings, a methodology was devised in which the first step was to estimate how much energy could be saved from various measures in each property type, assuming standard heating patterns.

For each project, a sample of at least 5% of properties was selected for monitoring. Meter reading data for a year before and after installation of insulation measures were analysed, taking care to eliminate estimated readings or other anomalous data. Readings were adjusted to take account of weather variations nationally and from year to year.

Results show that individual properties may save much more or less energy than the average predicted by the computer model. The reasons for this depend upon a wide range of factors including occupancy, heating patterns, ownership of electrical appliances and construction details. However, although individual differences may be large, on average they are not significant enough to demand modifications to the existing model. Furthermore, the variations do not relate to customer perception or acceptance of the programme and do therefore not justify a modification of the programme (e.g. alternative marketing approach or different target group).

Using a questionnaire, customer satisfaction with promoted EE measures is monitored by energy suppliers. A minimum of 5% of homes for all measures installed are monitored except for compact fluorescent lighting where 1% or 1,000 customers are monitored (whichever is the less).

Quality of installation is surveyed and reported on by energy suppliers in conjunction with local authorities in a minimum of 5% of homes receiving fixed “fabric” measures such as insulation or heating measures. This quality monitoring checks whether or not the measures have been installed in line with approved British/European Standards etc. For CFL schemes, quality criteria are fulfilled if lamps included on an approved list are used. For appliance schemes, assuming that all products used have relevant CE marking, there are no additional quality monitoring requirements.

So far, customer satisfaction and quality have been satisfactory.

Electricity Association, United Kingdom

Examples of possible functions of tracking and monitoring systems are:

- Comparing at regular intervals recorded progress against goals (kW and kWh impacts, participation, or penetration of measures);
- Comparing at regular intervals recorded expenditures against budgets;
- Monitoring backlogs;
- Monitoring contractor activities;
- Supporting reporting requirements of upper management and regulatory staff;
- Tracking effectiveness of promotional approaches;

- Characterising participants;
- Supporting ongoing benefit/cost analyses.

When using tracking and monitoring results, the evaluator should differentiate between findings uncovered by analysis of database and "anecdotes", to ensure that factual information does not get confused with judgmental information. All the same, a comparison of the two will provide valuable information on the factual and the perceived programme performance. Discrepancies could for example identify a need for better communication.

4.1.2 PRIMARY DATA SOURCES

The primary sources of data**{** XE "primary data sources" **}** for impact evaluations are presented below. The more complete and more accurate each of these data source are, the less expensive and more accurate the impact evaluation can be.

Programme tracking system data – Data about each participant in the programme, which can include contact/address information, account number, details about the measure(s) installed and equipment replaced (if any), demographic/business type information, facility characteristics, appliance holdings, and preliminary estimates of the participant’s energy impacts. Tracking system data quality is extremely important; it is the main record of what is happening in the programme. Also of high importance, for statistical billing analyses, is the ability to link a particular participant with that participant’s energy usage (e.g., via the account number).

Surveys with programme participants and/or non-participants – These can be performed via mail, telephone or in-person, and require market research expertise so that survey responses actually reflect the exact information the interviewer wanted to determine. They are used in most evaluations.

On-site facility surveys – These may be considered a subset of surveys with programme participants and non-participants, but they focus on the consumer’s facility, home, appliances, and/or energy-using equipment. They are also specifically used to verify that EE measures have been implemented. Usually, they are combined with surveys of the consumers, which can often be performed at little to no additional cost (the cost of placing the researcher at the facility has already been borne) and many surveys may take a relatively short time to complete, compared to the time it takes to complete a facility audit or efficiency measure verification.

Energy use/billing data – These data are collected using meters located at the consumer’s facility and serve as basis for energy bills to be sent to utility customers. They are one of the central data resources used in billing analyses (and, sometimes, the only one). Higher quality (cleaner) data will speed up the evaluation process and help ensure that precision of the impact estimate is maximised.

End-use metered data – These data are collected from instruments that measure energy usage by a specific piece of equipment or process, at the consumer’s site. The measurement instruments can range from relatively inexpensive, easy-to-install “loggers” that record only the number of hours a piece of equipment is “on,” to expensive, multi-channel devices that take significant skill to install and can record a number of different types of data (temperature, energy use, load level, on and off times, humidity, etc.) for more than one piece of equipment. Key to the use of end-use metering equipment is ongoing verification that the meters are calibrated and collecting data accurately. Even simple light loggers involve the expense of an installation visit; that expense is wasted if the unit malfunctions or for some reason the data it collects are not usable.

End-use metering is most useful for:

- Evaluation of gross savings.
- Estimation of coincident peak load savings.
- Focused evaluation of large-impact facilities that are not well suited to statistical analysis.
- Providing data for statistical analyses and combination approaches.
- Evaluations of specific technologies (gross consumption change for specific measure).
- Addressing specific research issues, such as determining operating hours or estimating interactive effects.
- Joint utility projects where the relatively high costs can be spread across utilities.

4.1.3 SECONDARY DATA SOURCES

Secondary data sources**{** XE "secondary data sources" **}** per definition already exist and are available from government offices, previous research studies, equipment manufacturers, research organisations, private firms, etc. From the perspective of the evaluation, they fall under the category of "the best information available" and are used:

- To help confirm the reasonableness of impact estimates or engineering assumptions.
- To provide estimates for needed data items that are otherwise impossible or too expensive to collect (equipment operating efficiencies under different load conditions, equipment sales for specific geographic areas, etc.).
- To help explain unexpected impact findings or supply information on such impact parameters as free-ridership, spill-over, rebound, or persistence.

4.2 EVALUATION TECHNIQUES

Evaluators have two basic types of evaluation techniques at their disposal: **Engineering methods{** XE "engineering methods" **}** and **statistical methods{** XE "statistical methods" **}**. Engineering methods are based on defining the basic physical relationships that exist between the change in energy use and the factors that determine that change, based on engineering principles. Statistical methods use recorded consumption data, and compare changes in the level of energy consumption for two populations (e.g., programme participants and a control/comparison group) to isolate the energy impacts of the adoption of the specific EE measures promoted by a programme.

The two techniques can also be combined, the so-called **hybrid technique**. Statistical methods can be enhanced by including an initial engineering estimate of the energy savings for each participant as an explanatory variable in the regression equations**{** XE "regression equations" **}**. The statistical model then estimates coefficients that represent not energy savings but realisation rates**{** XE "realisation rates" **}** (the factor by which the engineering estimates must be adjusted in order to reflect the true energy impact). The usefulness of this technique, of course, relies on the accuracy of the initial engineering estimates.

4.2.1 CONTROL GROUP – COMPARISON GROUP

Regardless of the techniques used, most evaluations are based on an experimental or quasi-experimental design, in which the impact of a programme is estimated by comparing a treatment group to a comparison group{ XE "comparison group" } or a control group (see also Section 5.1). The energy that the targeted population would have consumed in the absence of the programme cannot be observed directly; a proxy for this consumption must be used.

Case Example: Energy Efficiency Check (EEC)

Based on the new examination of the programme history we decided to perform a larger survey to ensure significant results. We chose a main sample and two comparison samples to answer our questions regarding effects related to “non-participants”, self-selection, rebound, free-riders and spill-over effects, etc. In total 1,200 customers in Akershus region were interviewed.

The three sample groups were:

- Customers who participated in the EEC programme, i.e., received, completed, and returned the form;
- Customers who received the EEC, but did not complete or return the form;
- Customers who did not receive the EEC (or other EE material from the EE centre over the past year).

The survey revealed several interesting characteristics:

- About 72% of the 2,400 people that completed the EEC were men. This might indicate that men are the ones most interested in implementing EE measures in general.
- The number of people in the household does not influence the reaction to the EEC.
- The income, however, seems to make a difference in whether you use the EEC or not. People with high income are more likely to participate in the programme. It seems that the medium size households with a living area of 100-250 square metres are more likely to return the EEC.
- The heating system of the houses has little influence.
- The main reason for implementing EE measures is to save energy and reduce electricity bills. More than 40% give this answer in all sample groups. Approximately 10% want increased comfort and about 10% say that general maintenance is the main reason. Women and people in older houses are more interested in increased comfort.
- The houses in the third sample group had paradoxically implemented more EE measures that the other houses. However, the houses in this group are in general older and hence they require more maintenance and there are more young people in older houses. Both may be contributing factors to why this sample group has implemented more EE measures on the whole than those that had received the EEC.
- The reasons stated why people do not implement EE measures vary between the sample groups. In the first sample 71% said that they had already implemented the measures. In the two other samples only 50% gave the same reason. This shows again that the people who have used the EEC are already very aware of EE. Other reasons given were “no need”, “new house”, and “can not afford”.

Norsk Enøk og Energi, Norway

Ideally, a control group should be used. A control group{ XE "control group" } is a comparison group, which shares the important characteristics with the treatment group and either was not offered the programme or could not participate for some reason. The impact can be found by looking at the difference between the two groups. The way to achieve this is to select randomly from the same population who is to participate and who is to be part of the control group. This is, however, rarely possible in real life. Often you have to settle for a comparison group from a different population. If the comparison group is from a different geographical area, then some of the characteristics of the members will most likely be different from those of the treatment group. Another typical type of comparison is between participants and non-participants within a certain geographical area. However, this is problematic in the sense that it often is the ones most interested or with the largest potential that choose to participate.

Usually, the effect of the programme is modelled as the difference between the programme participants' consumption and that of some group that represents participant consumption in the absence of the programme, for example:

- Participant consumption before the programme may be compared to participant consumption after the programme (pre-/post-treatment design).
- Participant consumption may be compared to consumption of non-participants either after the programme or both before and after the programme (treatment/comparison group design).
- Participant consumption may be compared to consumption of a group of consumers not exposed to the programme (treatment/comparison group design).

Special issues must be addressed with each of these designs (matching of participants to non-participants, self-selection bias, accounting for programme effects on non-participants, etc.). These issues are discussed in more detail in Chapter 5.

4.2.2 SAMPLING TECHNIQUES

In all except the crudest impact analyses (e.g., those based exclusively on a simple engineering algorithm, its related assumptions, and no specific data from programme participants), measurements are usually taken from a *sample* of the group being analysed. Therefore, evaluations must address the reliability of using the estimate of the sample as representative of the entire population. Sampling techniques**{** XE "sampling techniques" **}** have been discussed extensively in the existing evaluation literature and generally fall into four basic categories:

- **Random samples{** XE "random samples" **}**, which select a group of consumers/installations to be analysed using a random selection process.
- **Stratified samples{** XE "stratified samples" **}**, in which the study population is broken into homogenous groups and separate samples are selected from each homogenous group.
- **Weighted samples{** XE "weighted samples" **}**, which address the possibility that some participants may have greater impacts than others.
- **Ratio estimation{** XE "ratio estimation" **}**, in which a small group is selected for detailed and often more expensive analysis (e.g., using end-use metering) and, through a linkage based on variables common to the small group and the entire population of interest, results are extrapolated to the entire population. (Sometimes, two extrapolations are done: One to a larger group analysed at a less intensive level (e.g., through survey research) and then from the larger group to the entire population.

Careful sample design is important to the evaluation of EE programmes, because often more sophisticated sample designs can allow an evaluation study to obtain more precise estimates for the same evaluation expenditure or the same level of precision at a reduced expenditure. See the references in Appendix B for more detailed discussions of sampling strategies for impact evaluations. Sampling is also discussed in many market research and non-energy programme evaluation texts.

Case Example: Use of Electronic VSDs in Motors in the Portuguese Industry

Electric motor driven systems account for 67% of industrial electricity consumption in Portugal. Even so, awareness of the saving potential related to installation of variable speed drives is very low. Therefore a project was developed under PEDIP II programme with the main aim to identify the energy savings potential and sensitise industrial top level decision-makers to the application of the VSD technology.

The project consisted of a pilot action, where electronic variable speed drives and soft starters were installed in various industrial plants to allow measurement of the resulting energy savings. The results were then scaled up for each industrial subsector to arrive at an estimate of the national potential for energy savings (ratio estimation). The sample of industrial enterprises selected for pilot testing of VSD technology was, however, not representative of the whole industrial sector since preference was given to the following:

- Enterprises currently employing young technicians in an energy traineeship. CCE is currently conducting an EE programme, which provides 2 months training in EE to newly educated engineers followed by a 9 months traineeship in industrial enterprises with high electricity consumption. Furthermore, the two activities are likely to strengthen one another;
- Industrial sites listed in proposals prepared by VSD technology suppliers and where the suppliers appeared willing and able to provide e.g. the data and co-operation requested by CCE;
- Sites which had the highest possible variety of equipment sizes and types within its industrial branch;
- 50% of the total equipment cost for the pilot project was financed by the government (PEDIP II Programme) and the remaining 50% by the involved industrial sites. However, the budget limit for contribution from PEDIP II was 39,904 EUR in total. Therefore a suitable mix of industries had to be construed which avoided exceeding the permitted co-financing limit of 39,904 EUR;
- The selected projects should allow testing of a great range of motive power (between 11 and 200 kW), types of equipment (drum mills, compressors, fans, etc), and types of industries (ceramics, agro-food sector, cork, textiles, and chemicals);

The distribution of pumps, fans, compressors, and other motors varies between but also within the different industrial subsectors – mainly due to differences in manufacturing processes even for similar products. Therefore, extrapolation of pilot results to a national level does not necessarily lead to trustful values.

The consequences of this was not investigated since the aim was to estimate the approximate size of the energy saving potential of VSD introduction on a national level and not to obtain exact values for each industrial subsector.

Centro para a Conservação de Energia, Portugal

4.2.3 ENGINEERING METHODS

Planners develop basic engineering algorithms to estimate programme impacts prior to programme implementation.

There are three basic types of engineering methods:

- Estimation from **simple engineering algorithms { XE "simple engineering algorithms" }**;

- Estimation from **enhanced engineering algorithms{** XE "enhanced engineering algorithms" **}**; and
- Estimation from **engineering simulation models**.

Even before a programme is implemented, programme planners typically develop estimates of programme impacts, using engineering algorithms. These estimates help decision-makers decide whether programmes are likely to be cost-effective and provide very rough estimates of the programmes' impacts.

For example, engineering algorithms such as the ones presented below might be the basis for programme planners' estimates of the energy (kWh) and peak load (kW) impacts for individual measures in a non-residential efficient lighting programme (seen from a customer perspective the transmission and distribution losses should be excluded):

Change in kWh = (kW of removed or replaced unit - kW of efficient unit) * Number of units * Number of hours * (100% + Transmission & distribution system loss %)

Change in peak kW = (kW of removed or replaced unit - kW of efficient unit) * Number of units * Coincidence factor * (100% + Peak transmission & distribution system loss %)

The coincidence factor is the % of units "on" during system peak period.

The number of hours may be defined **per year** or **per lifetime** of the measure.

A more sophisticated set of algorithms for the same purpose might have separate algorithms for periods thought to be significantly different from each other and might include other factors that may significantly affect the actual impact from the programme. An example of a more sophisticated set of algorithms that address "summer" programme impacts might look like the following:

Change in kWh =

(kW of removed or replaced unit - kW of efficient unit) *

Number of units *

(1 + fraction of lighting in cooled space * Additional savings for cooling reduction factor) *

Number of hours *

(1 - Free-ridership fraction + Spill-over effect) *

(1 - Rebound fraction) *

(1 + T&D system loss fraction) *

Persistence fraction.

Change in kW =

(kW of removed or replaced unit - kW of efficient unit) *

Number of units *

(1 + fraction of lighting in cooled space * Additional savings for cooling reduction factor) *

Fraction of units "on" during system peak period *

(1 - Free-ridership fraction + Spill-over effect) *

(1 - Rebound fraction) *

(1 + Peak T&D system loss fraction) *

Persistence fraction.

In developing a pre-programme estimate of programme impacts, the planners would make assumptions about the values to use for each parameter in the algorithms, based on the best available information (e.g., previous technology studies, evaluation results from other years or other utilities/countries, wild guesses, etc.).[4] If using the more sophisticated algorithms, the planners would have similar algorithms for other systematically different periods such as winter or shoulder month periods or, for load impacts, shoulder and off-peak periods of the day.

Case Example: Energy Performance Standard in the Dutch Building Decree

At the end of 1995, an Energy Performance Standard (EPS) was introduced in the Dutch Building Decree. The aim of this legal instrument was to reduce the energy use in new houses, but leave freedom of choice to architects, developers, and house owners regarding how they prefer to reach the required performance level.

A calculation model for determining the energy performance level of a house therefore had to be developed. A "typical" new house (i.e., average) was defined for each of the categories: Multi-family house, row house, semi-detached house, and one-family house. An “energy budget” related to the EPS level (i.e., a maximum allowed consumption) was then defined for each category. The calculation model not only included energy consumption related to space heating, cooling and ventilation, and lighting. It also included water heating to provide additional stimuli for use of residential solar hot water systems. Using the calculation model it is then the responsibility of the architect to prove that the designed house does not exceed the allowed energy budget.

At the end of 1997, a comparison of the estimated energy use (based on the EPS calculation model) and the real energy use was made. The investigation concluded that the EPS could not be used to calculate real energy consumption. It could only be used to calculate the difference between the allowed energy budget for a specific house and the estimated energy consumption prepared by the architect using the calculation model. However, in spite of the fact that the EPS model could not be utilised on an individual level, it did on a national level arrive at energy savings estimates comparable to the realised savings in 1997.

Furthermore, it was found that the impact of behaviour and the penetration of new appliances in real households had to be included in the future analyses to be able to distinguish their impact on the household energy consumption level.

NOVEM, The Netherlands

Impact estimates based on planners’ engineering algorithms can be improved considerably using actual programme data.

These same algorithms could be used by evaluators to estimate the actual impacts from a programme. A range of methods could be used, from the most simple to very “enhanced” methods. Continuing our example of the non-residential lighting programme, options include the following:

- Substitute the actual number of units recorded in the programme tracking system and calculate the estimated impacts.

- Conduct telephone surveys with programme participants. Survey results could be used to:

  - Verify the number of units installed and the installed capacity (W) of both the replaced and newly installed units.

  - Obtain an estimate of all the other parameters in the algorithms (except for spill-over effects due to non-participants).

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[4] *They would also make implicit assumptions about the effect of weather on certain impact parameters such as number of hours the equipment is being used.*

- Conduct on-site visits with a sample of participants large enough and selected carefully enough to permit extrapolation of results to the entire participant population or to all participants in business segments that account for the greatest percentage of expected impacts. Surveyors would conduct essentially the same survey as conducted via the telephone but, by being at the site, would also be able to more accurately estimate parameters such as number and wattage of measures installed, % of lighting in cooled space, participant spill-over, persistence (as reflected in the number of efficient units still installed) by physically observing the facility. They might also obtain a better estimate of free-ridership, either through a more rigorous free-ridership estimation technique such as conjoint analysis or because they could talk to multiple individuals that might have been involved in the decision to install the measure (e.g., facility manager, building owner, financial officer).

- Install run-time meters (e.g., light loggers) on a sample of installed efficient units, and extrapolate results to the rest of the participant population. The purpose of this approach would be to develop a more accurate estimate of hours of use and possibly, depending on the sophistication of the meter, also the actual wattage of the efficient units (instead of "installed capacity" specified by the manufacturers) and the percentage of units "on" during the system peak period. Installation of the run-time meters could occur during a site visit as described above. A second visit would be required to retrieve data from the meters, as well as the meters themselves. Of course, additional visits could also be made to collect similar data during various time periods of interest (e.g., summer, winter, shoulder months, during the business's peak production season, etc.) during which energy usage was thought to vary significantly.

- Install more sophisticated meters on a sample of installed efficient units, so that load and energy use of the installed units and of possible affected HVAC equipment can be measured, and extrapolate results to the rest of the participant population. This would permit interaction effects of lighting on heating and cooling to be more accurately estimated.

- Install run-time or more sophisticated meters, or conduct site visits prior to measure installation, so that the change in load and energy use could be estimated more accurately.

    - Both types of meters, if not installed prior to the measure installation, provide a better estimate only of post-installation load and energy usage; assumptions would still have to be made about pre-installation usage. Installing the meters prior to installation allows energy usage of both periods to be measured, so that the change in load and energy use can be measured.

    - Site visits conducted prior to measure installation might reveal that certain lights are burned out. Consequently, a comprehensive retrofit of existing lamps with high-efficiency units might yield lower savings than expected, because more lights would be operating. Pre-installation site visits might also show that hours of use prior to measure installation actually differ from that after the installation. In the absence of the pre-installation visits the evaluation team must accept the survey respondent's report of the number of non-functioning lamps and the hours of use for specific lamps. The respondent may have an interest in inflating or these numbers, or may not know at the time of a telephone survey exactly how many lamps are burned out or exactly how many hours each lamp is used.

Engineering simulation models{ XE "engineering simulation models" **} are an engineering-based alternative to the use of simple or enhanced engineering algorithms.**

Rather than rely on the programme's engineering algorithms, the evaluation team could take an **engineering simulation** approach. Site-visit and metered data could be used to develop detailed engineering simulation models that could predict load and energy use changes resulting from measure installations. Load and energy usage of the baseline facility prototypes would be simulated, and then the simulations would be re-run using the efficient lighting measures. The programme tracking system could then be used, to extrapolate results to the rest of the participant population. Data on other impact parameters such as free-ridership, spill-over, etc., would still need to be estimated, probably using survey and verification data collected on-site.

Due to cost considerations, it is unlikely that this method would ever be seriously considered for a programme with measures as well understood and as diverse as lighting measures and for populations as diverse as the non-residential market. However, for other programmes, such as new construction or building envelope and weatherization, engineering simulation techniques provide the only real alternative to simple engineering algorithm methods.

Exhibit 4-2 sums up when it would be advantageous to use engineering methods for evaluation of DSM and EE services programmes.

Exhibit 4-2: Rules of thumb for engineering methods.

When	Comment
Always (simple engineering algorithms), as a reasonableness cross-check	Simple engineering algorithms can be used, in combination with tracking system data on participants and other site-specific data (e.g., from consumer surveys) to provide a quick-and-dirty estimate of impacts. This can serve as a reasonableness cross-check on estimates produced by more sophisticated or statistical methods.
When both energy or load/load shape impacts must be estimated	Engineering methods tend to be the most cost-effective approach to estimating load and load shape impacts.
When interactions between measures or end-use equipment must be accounted for	Interactions such as impacts of improving lighting efficiency on the energy use of space conditioning equipment are difficult to account for in statistical models. Engineering models are more effective for determining the extent of these interaction effects.
When measures are well understood	Engineering algorithms can often be used — supplemented by tracking system and site-specific data — to estimate impacts of measures whose impacts or impact components are well understood.
When a wide range of heterogeneous measures are being analysed	For programmes involving multiple measures implemented by different participants (e.g., many commercial and industrial programmes), the number of participants implementing the same measure will likely be limited, making statistical methods less reliable and less precise.

4.2.4 STATISTICAL METHODS

Impacts of some types of programmes can be estimated effectively using statistical analysis of energy data. Statistical approaches most often provide estimates of energy (e.g. kWh) impacts for some types of programmes as estimating load impacts with these methods requires a significant (and typically very costly) amount of participant and non-participant load data.

There are several basic statistical methods:

- Simple comparisons;
- Weather-adjusted comparisons; and

- Multivariate analyses.

The following basic evaluation issues must be addressed, regardless of the method being used:

- How did participant energy usage change after measure implementation?
- What portion of that change was due to the programme rather than other unrelated factors? Examples of unrelated factors that could be addressed include the following:
  - Changes in weather patterns from year to year;
  - Changes in disposable income, which might cause consumers to use more or less energy;
  - Changes in energy costs, which might cause consumers to use more or less energy;
  - Changes in attitudes toward energy conservation, for example, due to published reports of shortages of energy supplies or the need for environmental improvements;
  - Changes in the number or type of energy-using equipment or appliances in the home/facility;
  - Changes in the number of occupants, or the number of hours/timing**{** XE "timing" **}** of their occupancy;
  - Changes in production levels (for industrial facilities).
- What would their energy usage have been if there had been no programme?

Data on energy use is usually compiled in utility customer billing records. Energy data can also be obtained using questionnaires. This could be relevant if the programme or the evaluation is not carried out by the energy provider. Furthermore, there are programmes, which involve other energy resources than electricity and where a fuel switch is possible or desired. Also here statistical methods can be applied. For simplicity's sake the remaining part of Section 4.2 refers to **energy bill data** but the issues are also valid for other data sources.

SIMPLE COMPARISONS

Simple comparisons**{** XE "simple comparisons" **}** can be made of:

- Programme participant energy usage before and after implementing programme measures. Typically, energy bills for a minimum 12-month period before measure implementation and a 12-month period after measure implementation are compared (time series analysis**{** XE "time series analysis" **}**). The difference between the two totals represents a rough approximation of the programme's gross energy impacts.
- Programme participant and comparison group energy usage after implementing programme measures. This technique uses a similar methodology as the one above, except that bills of two different groups of consumers are compared (cross sectional analysis**{** XE "cross sectional analysis" **}**), rather than bills of one group of consumers at two different times (time series analysis). This method allows the analysis to account for some exogenous (non-programme-related) causes for changes in energy use (e.g., economic conditions, weather). The method can be useful for programmes in which pre-implementation data is not

available, such as new construction programmes. However, unless the comparison group can serve as a control group for participants (shares a wide variety of characteristics with participants), there is considerable uncertainty about what participant usage would have been in the absence of the programme.

- Programme participant and comparison group energy use before and after implementing programme measures. This method combines the two above-mentioned methods.

WEATHER ADJUSTMENTS

Each**{** XE "weather adjustments" **}** of the three simple comparison methods above can include an adjustment to account for the effect of weather on energy impacts. (This is of course most relevant for the time series analyses). Typically, weather data are used to provide a common basis on which to compare pre- and post-implementation billing data, by means of adjustments that account for differences in heating and/or cooling degree days**{** XE "degree days" **}**.

Weather data are also used to estimate total programme impacts over the life of the measure, through the use of adjustments to energy impacts based on how the weather associated with the billing data from the pre- and/or post-implementation periods compares to that of a typical meteorological year (i.e., compares to the most likely weather pattern to exist for the years that the measure will be producing energy impacts).

MULTIVARIATE METHODS

Multivariate methods**{** XE "multivariate methods" **}** are the most complex of the statistical methods, but they also provide the greatest accuracy. There are two general types: Conditional demand models and statistically adjusted engineering models**{** XE "statistically adjusted engineering models" **}**. In both model types, regression equations are used to account for changes in energy usage due to factors unrelated to the programme (economic conditions, appliance holdings, number of occupants, production levels, etc.) and differences between the participant group and the comparison group (if a comparison group is used).

The generic form of the multivariate method is a regression analysis based on a model such as:

$$y = a_0 + a_1*x_1 + a_2*x_2 + \text{etc.}$$

The coefficients a_0, a_1, a_2, … are determined in the regression analysis. The "y" may be the energy consumption of the individual customer. The "x"s may be background variables or characteristics (size of house, number of persons per household, average age, income, education, stock of appliances) or may describe the participation (did the customer participate in the programme or information on which measures the customer has implemented).

An important challenge in relation to using regression analysis is to select the correct model formulation. This task should not be underestimated. Often there will be an almost infinite range of possibilities. Based on a given set of data (which maybe has 10 variables) many new variables can be formed. One may for example chose to create **dummy variables{** XE "dummy variables" **}**, which each represents a certain interval of age (0-20 years, 20-30 years, 30-50 years, etc.). This can be relevant if one wishes to test whether there is a linear connection between age and energy consumption.

Interaction variables{ XE "interaction variables" **}** may also be created by multiplication of two variables. A large number of base variables enable the creation of an even larger number of interaction variables. Interaction variables are used when the significance of x_1 and x_2 are not mutually independent, but x_1 maybe has a particularly large influence when x_2 is large. Non-linear links such as $x_1 * x_1$ may also be created.

A single model with two variables

$$y = a_0 + a_1 * x_1 + a_2 * x_2$$

may thus turn into

$$y = a_0 + a_1 * x_1 + a_2 * x_2 + a_3 * x_1 * x_2 + a_4 * x_1 * x_1 + a_5 * x_2 * x_2 + \text{etc.}$$

A rule of thumb says that you need 10-20 times as many observations compared to the number of variables in your model. So if you have 100 observations then it will most likely not be possible to create models with more than 5 variables. The regression analysis shows, which variables ("x"s) influence significantly on the variation in "y".

Examples of regression analysis can be found in Tiedeman (1999), Torok (1999), Titus (1999) and Heinrich (1998) (fully listed in Appendix B). Togeby (2000) provides further examples on the use of regression analysis and warns against pitfalls.

Typically, two regression models are formed: One regarding the participation decision (a discrete choice model**{** XE "discrete choice model" **}**) to address the self selection issue, and one that includes a self-selection-correction variable (Inverse Mills Ratio) as part of a regression equation that disaggregates energy bills into their components, one of which is implementation of the programme measure.

The approach to deal with the issue of self-selection**{** XE "self-selection" **}** is best illustrated by an example, presented by Christie Torok et al. (1999) (the following is a quotation).

> Assume a net billing model specification that incorporates both participants and non-participants into one model. A disadvantage of this would be that the resulting sample is not randomly determined. There would be certain unobserved characteristics that influence the decision to participate. If these characteristics are not accounted for in the model, the net savings model could produce biased coefficient estimates.
>
> One solution to this problem is to include an **Inverse Mills Ratio{** XE "Inverse Mills Ratio" **}** in the model to correct for self-selection bias. This method was developed by Heckman (1976, 1979) and is used by others to address the problem of self-selection into energy programmes.
>
> It is assumed that the unobserved factors that influence participation are distributed normally. Including an Inverse Mills Ratio in the model as explanatory variable controls for the influence of the characteristics that cause participants to self-select into the retrofit programme. This corrects for the self-selection bias in the net savings regression as the unobserved factors affecting participation are now controlled for in the model. As a result, standard regression techniques should produce unbiased coefficient estimates.
>
> Goldberg and Train (1996) developed the technique of including a second Inverse Mills Ratio in the savings regression to account for the possibility that participation is correlated with the size of potential energy savings. The second Inverse Mills Ratio is interacted with a measure of energy savings, which allows the amount of net savings to vary with participation. The rationale for the second term is that those customers who have potentially large savings are more likely to participate in the programme. Consequently, the unobserved factors that are influencing participation are also affecting the amount of savings.
>
> To calculate the Inverse Mills Ratios, a probit model[5] of programme participation is estimated, and the parameters of this model are used to calculate an individual Inverse Mills Ratio for all participants and non-

[5] *A probit model is a model, which describes the probability of an occurrence. An example could be an investigation of the probability that a certain person chooses to participate in an EE Programme. If*

participants. This Inverse Mills Ratio is included in a net savings regression that combines both participants and non-participants into one model.

If the Inverse Mills Ratio controls for those unobserved factors that determine participation (i.e., the self-selection bias), and the other model assumptions are met, then the net savings model will produce unbiased estimates of net savings. The resulting statistically adjusted engineering coefficients on the energy impacts (that have been interacted with the Inverse Mills Ratios) are then used to adjust the engineering estimates of expected annual energy impacts (the original statistically adjusted engineering coefficients) for the entire participant population. This is one estimate of net ex-post energy impacts.

The latter model is a **conditional demand analysis{** XE "conditional demand analysis" **}** model. It models energy use as a function of the many end-uses of energy that exist at the consumer's home or facility, as well as any key attitudinal or other factors that may have a strong influence on energy use. Data on end-uses and other factors are obtained from surveys with those consumers whose bills will be analysed. Each period's consumption is disaggregated into its components. The difference between the pre- and post-implementation average consumption of the targeted end-use represents the programme's impact in that period (e.g. month, quarter). The differences in each period are then summed, to produce an estimate of total (e.g. annual) impacts.

The **energy usage regression equations{** XE "energy usage regression equations" **}** estimate coefficients for each end-use in the analysis, and those coefficients represent the portion of the e.g. monthly energy use that is attributable to each end-use. In a statistically adjusted engineering model, there is already a variable that includes an engineering estimate of the measure's effect on the targeted end-use. The regression estimates how that engineering estimate must be adjusted to better reflect the measure's impact on the end-use consumption. The estimated coefficient is an adjustment factor (*realisation rate*) to be applied to the engineering impact estimate.

The table below illustrates how each of the statistical methods addresses each of the key evaluation issues.

Exhibit 4-3: How statistical methods address key evaluation issues.

Method	Addresses Change in Participant Energy Use	Addresses Factors Unrelated to Programme	Addresses Consumer Energy Use in Absence of Programme
Simple time-series comparison	Yes	No	No
Simple cross-sectional comparison	Theoretically possible sometimes	Some factors addressed	Theoretically possible sometimes
Simple time-series and cross-sectional comparison	Yes	Some factors addressed	Theoretically possible sometimes
Weather adjusted methods	-	Addresses weather effects	-
Conditional demand analysis	Yes	Yes, in most cases	Theoretically possible sometimes
Statistically adjusted	Yes	Yes, in most cases	Theoretically possible

background variables exist on a number of persons, who participated, and others, who chose not to, then it is possible to calibrate the probit model.

engineering models			sometimes

As the table shows, the more advanced methods tend to better account for factors affecting energy use, which are unrelated to the programme.

All of the methods include the effects of participant spill-over and rebound, as well as first-year measure retention (as a proxy for persistence of savings), because they are based on an analysis of actual energy usage, not engineering algorithms. If participants have made additional energy-conserving improvements, unrelated to the programme (spill-over), the effects of these improvements will be reflected in their energy bills, relative to the comparison group. The same is true for additional energy use due to a perception that energy bills will be lower (rebound); this additional usage will be visible in the energy use that the statistical methods analyse.

Exhibit 4-4 shows that none of the methods is really reliable for addressing the baseline issue of free-ridership or non-participant spill-over (see Chapter 5). These analyses must be conducted separately, though free-ridership and (if non-participants are included in the analysis) non-participant spill-over data can be provided through the surveys conducted to gather the inputs for the conditional demand analysis.

Exhibit 4-4: Rules of thumb for statistical methods.

When	Comment
When there is a large number of homogenous participants (e.g., broad-based residential programmes; commercial programmes, when large participant segments can be constructed)	Statistical methods are effective when a large number of observations are analysed and energy use is the only (or one of the only) factor(s) varying significantly among those observations.
When the audience for the evaluation demands that impact estimates be based on actual measured energy consumption	Statistical evaluations are empirical, in that the change in energy use is inferred from an examination of observed energy consumption. An estimate may also be accomplished using metered data but is much more (usually prohibitively) expensive.
When there are reasons to expect that consumers' behavioural responses are significant	There sometimes is a tendency for participants to operate energy-using equipment more frequently or at a higher level of intensity after participating in a programme. They may perceive that each increment of energy use costs them less, due to the energy-efficiency improvement they have made. Because statistical methods observe actual consumption, they address this phenomenon. Also, for pilot programmes (when there is a higher likelihood of non-participants representing a true control group), statistical methods can account for naturally occurring adoption of the targeted efficiency measure. Engineering methods cannot generally address either of these issues, except through assumptions.
When energy impacts (as opposed to load/load shape impacts) are being estimated	Statistical methods require large sample sizes, and load impact analysis using statistical methods relies on load data for a large number of consumers. Typically, this requires extensive, expensive metering, or the resulting impact estimates will be too influenced by individual (and possibly idiosyncratic) data. Such metering is typically cost prohibitive.

4.3 CHOOSING BETWEEN SIMPLE AND MORE COMPLEX METHODS

A report for the U.S. National Association of Regulatory Utility Commissioners (NARUC)[6] identifies four main categories of EE measures promoted by EE programmes:

- Constant efficiency, constant load – e.g., most lighting equipment efficiency improvements (energy-efficient fluorescent lamps and ballasts, delamping) and constant load motors
- Constant efficiency, variable load – e.g., daylighting controls and energy-efficient water heaters, as well as some thermal energy storage, direct load control, and energy management systems applications; in short, measures for which the load can vary considerably, but the efficiency remains constant
- Variable efficiency, constant load – e.g., efficiency improvements to supermarket refrigerated cases, for which the temperature and humidity conditions in the store remain relatively constant but the efficiency of the refrigeration system varies considerably with outdoor temperatures and humidity (infrequent type of measure)
- Variable efficiency, variable load – e.g., heating and air conditioning measures, building envelope improvements, or variable speed motors, as well as some thermal energy storage, direct load control, and energy management systems applications for which both the efficiency and load vary with outdoor temperatures or production needs.

Such a classification of measures is helpful in that it permits statement of a basic rule of thumb for selecting impact evaluation techniques:

> *"As measures move from constant efficiency and constant load to variable efficiency and variable load, the analytic approach and data requirements become more challenging".*[7]

In other words, it is easier to predict the performance of measures or equipment when the primary components of energy use are constant. For constant efficiency/constant load measures, rather than accounting for a wide range of operating conditions, one may be able to assume just one, or a very limited number of operating conditions. Instantaneous measurements of load may suffice. For measures with variable efficiency and/or load, ongoing metering to collect data on how equipment operates at different times of day or in different seasons or in the context of different production schedules/volumes might be required.

For example, we can generally rely on the assumption that a 25 W compact fluorescent lamp that replaces a 100 W incandescent lamp will produce an energy reduction of 75 W, regardless of the time of day or time of year. We need only a simple engineering algorithm and data on the users' hours and timing of use to be able to reliably predict the energy savings[8]. In contrast,

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[6] Evaluating Energy-Efficiency Programmes in a Restructured Industry Environment: A Handbook for PUC Staff *by J. Schlegel, M. Goldberg, J. Raab, R. Prahl, M. Keneipp, and D. Violette. See the appendix to this report for a summary of this document.*

[7] *Ibid.*

[8] *Average resting time would also be important in such an evaluation, because certain values of average resting time can shorten the lifetime of the CFL (about 3min.).*

effectively predicting the energy savings associated with a variable-speed motor requires a more complex analysis and additional data (e.g., load factor, and operating profile derived from end-use metering).

If the measure has been the subject of rigorous studies in the past, some information on the degree to which various components of energy use vary by user should be known. Evaluators can then make decisions about whether and which specific engineering algorithm parameters require further investigation in estimating impacts for their own programmes.

Evaluation using simple engineering algorithms, a reliable tracking system identifying programme participants, and some basic site-specific data (baseline efficiency, hours of use, etc., which often may be collected by programme implementers or via telephone interviews) may provide reasonable estimates of the programme impacts for a variety of measures. One obvious goal for sponsors of EE programmes is to find or develop a set of reliable, transferable energy savings engineering assumptions and algorithms associated with as many measures as possible that are likely to be promoted in their EE programmes.

The U.S. Environmental Protection Agency has compiled such a list as part of its Conservation Verification Protocols to be used by states wishing to claim CO_2 emissions reduction credits for their EE programmes as part of efforts to come into compliance with mandated emissions levels. Use of the engineering algorithms for such "stipulated measures" guarantee that a specific level of energy savings can be claimed. This savings estimate is slightly discounted to account for its imprecision and can be increased slightly if more thorough analysis is conducted by the organisation making the energy savings claim. Exhibit 4-5 presents a similar list of net-to-gross factors[9] that can be used by applicants.

Use of these assumptions and algorithms must, of course, be adjusted for any differences between the U.S. and the user country with regard to the energy use of the targeted equipment (e.g., significantly differing operating conditions or hours) and its related efficiency measure (e.g., different technical characteristics/standards for the product).

Another option for controlling evaluation costs is to conduct joint evaluation research, several sponsors funding a rigorous study. In this way the costs of investigating less well-understood, but important, EE measures, or specific impact parameters for such measures, can be shared. Future evaluations by the individual sponsors can then rely on estimated parameters from the joint study with confidence, without having to conduct costly evaluations on their own.

[9] *See the following section for definition. Please note, that the net-to-gross factor refers to the relation (net/gross) and not the sequence in reaching the figures (first calculating the gross impact, then applying the factors to arrive at the net impact).*

Exhibit 4-5: Default net-to-gross factors.

Conservation Measure	Net-to-Gross Factor
Refrigerators	
- Pick-up	0.70
- High-efficiency replacement	0.90
Residential Water Heating Measures	
- Insulation blankets	0.60
- Anti-convection valves	0.90
- Pipe Insulation	0.60
- Low-flow showerheads and faucet aerators (utility-installed)	0.70
- Low-flow showerheads and faucet aerators (customer installed)	0.50
- Heat pump water heaters	0.95
Ground Source Heat Pumps for Homes	0.95
Higher Efficiency Lighting in Office Buildings	0.60
De-lamping in Commercial Buildings	0.80
Exit Sign Light Replacements	0.60
Higher Efficiency Street Lights	0.90
Higher Efficiency Motors for Constant Load Applications	0.60

Source: The User's guide to the Conservation Verification Protocols, Version 2.0, United States Environmental Protection Agency, Air and Radiation (6204-J), EPA 430-B-96-002, April 1996.

4.4 ECONOMIC EVALUATION

One**{** XE "economic evaluation" **}** of the central reasons for performing evaluation research may be to determine the cost-effectiveness of the programme. Do the programme benefits outweigh costs?

4.4.1 GENERAL RECOMMENDATIONS

The economics surrounding the evaluation must be considered. Some highlights are according to the Swedish Evaluation Guidebook, NUTEK et. al., 1993:

- The approach used to carry out the ex-post evaluation must be similar to that applied before initiation of the EE programme (i.e., that used for ex-ante evaluation) to allow easy comparison.

- Programme cost accounting should include all programme-related costs at market value and should be used for evaluation of most energy services (i.e., internal company transactions should booked at market value). Care should be made to include all "sunk" programme costs.

- Only variable costs should be included, i.e., costs incurred as a result of the programme. Fixed costs such as non-programme related administration costs should be omitted.

- It is recommended to use net-present-value calculations to allow taking the time factor into account (occurrence in time of payments and disbursements) especially for programmes intended at achieving long-term impacts. The important point is to take into account the long-term consequences of the programme and the cost of capital (exclusive of tax). Note that when considering tax impacts, the programme should not be considered independently but as a part of a larger enterprise. Furthermore, it is recommended that all financing costs (such as tax-deductible interest on capital debt) be taken into consideration when estimating the cost of capital.

- No generally accepted norm exists for adjusting for inflation, which is why most companies refrain from doing so. In this situation the costs are underestimated; inflation, in most cases, affects revenues more than costs because they occur later in the programme life.

- And finally, when evaluating the programme, evaluation of the consequences of alternatives can also be relevant.

4.4.2 BENEFIT/COST ANALYSIS

A publication prepared for the European Commission addressed benefit/cost analysis of EE programmes in detail[10].

Exhibit 4-6 shows the basic framework for B/C analysis{ XE "B/C analysis" }, including costs, benefits, benefit/cost ratio and other impacts from each of six perspectives.

Both costs and benefits can be indicated in present values{ XE "present values" } or by the balance (benefits minus costs, i.e., the net present value (NPV)). Calculating the B/C ratio{ XE "B/C ratio" } (the benefits divided by the costs) is not a necessary step, but enables a quick glance comparison of a variety of possible programmes.

Exhibit 4-6: Framework for B/C analysis.

Perspective	Costs	Benefits	B/C Ratio	Other Impacts
Customer				
Distribution				
Wholesale Utility				
Government				
Society				

The following Exhibit 4-7 shows the factors included in the “primary equation” (under “costs” and “benefits” in the table above) as well as factors that are “otherwise accounted” (under “other impacts” above).

[10] *The following consists of partial quotes from the report* European B/C Analysis Methodology: A guidebook for B/C Evaluation of DSM and Energy Efficiency Services Programmes, *prepared for the European Commission (DG 17), by SRC International ApS (Denmark) and a project advisory committee with representatives from numerous EU countries, February 1996. This document is summarised in the appendix.*

Monetized costs and benefits are typically given the most weight in the benefit/cost analysis. Other impacts, however, are sometimes critical to decision-making, and they are included formally in the matrix so that they can be included if desired. The following description, from the guidebook, presents a rationale for the consideration of quantitative and qualitative analyses.

Exhibit 4-7: Overview of relevant benefits and costs by perspective.

Perspective	Included In Primary Equation	Otherwise Accounted
Participating Customer	Consumption of Other Fuels Change in Energy Bill Industrial Productivity Customer Capital Investment Customer O&M Utility Incentives Third Party Incentives Tax Credits Taxes Other Customer Transaction Costs (*) Customer Value (*) Tariff Changes (*)	Proven Performance Ease of Implementation Availability of Capital (Other Customer Transaction Cost (*)) (Customer Value (*)) (Tariff Changes (*))
Non-participating Customer	Tariff Changes (*)	(Tariff Changes (*))
Generation and Transmission Utility	Energy Generation Costs Generation Capacity Cost Transmission Capacity Cost Power Purchase Revenue Wholesale Utility Programme Costs Wholesale Utility Incentive Payments Risk and Reliability (*)	Public Image (Risk and Reliability (*))
Distribution and Supply Utility	Power Purchase Cost Utility Revenue Change Distribution Capacity Cost Distribution Utility Programme Costs Distribution Utility Incentive Payments Tariff Changes (*)	Market Share Public Image Proven Performance Ease of Implementation Ease of Evaluation Availability of Capital Cash Flow (Tariff Changes(*))
Government	Tax Revenues Government Programme Costs Tax Credits Environmental Effects of Supply (*) Environmental Effects of Consump. (*)	Industrial Productivity Regional Employment Public Image Diminishment of Natural Resources Anti-Competitiveness (Environmental Effects of Supply (*)) (Environmental Effects of Consump. (*))
Society	Energy Generation Costs Generation Capacity Cost Transmission Capacity Cost Distribution Capacity Cost Utility Programme Costs Government Programme Costs Third Party Programme Cost Customer Capital Investment Customer O&M Environmental Effects of Supply (*) Environmental Effects of Consump. (*) Tariff Changes (*) Other Customer Transaction Costs (*) Customer Value (*)	Industrial Productivity Regional Employment Diminishment of Natural Resources Anti-Competitiveness (Environmental Effects of Supply (*)) (Environmental Effects of Consump. (*)) (Tariff Changes (*)) (Other Customer Transaction Costs (*)) (Customer Value (*))

(*) - Include if translated into monetary equivalents.

4.4.3 QUANTITATIVE METHODS

Quantitative methods{ XE "quantitative methods" } seek to measure all benefits and costs into a monetary unit. Recognising that numerous costs and benefits naturally are measured in different units, a dominant task in the quantitative task is to convert all relevant benefits and costs into a monetary value. If this task can be satisfactorily solved, the remaining task is methodological, e.g., calculating a benefit/cost ratio for measuring cost-effectiveness of DSM and energy service programmes.

Cost-effective outcomes may be expressed either as having a positive net present value (NPV) or having a benefit/cost ratio (BCR) in excess of one. In both cases the basic idea is simple; a programme is cost-effective if and only if benefits outweigh costs. Formally, the equivalence between NPV and BCR can be expressed as:

$$NPV = B - C \quad \text{or} \quad BCR = B/C$$

where

B	=	Present value of total benefits;
C	=	Present value of total costs;
NPV	=	Net present value;
BCR	=	Benefit/cost ratio.

There are a number of factors in favour of using a quantitative approach. These include:

- It is consistent – A monetary value of relevant benefit and costs provides consistent ranking of DSM and energy service programmes.
- It is transparent – It provides political and public insight into preferences and value trade-offs.
- It is flexible – Monetized benefits and costs are flexible, allowing for implementation into other planning contexts, and for application to other sectors of the economy than the energy sector.

The major difficulty in using a quantitative approach is establishing monetary values for the benefits and costs, some of which may appear as unquantifiable. Some benefits and costs are difficult to measure in a physical unit, and even more difficult to monetize. For example, reliability of an electricity supply system can be represented by the cost of unserved supply, or environmental impacts may be represented with the costs of environmental damage. The general pitfalls when using quantitative methods can be summarised as follows:

- Boundaries – There may be inconsistent boundaries between what should be included as part of the cost or benefit and what should not.
- Data – Sufficient reliable data may be difficult to establish.
- Illusory precision – A monetary value may imply more confidence in the accuracy of its value than warranted, considering the great uncertainty involved.
- What counts, versus what is countable – It is often easy to mistake what is countable for what really counts, thereby omitting important factors because they appear as non-quantifiable, even though they may be of crucial importance.

Another consideration with the measurement of quantitative impacts is whether full benefits and full costs should be used as opposed to *incremental* benefits or costs. There is no single rule that can be used to determine which is most appropriate. Generally, incremental impacts are used, but there are many cases in which totals are used. In these cases it is important to explain that only incremental impacts are affecting the BCR (but not the NPV).

4.4.4 QUALITATIVE METHODS

The**{** XE "qualitative methods" **}** principal motivation for using a qualitative approach relates to the above stated shortcomings of a quantitative approach. Basically, these problems relate to **the problem of monetizing relevant attributes**. How is it possible to establish representative monetary values that are acceptable to all concerned groups and individuals?

The qualitative approach recognises that there are relevant benefits and costs from DSM and energy service programmes that (1) cannot easily be measured in a monetary value, and (2) are non-commensurable or non-comparable. The perception of benefits and costs will vary among decision-makers, and the trade-off between benefits and costs will vary. In a qualitative approach, all relevant benefits and costs keep their original units, and the evaluation becomes the qualitative task of trading off benefits and costs to find the best solution, or rather the group of solutions that contain the best choice. The selection process is performed in the presence of irreducible uncertainties.

Because the numerous costs and benefits may be measured in different units, the decision-maker must be able to make trade-offs among the values. This can be difficult and often depends on qualitative judgements that may differ among decision-makers. The desire to make these trade-offs more explicit, is the reason that quantitative methods are often used that require monetization of all impacts.[11]

For a more detailed discussion of the EU benefit/cost analysis method, see the summary of this document in Appendix B.

[11] *Ibid.*

5 KEY IMPACT EVALUATION CONCEPTS

Before entering a discussion on choosing evaluation approaches and procedures, some key concepts must be defined and explained to give an impression of the associated effort and cost requirements.

5.1 GROSS & NET PROGRAMME IMPACT ESTIMATION

All programme impact evaluation involves comparing what happened in the context of the programme to what would have happened in the absence of the programme. In ideal circumstances, this involves comparing a **treatment group{** XE "treatment group" **}** (those exposed to the programme) to a control group (those not exposed to the programme) with regard to the characteristic of interest (improvement in health, educational performance, change in energy use, etc.). Ideally, the **control group** is identical to the treatment group in every way other than having received the treatment. The performance of the control group represents the **baseline** against which the performance of the treatment group is compared. The baseline thus represents the performance of the treatment group in the absence of the programme.

5.1.1 GROSS IMPACT ESTIMATES

EE programme planners typically develop an estimate of the impacts that will result from a programme *prior to the programme being implemented*. In this way, programme costs can be compared to programme benefits, to ensure that (1) it is more beneficial (cost-effective) to implement this programme rather than another and (2) the programme benefits will outweigh programme costs.

To accomplish this task, planners must make assumptions about **programme baselines{** XE "baseline" **}** i.e., about energy use (and for some programmes initial levels for key market indicators) in the absence of the programme. These assumptions in turn are based on assumptions about the components of energy use, such as equipment/facility efficiency levels, hours of use of the targeted technology, technological development, market saturation, etc. The "assumed baseline" functions as the planners' estimate of the performance of an ideal control group for the programme.

Case Example: Campaign for Lower Clothes Washing Temperatures

The surveys showed a remarkable decrease in the frequency of washes at 90°C or more and that the general shift was from 90°C towards 40°C washes. It is difficult to conclude what part of the change is caused by the campaign. A background trend towards reducing the frequency of 90°C washes does exist. When a trend already exist it is imprecise to use the start year as the baseline.

German data indicate a trend towards reducing the number of 90°C washes by 1% per year. During the campaign the reduction was 3% per year in Denmark. However, it is close to impossible to determine which cultural differences exist between Denmark and Germany concerning washing habits.

Elkraft System, Denmark

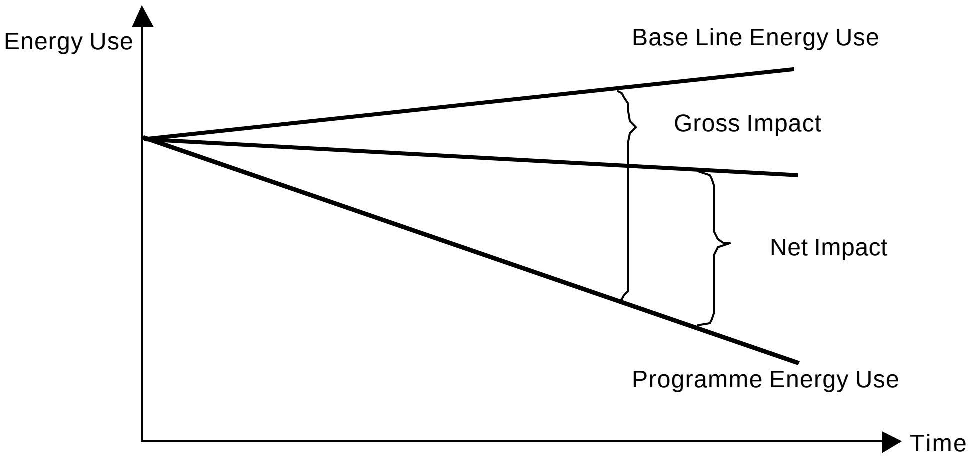
The difference between the assumed baseline energy use and the programme energy use is the "**gross impact{** XE "gross impact" **}**" of the programme.

Historically, planners and evaluators have had a great deal of difficulty estimating the programme baseline. In most EE programmes, everyone within the jurisdiction of the programme sponsor is typically exposed to the programme and so a real control group does not exist. Everyone has been exposed to the programme, and some portion of those who have been exposed become programme participants. Those who do not become participants may be categorically different from participants and so cannot serve as a control group.

This non-participant population may include many who have actively rejected the measure or who do not need what the programme has to offer. There is also self-selection bias (see also Section 4.2). Many consumers who would make the targeted improvements even in the absence of the programme (free-riders) are likely to become programme participants if a programme exists, leaving fewer of this type of consumer in the non-participant population. As a result, the average consumption of the non-participant group is likely to be higher than it would have been if these free-riders were still in the group. The non-participants' energy use is certainly not a good proxy for participant energy use in the absence of the programme. Therefore, an estimate of the programme baseline must be developed in some other manner.

This is one of the major challenges in evaluating EE programmes – defining the baseline

Exhibit 5-1: Graphic representation of the relation between baseline, gross impact, and net impact.



5.1.2 NET IMPACT ESTIMATES

While planners (and evaluators) can certainly do much to maximise the accuracy of their impact estimates, much is out of their control. Causes for inaccuracy in impact estimates are numerous and might include factors such as the following:

- Equipment nameplate efficiency[12] is different from its real-world efficiency.

[12] *The efficiency or typical energy use of a product, as reported by the manufacturer.*

- Planners and evaluators were not aware of existing plans of customers to install efficient equipment without an EE programme.

- Consumers/businesses studied prior to the programme are different from those who actually participate in the programme – the households may be larger or smaller; the equipment installed may have a larger or smaller energy capacity than expected; etc.

- Consumer/business or trade ally attitudes and practices may change during the programme for reasons having nothing to do with the programme (e.g., changes in economic conditions or employment, or a major environmental incident may occur that suddenly creates a strong interest in energy efficiency).

- Consumers/businesses use the targeted energy-using equipment differently than expected (e.g., they may use it more hours per day or less hours per day; they may use it only at partial capacity).

In the context of EE programmes, **net-to-gross{** XE "net-to-gross" **} estimation** differentiates between total changes in energy use (gross impacts), on the one hand, and only those changes that were specifically caused by the programme (**net impacts{** XE "net impact" **}**), on the other. The net impact is estimated by applying **adjustment factors{** XE "adjustment factors" **}** to the estimated gross impact. Such adjustment factors include free-ridership, spill-over, persistence, and rebound effects.

An example of an energy savings engineering algorithm which acknowledges net-to-gross factors**{** XE "net-to-gross factors" **}** (in italics) follows:

Change in kWh = (Replaced load - Programme load) *
Number of hours of use/year *
Number of measures *
Lifetime of measure *
*(1 - Free-Ridership Fraction + Spill-over Fraction) **
*(1 - Rebound Fraction) **
(Persistence Fraction)

An important element of impact evaluation is to provide feedback to programme planners on the size of these adjustment factors and their significance in relation to the specific programme. These factors are also referred to as “net-to-gross adjustment factors” since they describe the size of the net impact relative to the gross impact (net/gross).

If decision-makers could count on planning estimates and evaluation estimates being the same, they would not need impact evaluation activities, to know how the programme affected energy use (though evaluation could contribute to an understanding of customer satisfaction, how to improve programme cost-effectiveness, and how the programme is affecting the market). Of course, this is rarely the case, and sometimes the difference between the two impact estimates is quite large.

Furthermore, if decision-makers cannot obtain a reasonable estimate of what would have occurred in the absence of the programme (i.e., a credible baseline), they can never be sure of whether they are wasting money on trying to persuade consumers and businesses to take actions that they already plan to take or that they would take even without any persuasion. This not only affects whether a programme is cost-effective enough to continue; it may also affect decisions about implementing one programme rather than another. One programme may provide a much greater gross impact than another, but that other programme may actually yield a greater net impact.

Each of the above-mentioned net-to-gross adjustment factors is described briefly below.

5.2 NET-TO-GROSS ADJUSTMENT FACTORS

The impact of programmes may be adjusted analysing four different factors: Free-ridership, spill-over, rebound, and persistence of savings.

5.2.1 FREE-RIDERSHIP

Free-ridership**{** XE "Free-ridership" **}** is that portion of gross programme impacts that would have occurred even if there had been no programme. A free-rider is a customer who would have adopted the actions recommended by the programme even without the programme and who participates directly in the programme. Because some free-riders may have larger end-use equipment or may use it more than others, they may have different levels of free-ridership impacts that must be deducted from the gross impact estimate to obtain the net programme impact estimate.

For example, assume a programme had two participants yielding a gross impact/saving of 300 kWh/year. Also assume that Participant A installed equipment that was twice as energy-intensive as that of Participant B, but both pieces of equipment had the same EE rating. If Participant A is a free-rider, one cannot simply say that free-ridership is 50% and arrive at a net impact estimate of 150 kWh/year. One must deduct from the gross impacts that portion of the impacts contributed by the free-rider – in this case, two thirds of the impacts – and reduce the net impact estimate to 100 kWh/year.

Free-ridership is of three types:

- Pure or full free-ridership,
- Partial free-ridership,
- Deferred free-ridership.

Pure or full free-ridership exists when all of the gross impact related to an installation or some other unit of programme implementation would have occurred exactly as it did in the programme, even if the programme had not existed.

For example, assume that the planning estimate for the programme's baseline is that firms installing new boilers will install boilers having 84% efficiency, and that their existing boilers are typically 77% efficient. An industrial firm may have planned to install a 90% efficient boiler prior to hearing about a programme promoting the installation of energy efficient boilers. The firm participates in the programme – in order to receive a programme incentive that might be offered, or publicity, or special financing – and installs a 90% efficient boiler. All of the energy savings associated with the change between a 90% efficient boiler and an 84% efficient one would have occurred if there had been no programme. Therefore, all of these savings should be discounted from the estimate of the programme's gross energy savings, to accurately portray the true level of (net) energy impact the programme had. This programme had no energy impact on this participant.

Partial free-ridership exists when only some portion of the gross impact{ XE "gross impact" } would have occurred in the absence of the programme.

For example, the same firm may have planned to install the 90% efficient boiler but, due to the programme incentives or information, installs a 92% efficient boiler. The gross savings represented by the difference between 92% and 84% efficiency must be partially discounted, to account for what would have happened in the absence of the programme. Rather than an 8% difference in efficiency (92%-84%), the programme is responsible only for a 2% difference (92%-90%) and the energy savings associated with that difference.

Deferred free-ridership is more complex. It exists when some portion of the gross impact would have occurred in the absence of the programme, but would have occurred at a later date.

An industrial firm installs a 90% efficient boiler but reports that it had planned to install a more efficient boiler, anyway, in two more years. The evaluation must determine (1) how likely this later installation would have been (in light of the many factors that might influence the firm's purchase decisions in the next two years), and (2) what the efficiency of that more efficient boiler would have been. If the firm's stated intention is taken at face value, the gross savings estimate must be changed to reflect the fact that (1) the baseline is not 84% (the efficiency of new boilers firms would install in the absence of the programme) but rather 77% (the efficiency of the existing boiler), and (2) the time period over which the difference between the new baseline energy use and the programme energy use exists is now only two years rather than the life of the boiler.

Many evaluators address this problem by applying a **greater discount factor** to the free-ridership estimate the further into the future the planned installation is. For example, if the firm reports that it planned to purchase a 90% efficient boiler in two years time, the evaluator could:

- Calculate the savings associated with switching from a 77% efficient boiler to a 90% efficient one, for two years.
- Calculate the savings associated with switching from an 84% efficient unit (if the baseline is assumed to be constant for the next two years) to a 90% unit, for the life of the measure minus two years.
- Develop a discounting factor to reflect the probability that the firm's estimate two years into the future is incorrect; rather than discounting all the savings associated with the 84% to 90% efficiency change-out, only 75% or 80% of those savings might be discounted.
- Or, instead, the evaluation could take a simpler approach, either assuming that this firm is contributing no net savings (ignoring the two-year delay and labelling the savings as pure free-ridership) or – applying a discount to the pure free-ridership to account for the probability that the firm's estimate two years into the future is incorrect – count as net savings 20-25% of the difference in savings associated with the switch from a 90% efficient unit and an 84% efficient unit.

Several **methods** are at evaluators' disposal in estimating free-ridership.

One is to conduct surveys/interviews with participants and ask them what they would have done in the absence of the programme. This method has been used frequently in the past and is often used along with more sophisticated methods, as a cross-check. The problems with this method include the following:

- First and foremost, many participants simply do not know what they would have done in the absence of the programme. They may be able to guess but they really may not know.

- Those responding to survey or interview questions may have a tendency to say what they think the interviewer wants to hear (halo effect), or what they think will make them appear more knowledgeable, more environmentally conscious, etc. (self-agrandissement).

- Those responding may not remember their state of mind and intentions at the time of their purchase decision.

- Survey respondents may also fear that certain responses will jeopardise their eligibility to participate in the programme, participate in future programmes, receive any programme incentives that may be offered, etc.

To **maximise the validity** of the survey results evaluators may take some or all of the following steps:

- Conduct the survey as soon as possible after the participation decision.

- Assure the participant that no programme benefits will be jeopardised by how the respondent answers the survey questions. Inform the participant that the responses will be kept strictly confidential and reported only in aggregate.

- Rather than asking one question about intentions, ask a series of questions that require the participant to demonstrate in different ways that he/she would have taken the same action in the absence of the programme. For example:

  - Ask whether the participant has taken other efficient actions in the past. Free-ridership would be more likely if the participant has taken such actions.

  - Ask why the participant participated in the programme. Free-ridership would be implied if participants participated to receive a programme incentive or recognition, but not if they participated to save energy or reduce their energy bills; they could have done that even without the programme.

  - Ask why the participant installed the targeted equipment. Free-ridership would be implied if they installed the equipment strictly to reduce their energy bills, but not if they installed it in order to obtain a programme incentive or recognition through the programme.

  - Ask whether the participant had prior plans to install this type of equipment, whether these plans were for a specific efficiency level, what that efficiency level was, and how much more the participant expected to pay for the more efficient unit than the standard replacement unit. Free-ridership would be implied if the participant's plans were specific and the participant was fully cognisant of the cost premium of the more efficient equipment.

  - Provide typical costs for more efficient units (the efficiency level purchased, as well as units at higher efficiency levels) and for a standard unit, and ask participants how likely they would have been to pay the incremental cost for each if there had been no programme. Free-ridership would be implied if the they would have purchased units of the same or greater efficiency they purchased under the programme.

Another possibility is to conduct research with a **quasi-control population**, such as one in a different region or country. The difficulty here, of course, is that of making a convincing case that this "control" population is similar enough to the population that was exposed to the programme to really represent what the participants would have done in the absence of the programme. Unfortunately, populations in different geographic or political regions can exhibit a wide variety of differences that may affect their behaviour regarding the use of energy and purchase or installation of energy-using equipment, such as:

- The types of products offered by retailers.
- Energy prices.
- General economic conditions and employment.
- Energy-related infrastructure.
- Product distribution channels.
- Common trade ally practices.
- Awareness/understanding of energy efficiency.
- Awareness/understanding of the product or practice being promoted by the programme.
- Other cultural differences.

Thirdly, the evaluator may use **conjoint analysis{** XE "conjoint analysis" **} or discrete choice modelling** to identify how participants would have behaved in the absence of the programme. Both methods have the advantage of obtaining information on participant behaviour indirectly, so that the participant cannot try to portray themselves in a certain light (i.e., the methods address halo effect and self-agrandissement). Both methods have been used extensively in market research, mostly to gauge the future actions of consumers rather than to model their past actions.

5.2.2 SPILL-OVER

Spill-over**{** XE "spill-over" **}** can be defined as energy impacts caused by the programme other than those resulting from participants making the specific improvements targeted by the programme.

The most frequently cited examples of spill-over in EE programmes include the following:

- Participants are sometimes influenced by the programme to make EE improvements not directly targeted by the programme, perhaps due to an increased awareness of the benefits of energy efficiency in general.
- Consumers make the efficiency improvements promoted by the programme because of the programme, but do not bother to officially participate or let the programme sponsor know they are making these improvements.
- Trade allies are influenced by the programme to change what they recommend to their customers or change the types of equipment they stock because of the programme. Some

portion of the consumers with which they interact are affected by these actions to improve their energy efficiency but may never even know of the programme.

In each of these cases the programme is responsible for impacts outside of the formal programme participation process. **Methods for estimating spill-over** generally include the following:

- Surveys of non-participating consumers – These are subject to the same type of problems as those affecting free-ridership surveys and are generally addressed in similar manner. In fact, evaluators must be careful to differentiate spill-over effects from instances in which programme non-participants would have taken the action even in the absence of the programme.

- Surveys with trade allies and analyses of sales data and stocking practices – Depending upon the trade ally group being examined, such data may be very difficult to collect: It may be considered proprietary information, or it may not be readily available from the trade allies in a form which can be used for the evaluation. If spill-over effects are thought likely in a programme, it is best to try to plan trade ally data collection activities into the basic design of the programme (e.g., payment of trade allies to collect data, or providing trade allies with forms ahead of time on which to record the data).

5.2.3 REBOUND

Rebound**{** XE "rebound" **}** is increased energy use caused by participants **trading** some portion of their programme induced energy "savings" for other benefits.

Rebound can manifest itself in several ways, depending on the market sector targeted by the programme. In residential programmes, some participants may feel that since they are saving money on their energy bills as a result of making the EE improvement promoted by the programme, they can afford to use more energy. They may end up having higher energy bills, unchanged energy bills or even lower energy bills, but they have traded their energy savings for some other benefit, typically convenience or comfort.

In commercial/industrial programmes, the programme may make it possible for some participants to produce or sell additional products at no additional energy cost. For example, they may be able to afford to keep a retail store open longer, or add or extend a work shift for a production process, because per-hour or per-unit-of-production energy costs have decreased.

Survey research is typically used to identify such changes in participant energy use. For some programmes, pre- and post-installation metering of the affected equipment may be worthwhile, especially if estimated savings from a single installation is relatively high.

5.2.4 PERSISTENCE OF SAVINGS

Persistence of savings**{** XE "persistence of savings" **}** is the ratio between the energy use associated with programme participation and the energy use baseline which continues throughout the life of the EE measure, measured in percent.

Some programme participants remove or never install the more efficient equipment promoted by the programme, for a wide variety of reasons (lack of time, complexity of installation, aesthetics, unsatisfactory performance, impracticality), or they discontinue the energy efficient behaviour because it becomes impractical, makes them too conspicuous, etc. The persistence issue is an important one for evaluators because lack of persistence can have very significant effects on overall net programme savings estimates. For example, if an EE measure with a 15-year lifetime is removed after only two years, most of the savings thought to result from that installation will not materialise.

Programmes with significantly low persistence rates may be redesigned, to minimise this problem, through better programme targeting, more comprehensive programme promotional materials, or through obtaining commitments from participants about persisting with the programme measure or activity.

Persistence of energy savings has three components:

- Measure retention – Is the EE measure still installed?
- Effective measure life – How long does the measure continue to function at its rated efficiency?
- Rate of technical degradation of performance – At what rate does the technical performance of the measure degrade?

Both the effective measure life and the rate of technical degradation of performance only matter to the extent that they differ from the “replaced load”, i.e., the equipment or behaviour the measure is replacing. If both the baseline/replaced load and the programme load have the same measure life and the same rate of technical degradation, these factors can be ignored. “Measure retention” is usually more of an issue. EE measures may be removed for many reasons, as noted above.

Some persistence research may be based on existing data from manufacturers and other sources. Literature from product testing laboratories and/or manufacturers can be examined, to determine whether the effective lifetime and the rate of **technical degradation** of the programme measure differs from that of the technology or activity it is replacing. This provides an estimate of the energy savings that are technically possible.

Measure retention research typically occurs both at the same time as the rest of the evaluation and also at later dates. For some EE measures, telephone surveys can be conducted with participants, asking them whether measures are installed and whether they are still functioning. More rigorous approaches use on-site surveys, so that the researchers can actually observe that the measure is still in place and functioning properly. On-site surveys are usually recommended, especially for measures involving multiple installations at one site. Surveys are typically conducted with a carefully constructed sample of participants, and the results are generalised to the entire population, accounting for any segment differences.[13]

A more rigorous method for estimating measure retention is survival analysis. Survival analysis is a technique used in bio-statistics, typically to estimate human life expectancies. In the EE programme application of this technique, measure failure/removal is tracked for a specific programme-year population, and a survival function is estimated to predict the distribution of measure failures/removals over the life of the measure. Of course, the more years of failure/removal rate data one has, the better the function can be estimated. This technique requires that numerous measure retention surveys be conducted, to provide data for the model being developed. It can therefore be used in combination with the measure retention technique.

[13] *Measure retention rates can vary by business type, housing type, socio-economic status, etc.*

However, decision-makers may not be willing to conduct numerous retention studies unless there is strong reason to believe that measures will fail or be removed at a significant rate, in which case they may reconsider programme implementation entirely or at least a significant programme redesign.

However, measure retention studies only result in an indirect estimate of the persistence of the energy savings resulting from a programme. We are interested not in whether the measures are still installed, but in whether they are still yielding energy savings.

Billing analysis may be used to estimate persistence of savings for certain types of EE measures, and with certain caveats. The most likely chance of success with persistence billing analysis study is when it is used to estimate the persistence for certain residential EE measures.

Billing analysis reveals energy savings if they represent a significant percentage of energy use (e.g., ≥10%). Applying this method to measures yielding smaller savings percentages is generally not feasible because the small savings tend to be masked by the imprecision of the impact estimate.

A large participant population is also necessary. The **size of a participant population** tends to diminish over time. Businesses close, move, or expand production. Households move, change their appliance mix, change their demographics (higher or lower income, greater or fewer occupants, changes in the age of occupants and therefore in their energy use). These factors result is a significant whittling away of the available sample frame for later persistence studies.

In addition, a multitude of factors unrelated to the programme can affect participant energy usage in the years between original participation and later, follow-up persistence studies. These factors confound efforts by evaluators to attribute differences in energy use solely to the original programme. Measuring persistence using billing analyses is both risky and expensive.

6 SELECTING IMPACT EVALUATION STRATEGIES

The appropriateness of a given evaluation strategy will depend on the type of programme or project subject to evaluation. In this chapter guidelines for selecting an impact evaluation strategy are given for six different types of programmes/projects, namely

- Targeted information programmes,
- Market transformation programmes,
- Transmission and distribution programmes,
- Load management programmes,
- Customer retention programmes, and
- Energy service company projects.

6.1 TARGETED INFORMATION PROGRAMMES

Most evaluation in the EE field has been conducted for incentive programmes, which count as participants only those consumers who implement the targeted programme measures. Information programmes, in contrast, attempt to influence measure implementation decisions by educating the consumer or business so that they will then implement measures at a later date. The implementation effect is thus one step removed from the programme.

The main problem of evaluating information programmes is that it can be very difficult to assess which piece of information made the target group react. A further complication is that the full programme impact may not be immediately visible – there may be a time delay in the impact (e.g. the full effect of educating school children in energy efficient behaviour may not be seen until years later). How can programme expenses be justified when impact cannot be directly measured or proved? Can a greater uncertainty in proof of impact be accepted? How is such a programme optimised? This "lack of proof" is why the majority of information programmes are carried out by public authorities or on behalf of these as public service obligations.

6.1.1 TYPES OF INFORMATION PROGRAMMES

From an evaluation point of view, there are two basic types of information programmes**{** XE "information programme" **}**: Those for which the participant is **known** and those for which the participant is **not known**. This section deals with targeted information programmes for which the participant is known, such as energy audits, or training seminars and workshops. Programmes with unknown participants may be treated similarly to market transformation programmes, with regard to evaluation. Evaluation of these programmes is addressed in Section 6.2.

For targeted information programmes for which the participant is known, such as energy audits, training seminars, or workshops, several characteristics facilitate the evaluation effort. This is very clear in energy audit programmes:

- Contact information for each participant is recorded in the programme tracking system.
- Engineering algorithms are used to generate impact estimates for each recommended measure for each participant, as part of the tracking system data.
- Well-designed programmes include a statement by each participant, recorded in the tracking system, regarding whether they plan or are likely to make specific EE improvements.

Case Example: Campaign for Lower Clothes Washing Temperatures

At the campaign's outset in 1995, electricity consumption for washing and drying clothes accounted for approximately 18% of the Danish households' total electricity consumption. Washing alone accounted for 4.5%. Washing at 90°C or more accounted for 15% of all washing in 1997 - a high percentage in comparison with other European countries. This combined with the fact that washing at 90°C uses approximately twice as much electricity as washing at 60°C, and modern detergents make washing at temperatures above 60°C superfluous, motivated the campaign.

It was also estimated that the biggest obstacle towards changing the washing habits in the target-group was objections that the clothes would not be completely clean, odours would not be removed or washing at lower temperatures is unhygienic. As background and foundation for the campaign the National Consumer Agency therefore made a study together with the Danish Technological Institute, which showed that there were no health or hygienic problems connected with washing household clothes at only 60°C.

The aim and message of the campaign was that one could lower the washing temperature, and thereby improve the environment and save electricity, without lowering the cleanliness of the clothes or comfort of the consumers.

Elkraft System, Denmark

6.1.2 DETERMINATION OF IMPLEMENTED MEASURES

The major task for the evaluation team is to determine, which measures were implemented by the participant. This can be done as follows:

- Select a sample for verification surveys, which best represents the participation population, in terms of total programme savings. (Total programme savings here means total savings associated with measures participants reported they planned to implement or were likely to implement.) Especially for non-residential audit programmes, a sample stratified by contribution to total programme savings is appropriate. So that evaluation resources are used to provide greater accuracy regarding the largest portion of the tracking system's estimated savings, the verification survey sample should be weighted toward programme participants thought to yield the largest percentage of total programme savings. This will result in verification of the largest percentage of estimated savings.
- Conduct follow-up telephone or mail surveys with participants, asking them to report:
  - The recommended measures they implemented, including the energy use of the measure (which may differ from the recorded level in the programme tracking system);
  - Other measures they may have implemented;
  - The degree to which measures were implemented as a result of the programme;

- Details of all measure implementations that will permit a more accurate estimate of each measure's impacts;

- Details about the participants that will allow extrapolation of the results to the entire tracking system of participants.

➢ Conduct follow-up verification visits with a sample of those participants who report having implemented specific measures (again, weighted toward those with the highest savings), to verify the type, number and level of the measure.

6.1.3 FOLLOW-UP ACTIVITIES

The follow-up activities should yield two percentages:

➢ Reported actual savings compared to savings intended implemented – The percentage of the savings from measures participants said they planned or were likely to implement, as recorded in the tracking system, the percentage verified through the telephone/mail surveys.

➢ Savings verified on-site compared to reported actual savings – The percentage of the telephone-verified savings reported by each implementing participant that can be verified through the on-site visit.

These percentages can then be applied to the entire tracking system, to estimate the total energy impacts for the entire programme. The precision of this estimate, of course, will not be as high as for programmes that deal directly with measure implementation (e.g., incentive programmes) since the measures that were actually implemented must be estimated, rather than being recorded in the programme's tracking system.

The specific approaches to estimating impacts from each measure should follow the guidelines presented in Chapters 4 and 5, but it is likely that enhanced engineering estimation will be most suitable. Note that industrial firms are more likely to implement certain EE measures in order to obtain non-energy benefits (especially increased production or lower cost production), and may therefore be more likely to be free-riders.

6.1.4 PROGRAMMES ONE STEP REMOVED FROM IMPLEMENTATION

Other targeted programmes, such as training programmes for trade allies, may be one step removed from measure implementation in that the implementation act itself occurs not by the individuals participating in the information programme but by consumers who are influenced by these individuals.

Well-designed training programmes will include brief surveys prior to and immediately after the training exposure, to document whether the participants' attitudes and intentions may have changed as a result of the training, and to record statements of the participants' intentions about behaviour leading to higher energy efficiency. There are two options for estimating the programme impacts:

➢ Contact the trade ally to identify influenced clients and contact these directly to assess the degree and character of measure implementation. This is more feasible with smaller information programme participant populations.

- Obtain estimates from the participating trade allies regarding the impact of the programme on the EE decisions of their customers/constituents. This information should be quantified and should include an estimate of the number of measures implemented, the efficiency level of those measures, and the actions that would have been taken in the absence of the programme.

With either approach, supporting data regarding the effects of the programme and of the trade allies should be gathered, if possible, including any other indicators that consumer/business decisions have changed. For example, if the participating trade allies are contractors, and the efficient measures they recommend to their customers are sold through retail outlets, the retails outlets can be surveyed to determine whether there has been an increase in sales of efficient units.

6.2 MARKET TRANSFORMATION PROGRAMMES

Market transformation is more an intended programme result rather than it is a programme type. The programme targets the removal or lowering of specific **market barriers{** XE "market barriers" **}** to higher efficiency. The appeal of market transformation programmes**{** XE "market transformation programme" **}** is that they attempt to cause *lasting* changes in specific markets, leading to higher efficiency purchases and behaviours. The underlying assumption is that since the targeted changes are lasting, additional programme intervention is not needed. This is in contrast to many traditional programmes, whose impacts on efficiency decisions last only as long as the programme intervention occurs.

6.2.1 TYPES OF MARKET TRANSFORMATION PROGRAMMES

Some example of programme types include:

- Manufacturer incentive programmes, in which incentives are used to reduce the risk and/or cost to manufacturers of developing or bringing to market more efficient products and technologies.

- Labelling programmes, which reduce the risk to consumers of knowing whether product efficiency claims can be trusted.

- Technology procurement programmes, in which manufacturers' risk in developing and bringing more efficient products to market is reduced through the use of a guaranteed or "highly likely" pool of purchasers who specify their exact product requirements (efficiency- and non-efficiency related).

- Mass market information programmes that seek to condition the market to accept and demand more efficient products and behaviours for a variety of market actors. Such programmes reduce risk to manufacturers and other trade allies who can provide the targeted efficient products and practices. They can also reduce transaction costs to consumers who face a need to better understand efficient products and their availability before they can feel comfortable purchasing them.

6.2.2 TWO MAIN COMPONENTS

Market transformation programmes have two main components that focus the programme evaluation:

- Direct energy savings – They often result in immediate energy savings stemming directly from programme activities, much as traditional EE programmes might. These must be quantified as part of the evaluation.

- Indirect energy savings – They intend to result in lasting market changes[14] which must be identified and tracked throughout the programme and for a period afterward, and the indirect energy savings they cause must be quantified.

To estimate **direct energy savings** from a market transformation programme, the evaluation must identify and quantify the number of participants and the efficient actions they may have taken. Once participants have been identified, the methods described in earlier chapters can be used to quantify the direct energy savings resulting from the programme. However, there is one difference: The level of resources allocated to estimating per-unit gross energy impacts should be minimised, so that evaluation resources can be focused on estimating market transformation impacts and attributing these impacts to the programme. As a market transformation analyst said, "The net effect of investing heavily in measurement of gross savings is therefore akin to estimating the total weight of a crowd of people by carefully weighing a sample of them, and then multiplying by a very rough estimate of the size of the crowd."[15]

The **indirect energy savings** from the programme – those resulting from the transformation of the market – are more challenging to estimate. The recommended evaluation approach is as follows:

- Ensure that the programme design has documented how the targeted market operates and how the programme is expected to interact with the market, including the key market actors, how they interact, the current level of efficiency, barriers, the type and nature of perceived market barriers, how the programme is expected to remove/lower them, etc. If it has not, try to reconstruct this information. This task is sometimes seen as an evaluation task, but it falls more logically into the role of the programme designers.

- Define the market indicators that will serve as evidence that the market is indeed changing. The market indicators selected should be logical and believable to the individuals who must make decisions about the programme.

- Estimate the baseline levels for these indicators e.g., through surveys with consumers and other key market actors such as product distributors and retailers, or possibly through an analysis of secondary data on market penetration or product sales. Develop thereafter a baseline estimate of the natural change in the market, in the absence of the programme. This should be based on an analysis of longer term trends in the market e.g., through an analysis

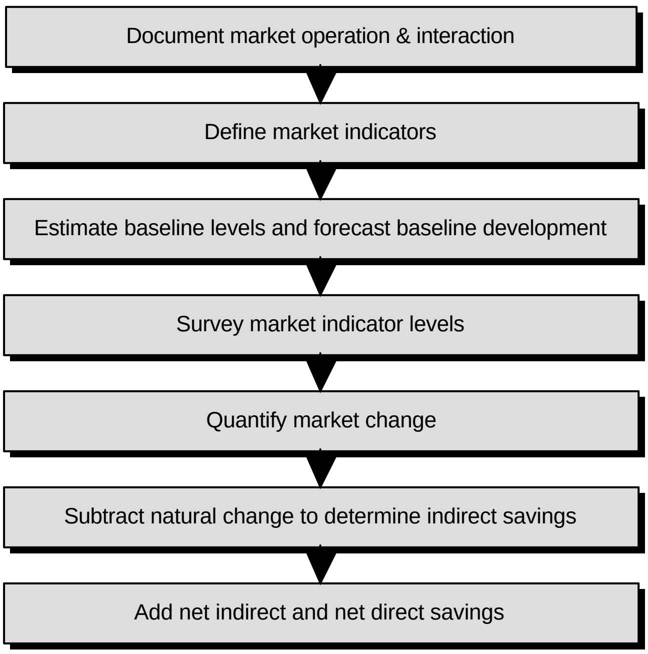
[14] *One might also think of this as permanent non-participant spill-over: Those not directly participating in the programme continue to make the efficient decisions promoted by the programme, because of the programme.*

[15] Evaluating Energy Efficiency Programmes in a Restructured Industry Environment: A Handbook for PUC Staff*, by J. Schlegel, M. Goldberg, J. Raab, R. Prahl, M. Keneipp and D. Violette, April 1997. See appendix for a summary of this document.*

of secondary data and/or interviews with key market actors such as manufacturers, distributors and retailers associated with the product.

- Conduct periodic surveys of the market (and use secondary data as appropriate) to measure the market indicator levels throughout the programme and shortly afterward.
- Quantify the change in the market based on changes in market share or penetration and evidence of permanence in these changes.
- Convert the changes in market share/penetration to changes in efficiency for a specific number of products, so that the change can be expressed in terms of energy savings.
- Subtract out the effects of natural change in the market, to determine the net indirect energy savings resulting from the programme.
- Add these net indirect energy savings to the estimated net direct energy savings for the programme.

Exhibit 6-1: Evaluation approach for indirect savings.



Forecasting the baseline development is probably the most challenging aspect of the evaluation of indirect savings. One must forecast how a market will change in the future. Typically, the market is not at a steady state, and there may or may not be a steady trend that lends itself to easy extrapolation into the future. It is helpful to develop a number of independent estimates of this factor and make an informed judgement based on all available data. Certainly, product sales trends can play a part in this baseline market change forecast, as can reports prepared by various trade allies associated with the measure. What is not very likely is that the evaluation team will be able to develop a reliable natural change baseline for many years into the future (i.e., beyond the end of the programme). The use of a comparison/control country as a baseline is questionable, especially in the European context, since countries differ too much from each other. In any case, the evaluation team and the programme sponsor must agree upon decisions about the natural change baseline up front, with full admission of the uncertainties surrounding such estimation.

6.2.3 MARKET INDICATORS

By way of example, the following is a list of market indicators{ XE "market indicators" } defined for a programme seeking to transform the market for efficient lighting during lighting remodelling:

- Increased knowledge or awareness among planners, designers, and decision-makers about efficient lighting technologies (e.g. recognition rate).
- Existence and deployment of decision-making tools and structures which are likely to lead to efficient design and equipment installation, and which are being used on more jobs (number of businesses with energy management strategies).
- More frequent recommendation or specification of efficient equipment and design (e.g. publicity rate of efficient equipment).
- Increased sales/purchases of efficient equipment or design (e.g. sales statistics of efficient equipment).
- Increased application of efficient equipment or design (e.g. number of washes on economy programmes relative to normal washing machine programmes).
- Attendance at training and intent to implement training (e.g. number of training seminars and participants).
- Transfer of experience with efficient equipment and design to other buildings (e.g. inspiration source of EE initiative).
- Changes in the costs of efficient technologies and practices (e.g. retail prices).
- Changes in the equipment stocked by retailers/end-users.

The methods recommended for measuring these market indicators include interviews with vendors, contractors, and managers of targeted large firms, as well as walk-through surveys or plan reviews of samples of remodelled buildings.

6.2.4 "LIFE" OF SAVINGS

Some decision will have to be made regarding the methods for determining the number of years to assign to the "lifetime" of the market transformation effect. This, along with the above mentioned other elements of the evaluation, should be agreed upon up front with the key decision-makers.

Questions to be answered are for example:

- How permanent is a lasting change in the market?

- How does one account for new technologies being introduced into the market that may displace the one being promoted by the programme?
- Should the "life" of the market transformation impacts be considered as the number of years by which the natural diffusion of the technology into the market has been advanced by the programme?
- What is the basis for estimating that advance to the diffusion curve?

These factors must be decided and agreed upon. Conservative estimates are appropriate for high-profile programmes.

6.3 TRANSMISSION & DISTRIBUTION PROGRAMMES

As noted earlier, the basic concept of T&D**{** XE "T&D programmes" **}** DSM programmes is that, by delaying T&D upgrades through EE or load management programmes, the responsible utility can save substantial sums of money.

Evaluations of targeted T&D DSM programmes are relatively straightforward. However, as with most evaluations, their accuracy depends largely on the accuracy of the estimates of baseline conditions.

The utility's supply and expansion forecast plans should include time-based estimates of customer load. For evaluations of T&D EE programmes, this forecast can be supplemented by market research, to collect data on the penetration of the targeted efficiency measures, intentions regarding purchases or behavioural changes promoted by the programme, and other free-ridership issues, to help refine estimates of baseline energy use. For evaluations of dispatchable load and load management programmes, supplementary data may be needed regarding intended use of the equipment or facilities targeted for curtailment during the programme's dispatch period, to address similar concerns.

The mechanics of evaluating the programme follow those of evaluations of other EE or load management programmes (cf. Section 6.4). The difference for T&D programmes is that the "treatment" or "post-programme" estimate of demand and energy use can be based on readings at the substation level, using monitoring equipment installed at the substation and either recorded there or observed and recorded at a central facility. Substation measurement of energy use is not typically done for other types of DSM programmes, because effects at individual substations are usually too small to observe, amidst the normal variation in substation load. T&D DSM programmes are designed to produce significant demand reductions capable of being observed at the substation level.

6.4 LOAD MANAGEMENT PROGRAMMES

Load management programmes**{** XE "load management programmes" **}**, as a category of programmes distinct from other EE programmes, comprise those initiatives designed to reduce the instantaneous demand for energy, typically so that additional energy resources are not needed to meet the system's energy demand. The objective is to avoid costly additional production and purchase of energy during **peak load periods** when energy costs are highest.

Examples of load management programmes are:

- Utility control of high-energy-intensity home appliances such as heating, air conditioning or water heating, or pumping equipment. Typically, the utility can send a signal to a control device, which either switches the targeted equipment off or cycles it.

- Utility control of similar equipment at commercial or industrial facilities.

- Thermal energy storage, in which equipment or systems use energy at off-peak hours and deliver it to the home or facility during peak hours, as needed.

- Timers on various types of high-energy-intensity equipment.

- Interruptible rate, curtailable rate, or standby generator programmes, which either turn off pre-specified energy end-uses at the customer's facility, request that the customer do so, or switch pre-specified equipment to generator-produced electricity rather than electricity from the power grid. In return, the customer is typically either paid an incentive or given a lower energy rate.

Key issues in evaluating load management programmes include:

- If equipment is turned off by the utility, for what percentage of the equipment does the "switching" work, i.e., what is the control system's reliability? It is unlikely that all switching systems will work perfectly, resulting in a portion of the "controlled" equipment not being controlled when the utility believes it is being controlled. The result is lower energy impact than expected or believed.

- Would the equipment being controlled during the peak period have been operating when the control strategy was activated, or would it already have been off (e.g., the homeowner would not have been home)? In such cases the programme would have had no real energy impact.

- If the equipment to be controlled would have been on when the control strategy was activated, at what level would it have been on, i.e., what would the actual load have been? While the programme should have recorded the rated capacity of the equipment, often equipment is not used at its full load capacity in a specific installation. The evaluation cannot assume that the equipment is operating at its full rated capacity.

Strategies for evaluating these issues include:

- For programmes requiring end-use/special meters, metered data can be analysed to determine operating conditions before, during and after the control period. Follow-up surveys can collect data on what load levels would have been like if the control period had not been in effect. The metered data can also be used to examine loads on similar days under similar conditions that can serve as a baseline for the control-period load.

- For load control programmes:

  - Use previous studies, if any exist, of the in situ load of the targeted end-use equipment, especially studies that included end-use metering to determine such loads. Per-unit energy impact estimates derived from such studies may also be of value as a cross-check on the evaluation's results.

  - Develop end-use simulations of prototype homes/facilities using and not using the equipment targeted for control.

- Meter a sample of the targeted end-uses before, during and after control periods. Ideally, the sample would include non-participant end-uses in addition to the participating ones.

- Conduct customer surveys to obtain data on:
  - Typical operating schedules for the targeted equipment/systems;
  - Customer characteristics that will allow data from matching non-participants to be analysed (e.g., for residential programmes - number of occupants at home during control period, appliance saturation; for commercial programmes - facility/business type, square metres, operating hours);
  - Whether controlled equipment was scheduled to be on during the control period;
  - Whether it was on just prior to the control period;
  - Whether it was controlled during the control period;
  - Operating settings and facility characteristics that would determine the percentage of rated capacity for the equipment (e.g., thermostat settings for space conditioning and water heating equipment, square metres of space affected by space conditioning equipment).

➢ In some circumstances, load data for participating and non-participating customers may be available (e.g., from cost-of-service load research studies):

- Load data from several days (e.g., 10) most similar to the control day(s) can be examined for both participants and non-participants.

- Weather data can also be collected and compared to similar data for a typical meteorological year (TMY). Load data can be adjusted to reflect the TMY.

- Participant usage can be subtracted from non-participant usage, to estimate programme impacts. Or, depending on the equipment controlled and the availability of data, participant usage during the control period can be analysed in terms of the similar uncontrolled periods to predict what usage would have been in the absence of the programme.

- Survey data can be used to confirm assumptions regarding operating schedules, facility characteristics, etc.

It is worth noting that the establishment of a baseline can prove very difficult in societies undergoing large changes in economy (see also Section 6.2.2). It is for example difficult at present to determine a reasonable baseline for the development in the energy sector in some of the East European countries. Evaluation of load management programme impacts compared to no intervention is in such situations problematic. The same holds true for new equipment markets in rapid development.

6.5 CUSTOMER RETENTION PROGRAMMES

The central objective of EE programmes operated for customer retention**{** XE "customer retention programmes" **}** purposes is **profitability**. In this sense they have the same goal as EE projects implemented by energy services companies. Energy impacts are secondary to the primary objective of retaining customers (or attracting new ones). In case evaluation of the energy impacts is carried out it is typically done to obtain public relations benefits. Evaluation of the energy impacts associated with individual projects is primarily done to satisfy the customer's need for assurance that the projected benefits actually are achieved.

The evaluation of central concern to the energy provider is of profitability: **Does the programme succeed in retaining customers and, if so, do the profit margins on the retained customers outweigh the costs of the programmes?** In competitive environments energy providers are likely to charge fees for many of their EE services, with the retention effect stemming from expanding the range of services available to the customer, the quality of those services and perceptions that the provider is looking out for the customer's best interests. The provider may discount certain types of services for certain customers who are deemed as having high value, and may provide some inexpensive services for free, as a benefit of being a customer of the provider.

In this context the evaluation of the customer retention programme is a study of overall profitability and, as a secondary objective, changes in market indicators of customer satisfaction. Customer retention programmes can be quite varied and so it is difficult to provide step-by-step guidelines for their evaluation. However, the primary issue to be addressed is that of whether the services provided (fee-based, free or discounted) function to retain customers who otherwise may have switched energy providers.

6.5.1 COMPETITIVE MARKETS

In competitive markets, evaluations should assess the many sources of profitability of long-term versus new customers (e.g., less expensive marketing costs, greater likelihood to purchase a wider range of services), to determine the extent to which retained customers provide such benefits for the energy provider.

Retention rate benchmark studies{ XE "retention rate benchmark studies**" }** can be performed i.e., the energy provider's retention rate before and after implementation of the programme can be compared to each other and to the benchmark.

In addition, the value of the specific customers retained through each year of the programme can be analysed on the basis of their contribution to profit margins and the cost to serve them.

6.5.2 MARKETS IN TRANSITION

For markets that are making a transition to retail competition, the analysis is somewhat speculative. How does one measure the success of a programme to retain customers when customers do not yet have a choice of energy supplier? Most such studies rely on:

- Indicators of customer satisfaction and likelihood of switching suppliers for various discounts in energy price or various combinations of price discounts and other energy services (using survey research).
- The change in the company's profitability resulting from customers who are persuaded to sign long-term contracts, often at discounted energy prices (i.e., profits relative to having the customer defect to another energy provider).

The problem with the first of these indicators is that one never knows what the competition will be offering and how the customer will really respond to it. Satisfaction levels can be very high and customers can report that they are not at all likely to switch providers under a number of specified assumptions. However, these assumptions may not hold. The customer may be offered a product or service, or combination of products and services not anticipated in the research.

The customer's preconceptions about the nature of firms that might offer the competing services may be different from what actually would occur (e.g., the customer may be envisioning a neighbouring utility company when the real competitor is a highly regarded national provider of a different type of product who expands into the energy services market).

The customer may express some level of dissatisfaction with the current energy provider and even a willingness to switch under the circumstances posited during a survey, **but fear of the unknown and a low tolerance for risk** may prevent the customer from following through with such an action.

On the other hand, customers could be tempted to switch just because it becomes a possibility which is given massive media attention and other customers appear to switch.

Results of such studies are tentative at best, and best used for identifying areas for improvement rather than quantifying the profitability benefits from the customer retention programme.

Other issues to be addressed include:

- How any fees charged for EE services compare to the costs of providing those services.
- Whether the pricing points for various services maximise profitability.

6.6 ENERGY SERVICE COMPANY PROJECTS

In relation to EE projects performed by energy service companies**{** XE "ESCO projects" **}** (ESCOs), evaluation serves a monitoring and verification (M&V) function. The nature, methods and costs of this M&V effort are defined in the contract between the ESCO and that provider's customer, with the M&V activity serving as a basis for payments from the customer to the ESCO.

There are three interlocking **objectives** of M&V efforts:

- Determine the amount of the customer's payment to the ESCO.
- Provide information that will aid in operating the facility more efficiently.
- Assess whether the EE measure is performing as expected.

Ideally, an outside agent, independent of both the ESCO and the customer, should perform the M&V. However, in most cases the ESCO provides this function, to simplify execution and control costs. The extent of the evaluation depends on the level of uncertainty and perceived risk on the part of the customer; the higher the perception of risk, the more important and more extensive M&V is likely to be. M&V becomes a method for allocating risk between the ESCO and the customer.

The customer has a vested interest in spending as little as possible to reap the financial rewards of the EE project and knows that the M&V represents a cost that must be subtracted from the financial benefits it will receive. Chapter 4 explores the various conditions, which cause more extensive and comprehensive M&V.

The **three typical steps** in the M&V process are as follows:

- Verify the baseline.
- Verify the installation and correct operation of the EE measure.
- Verify the continued operation of the measure at regular intervals.

For well-understood measures being implemented at customer facilities having sophisticated facility managers or even energy managers, some or all of these steps may be bypassed.

A guidebook published in 2000 by the U.S. Department of Energy suggests that there are four options for M&V of ESCO projects[16]. These are presented in Exhibit 6-2 below.

Exhibit 6-2: M&V Options

Measurement & Verification Option	How Savings Are Calculated	Cost
Option A: Focuses on physical assessment of equipment changes to ensure the installation is to specification. Key performance factors (e.g., lighting wattage or chiller efficiency) are determined with spot or short-term measurements and operational factors (e.g., lighting operating hours or cooling ton-hours) are stipulated based on analysis of historical data or spot/short-term measurements. Performance and proper operation are measured or checked annually.	Engineering calculations using spot or short-term measurements, computer simulations, and/or historical data.	Dependent on no. of measurement points. Approx. 1-5% of project construction cost.
Option B: Savings are determined after project completion by short-term or continuous measurements taken throughout the term of the contract at the device or system level. Both performance and operations factors are monitored.	Engineering calculations using metered data.	Dependent on no. and type of systems measured and term of analysis/ metering. Typically 3-10% of project construction cost.
Option C: After project completion, savings are determined at the "whole-building" or facility level using current year and historical utility meter or sub-meter data.	Analysis of utility meter (or sub-meter) data using techniques from simple comparison to multivariate (hourly or monthly) regression analysis.	Dependent on no. and complexity of parameters in analysis. Typically 1-10% of project construction cost.
Option D: Savings are determined through simulation of facility components and/or the whole facility.	Calibrated energy simulation/modelling; calibrated with hourly or monthly utility billing data and/or end-use metering.	Dependent on no. and complexity of systems evaluated. Typically 3-10% of project construction cost.

Sophisticated purchasers and those with significant capital resources have little reason to use an ESCO since the ESCO adds little value.

Unsophisticated, capital-constrained purchasers have more interest in arrangements that can produce an energy cost savings stream derived from a performance contract, such as ESCOs offer. These customers may pay more for their EE measures but many ESCOs can offer contracts that (1) keep the cost of the measure off the balance sheet of the customer and (2) shift

[16] International Performance Measurement and Verification Protocol, *U.S. Department of Energy, 2000. This document is available on the World Wide Web at http://www.ipmvp.org*

the risk of the efficiency measure not producing the expected savings to the ESCO{ XE "ESCO" }. It is where project risk is shifted to the ESCO that M&V is most important. The ESCO must prove that savings have accrued in order to be paid, and the ESCO consequently charges the customer for that proof.

The methodologies described in the International Performance Measurement and Verification Protocol are certainly state of the art for monitoring and verification of the savings of ESCO{ XE "ESCO" } projects, and therefore also applicable in the EU. They are, however, very general, and require project-specific adaptation. In many EU Member States, technical rules, norms, or guidelines for assessing the energy consumption of buildings, heating, ventilation, air conditioning, lighting, production plants, etc., do exist, but may not be known to potential customers of energy performance contracting projects and third party financing projects.

A compilation of a national common set of existing or new technical rules, norms, or guidelines for assessing the energy consumption of buildings, heating, ventilation, air conditioning, lighting, production plants, etc. will be able to function as a national "reference guideline" to both ESCOs and potential customers for monitoring and verification of the savings of ESCO projects.

Case Example: DSM Bidding Pilot Programme

After the introduction of a competitive market, Stadtwerke Düsseldorf offered a DSM bidding pilot programme to medium-sized industrial and commercial customers. An example of evaluation strategy for a project granted support is given in the following.

The bidder (ESCO) who won the contract was the building management unit of the client. The client was a large service sector company.

Energy conservation measures:

- Reduction of air leakage by closing "short-cuts" between air inflow and air outflow;
- Closing down 7 fans that are no longer needed after the reduction of the leakage;
- Installation of variable speed drives in the remaining 12 ventilation fan motors to reduce the circulating air quantities as well as the electricity demand further.

The bidding company implemented the measures itself, so no third party financing took place. Hence, the bidder had to verify the savings to Stadtwerke Düsseldorf to get the full award payment. Wuppertal Institute proposed the methods for verification of the savings based on the IPMVP. More precisely a mix of Option A and Option B was proposed:

- For the measurement of the situation before measures, Option A was chosen. It was proposed to measure for a short term the actual value of the power input and the air volume of a representative of each of the three types of fan/motor systems that were present among the 19 fans in total. This was justified because the motors were the same type and size and running continuously before the refurbishment.
- For the measurement of the situation after measures, Option B was proposed and chosen by the bidding company. The original proposal was to make short-term measurements of the power input and the air volume, and to monitor the operating hours of each of the fans over a longer period. This was needed because the 7 fans, which were closed down, still remained in place as back-up for defects or exceptional heat loads. However, the company found an even cheaper and better way to monitor the energy consumption: It simply installed 2 meters into the 2 electric circuits that exclusively feed the 19 fan/motor systems, and continuously measured the consumption using the building automation system in place.

Wuppertal Institute, Germany

7 PROCESS AND MARKET IMPACT EVALUATION

Much has been written about the survey techniques used in process evaluations and market impact evaluations, because they are in large part identical to those used in **market research**. Their use in the evaluation of EE programmes is different primarily with regard to the content of the research questions addressed, but not in how the methods are implemented or how the results are analysed. This chapter briefly describes the techniques used[17]. For more information on survey techniques**{** XE "survey techniques" **}** the reader is referred to the evaluation research references documented in Appendix B of this guidebook.

Surveys related to process and market impact evaluation may for example address:

- Efficiency of programme procedures, outreach, and information processing.
- Methods for streamlining the programme and improving cost-effectiveness.
- Explanations behind programme impact estimates (i.e., how and why the impacts were as estimated).
- Market segments that participate and do not participate in the programme.
- Effects of the programme on equipment manufacturers, suppliers and market channels.
- Participant satisfaction with the programme.
- Effectiveness of marketing strategies and promotional materials.

7.1 PRIMARY SURVEY TECHNIQUES

The primary survey techniques**{** XE "primary survey techniques" **}** used are as follows:

- In-person interviews — These are often conducted with programme staff and sometimes trade allies or implementing contractors, to provide a comprehensive understanding of how the programme is actually operating.
- Analysis of the programme tracking system — This is used to better understand which market segments are actually participating in the programme and to develop sample frames for participant and non-participant/comparison group surveys (see also Section 4.1.1).
- Telephone, mail or on-site surveys with customers — These often serve both demand impact estimation and process/market evaluation purposes, and are used to gain information on how the programme is operating, from the customer's perspective.

[17] *Part of the following text is inspired by "The Swedish Evaluation Guidebook" (NUTEK et. al., 1993). The structure has, however, been modified and the text concentrated and re-arranged with some small additions/changes.*

- Secondary market research — This method is sometimes used to collect information on how markets operate, and to construct baselines for market indicators that may be useful in estimating the market impacts of programmes.

- Other techniques sometimes used in the context of EE programme evaluation include:

  - Mystery shopper analysis, in which researchers pose as potential purchasers, to determine how sales people portray EE products or the concept of energy efficiency to potential purchasers.

  - Research panels, similar to focus groups, except that the number of individuals attending the group can be much larger (e.g., 30-40) and the group may include both quantitative (e.g., written questionnaire) and qualitative (e.g., focus group-like discussions with smaller subgroups) research.

7.2 DIRECT OBSERVATION AND MEASUREMENT

Direct observation**{** XE "direct observation" **}** and measurement has the advantage of not relying on respondents' ability and willingness to answer. To the degree that it is possible to observe/measure that which you want to know, the answers you receive will be of much higher quality than from questions put directly to the respondents.

The disadvantage of direct observation is that you have no way of finding out what the target group likes or is thinking. In addition, the method can be rather expensive. For example, it is possible to observe that energy consumption has changed, but finding out why this has occurred, probably requires asking the consumers. Therefore, direct observations are often combined with surveys.

Some examples of which questions regarding the "energy market" the method could be used to answer are:

- Who pays their bills at the customer service office?

- Who visits the customer service office?

- Who participates in voluntary activities (like energy clubs)?

- How much energy does the household consume?

- How do time of day tariffs affect energy consumption?

- How does energy consumption in an area vary due to the programme?

It is often advisable to combine the results of direct observation with surveys, but the use of the direct observation is often decided by the ease of performing it and the advantages it has over using only surveys.

7.3 PERSONAL INTERVIEW, TELEPHONE SURVEY, OR MAIL SURVEY

A survey is typically a **randomly selected investigation** with the purpose of describing a target population. A survey is carried out when a representative picture is desired of what the market thinks, feels, or does.

The data collection methods chosen depend on the existing circumstances. How many resources are available? How many people do you need to reach? Do the questions require explanations or modifications for each individual respondent? Do you want an immediate reaction, or is it more important that the respondents have time to think over their replies? How much time is available before the survey results must be presented?

Below advantages and disadvantages are listed for each of the three methods personal interview**{** XE "personal interview" **}**, telephone survey**{** XE "telephone survey" **}**, and mail survey**{** XE "mail survey" **}**.

7.3.1 PERSONAL INTERVIEWS – FLEXIBLE BUT EXPENSIVE

ADVANTAGES

- The interviewer and the person providing the information meet face-to-face, which is the most flexible situation.
- The interviewer has an opportunity to explain things.
- Many questions may be put forward in a short time.
- Virtually all kinds of questions may be asked - even sensitive ones - if special measures have been taken (such as an anonymous, written section included as part of the interview).
- Open questions may be asked if the interviewer is skilled enough to follow up on the replies.

DISADVANTAGES

- Personal interviews are very expensive.
- It may be difficult to limit the responses to the intended respondent (that is, other persons may be present).
- There is much room for non-verbal communication that is difficult to control.

7.3.2 TELEPHONE SURVEYS – SIMPLE RESPONSE CATEGORIES BUT QUICK

ADVANTAGES

- Less of a problem concerning the presence of others.
- Only verbal communication takes place but pauses can be troublesome.

- Less room for bias from the interviewer.
- Most topics can be addressed with the possible exception of the most sensitive.
- A large number of respondents can be contacted in a short amount of time.

DISADVANTAGES

- More limited social interaction, the interviewer remains anonymous. Less flexible.
- Only a limited number of questions can be asked.
- Open-ended questions are more difficult, and the interviewer has limited time for writing them down.
- Simple response categories are required, since the respondent can't look at the available choices.

> **Case Example: Evaluation of the Energy Efficiency Check**
>
> Our initial strategy was a qualitative survey using 400 telephone interviews including a control group. However, based on the Guidebook and expert advice we realised that it would be difficult or impossible to establish a control selection or "baseline". Based on the vintage of the programme and an assessment of, which questions we wanted to answer, we decided to perform a quantitative survey with 1,200 telephone interview to ensure significant results. We chose a main sample and two "control" samples to answer our questions regarding effects related to "non-participants", self selection, rebound, free-riders and spill-over effects, etc. As a result we decided to use an agency specialised in market analyses and not the initially chosen agency specialised in psychology and depth interviews.
>
> **Norsk Enøk og Energi AS, Norway**

7.3.3 MAIL SURVEYS – INEXPENSIVE BUT LOW RESPONSE RATES

ADVANTAGES

- No interviewer bias, but on the other hand, no interviewer who can explain.
- All topics are possible, even sensitive ones.
- Inexpensive way to gather data, especially when a large number of respondents are desired.
- A relatively large number of questions may be posed.

DISADVANTAGES

- The initial contact is made exclusively via a cover letter and the questionnaire itself (least flexible situation).
- Difficult to assist the respondent (such as with difficult questions).
- Open-ended questions are hard to use.

- The response rate can be low.
- A long time is needed for collecting the answers and a large number of follow-up mailings are typically required.

Case Example: National Energy Efficiency Programme

The Czech Ministry of Industry and Trade has a national financial support programme to encourage EE. Subjects applying for support are obliged to carry out an energy audit, describing the actual state of energy consumption and the energy saving possibilities. Demonstration projects approved by the CEA receive 40% support while replicated projects receive 15% of investment costs.

An annual monitoring report specifying the energy consumption by type of energy for the past year must be submitted to the Czech Energy Agency. A list of simple questions guide the recipients in making their monitoring report. Part of the contents of the monitoring report is based on the recipient's energy bill (which in the Czech Republic contains information on energy units consumed, unit price, and total cost per energy type).

One of the lessons learned from the ex-post evaluation was that the correctness of the values of the indicators in the monitoring reports was questionable:

- Some mistakes were caused by incorrect conversion of energy units (e.g. m^3 of natural gas conversion to GJ). The monitoring requested conversion to GJ, which appeared not to be a straightforward task.
- There was irregular application of weather adjustment in the monitoring reports.
- The price of fuel was not filled in correctly taking into account the different prices of fuel in the individual districts and the price changes over time.

The evaluation clearly proved a need for improvement of the monitoring system. The guiding questions for the monitoring must be further simplified and reassessed. The monitoring reports are not prepared by professionals (contrary to the tender documents). The indicators to be included in the annual monitoring report should therefore be simple, so that the project responsible does not have to carry out the slightest recalculations or adjustments.

SEVEn, Czech Republic

7.4 IN-DEPTH AND GROUP INTERVIEWS

Another group of market surveys is based on exploratory methods. An exploratory survey is carried out whenever there is not enough knowledge about the survey topic. These are most often qualitative surveys using in-depth**{** XE "in-depth interviews" **}** and group interviews**{** XE "group interviews" **}**. Their purpose is to find out why people act in certain ways.

This type of survey is thus focused on individuals and their way of reacting, which is different from descriptive surveys, which are question-oriented. Personal interviews present great opportunity for exploring in-depth **why** an individual reacts in a certain way. The method puts a lot of responsibility on the interviewer to interpret the replies. Conversely, the aim of a question-oriented survey is to find out what proportion of individuals (i.e., **how many**) have reacted in a certain way.

The most common type of qualitative study is the **in-depth interview**. In this case, the respondent (the person being questioned) has a lot of freedom in addressing the relevant topics, while in market surveys the interviewer retains the initiative by directing the respondent's attention. The interviewer often has a list of specific points to be taken up, but it is important to leave room for in-depth follow-up questions that can lead to further insight and understanding.

It is also possible to do the same kind of interview with a group of respondents under the guidance of a question leader, that is a **group interview**. There is an abundance of group interview techniques that may be used. The survey leader responsible for the interview should be trained in carrying out group interviews. It is important that the answers are not steered, while at the same time the discussion should not become side-tracked from the intended topics. Since group members influence each other, experience has shown that the best results come from building groups that are relatively homogenous.

A common view is that qualitative surveys should be a complement to other surveys in order to provide better insight into marketing problems. In-depth and group interviews should therefore be used along with other surveys, business evaluations, and creative inspiration. The goal is not only confirming or discarding results that have been obtained, but also to open new angles of attack.

Since the number of interviews is low (inexpensive evaluation) and statistical representation of the sample is not required, these methods are especially suitable for preliminary studies. However, qualitative surveys should not replace quantitative surveys, even if it is tempting to hope that the results are sufficiently representative of the entire target group.

An important issue is the interpretation of the answers. It is easy to interpret the answers so that they correspond to what you want to hear, which is why every attempt should be made to use a group leader trained for the task instead of trying to conduct a group interview by yourself. In addition, the less steered the interview, the harder it is to compare the various respondents' replies.

7.5 QUESTIONNAIRE DESIGN

Questionnaire design**{** XE "questionnaire design" **}** consists of three steps as illustrated by Exhibit 7-1.

Exhibit 7-1: Questionnaire design process.

7.5.1 PROBLEM ANALYSIS

The point of departure for all market surveys is problem analysis. It is extremely important to do a proper problem analysis before formulating the questions. The analysis should clearly state, which issues may influence the topic to be surveyed.

Reading through a well-executed problem analysis, it is easy to understand why all items of the resulting survey instrument were included. In addition, it should be clear why certain other items were not included, items that may appear to be important in the given context.

Carefully think through the problems to be surveyed. Specify concepts and get an overview over which variables are essential for the survey before you begin to formulate the actual questions. Too often people start writing concrete questions too early.

The definition of the problem area, question structure, sampling considerations and data collection methods are all related and affect each other. The questions of a questionnaire can be formulated in many different ways depending on which segment of the population is to be questioned and which method for gathering the data is to be used.

It is difficult to make general rules about how this important, initial work is to be carried out. Creativity, imagination, and the ability to put oneself in someone else's place are important ingredients during the planning stage. Also, it is not really possible to give rules of thumb on how one should go about finding the best approach for a survey or working out the best design or strategy. The best training for this kind of work is, presumably, to read and study how these problems have been solved in previous surveys.

Furthermore, it is wise to decide whether the survey will be carried out as face-to-face interviews, telephone surveys or mail surveys, before writing the questions.

Case Example: Improving the Heating System Balance in Buildings

The objective of the evaluation was to estimate the heating system situation after programme implementation.

The first step of the evaluation was collection of information on programme and the follow-up studies and interview of partners involved in the programme. Based on this information, two questionnaires were developed targeted at the house managers involved in the programme (second step). The objective of one questionnaire was to collect information on the building and the programme related renovation of the heating system while the objective of the other questionnaire was to collect information regarding participant satisfaction and energy awareness level.

And finally the last step was collection of energy consumption data for the individual buildings from the district heating companies.

Motiva, Finland

7.5.2 DESIGN OF QUESTIONNAIRES WITH MULTIPLE-CHOICE ANSWERS

The instrument applied in a market survey of energy services is commonly a standardised questionnaire. The main advantage of a standardised questionnaire, i.e., a questionnaire with multiple-choice answers**{** XE "multiple-choice answers" **}**, is that these are easier to encode and analyse than questionnaires using many open-ended questions.

In the actual construction of the questionnaire, the content, the structure, and the order of the questions; the layout; the respondent characteristics; and review of the topics once more have significance on the replies. Below, a checklist for the design is given.

Question content, structure, and order:

- Consider a mix of data collection methods from the very beginning of the design process.

- Reflect on the order of the questions. The basic recommendation is to begin with broadly worded questions and proceed to more detailed ones. There should also be a logical sequence to the sub-topics. In other words, a “train of thought” running through the questionnaire. Especially sensitive questions should be saved to the last so that the respondent is not frightened off.

- Think about the possible effects of preceding questions and replies and thus the right question order. For example, once you have made the respondent aware of a price, this will bias the replies to the remaining questions.

- Consider the amount of effort the respondent will need in answering the question.

- Use open-ended questions only when really needed.

Layout:

- Take advantage of the opportunity that interviews and mail surveys present for using illustrations to make the content of quantitative reply alternatives more clear.

Formulation:

- Don’t include questions just because they might be nice to have.

- Define the questions in place and time.

- Ask only about one thing at a time.

- Be careful when using “yes/no” questions. In most cases more alternatives are needed.

- If predetermined multiple-choice responses are used, then the available choices should be exhaustive, mutually exclusive, and easily comprehensible.

- Avoid unbalanced questions that gives a certain answer a positive/negative bias; or alternatively, use several questions with opposite emphasis.

- Ask secondary questions that touch on the thoughts and notions that lay behind the attitudes of the answer to primary questions.

- Be careful with hypothetical and retrospective questions. The replies may be very difficult to interpret.

- Avoid value-laden words and leading questions.

- Be as concrete as possible.

Respondent characteristics:

- Is the respondent able to reply to the question? When asking about one’s knowledge of something that only some of the respondents will be able to reply to, there should be a “don’t know” alternative to multiple choice items.

- Is the respondent able to express his thoughts and opinions in words? Don’t force an opinion from the respondent unless there are specially motivated reasons for doing so.

- Will the respondent actually do what he says he will? What the respondents say they are going to do often differs from what they actually do. The relationship between the respondent's plans and actions will be greater the more important the issue is to the respondent. Thus, questions concerning the respondent's intentions should only be asked when important decisions are concerned.

Review the topics once more:

- Have you considered how the results are to be used or how the results are to be analysed?
- Will the questions really answer what you want to know?
- Are the questions so well thought out that they can be used in the future for comparing results between different years? The slightest little revision in the wording can result in making it impossible to compare the replies to previous years.

7.5.3 PRE-TEST THE QUESTIONNAIRE

Always pre-test a questionnaire! All interview questions must be tested. A survey's efficiency is dramatically improved if the draft questionnaire undergoes various "desk top tests" and pre-testing in the immediate environment even before testing it in the field.

This also applies to borrowed questions if they are being used in a new context. It is important to use every available opportunity to pre-test the questionnaire in the field. The efficiency of the questionnaire is further improved if you have a clear idea about just what it is you wish to test. You should also seize the opportunity to work on reducing the size of **measurement errors**.

There are many reasons why measurement errors are made in market surveys. Measurement errors may be classified as **interviewer bias{** XE "interviewer bias" **}**, instrument effects, or respondent effects.

Measurement errors stemming from interviewer bias show up when different interviewers get different answers or replies when asking the same question to the same individual. Studies have demonstrated that one interviewer may systematically obtain more positive replies than other interviewers. Some causes for interviewer bias include:

- The interviewer communicates ideas to the respondent that biases how the respondent replies.
- The interviewer's outlook is such that he interprets the replies in a different way than others would interpret the same replies.
- Emphasis given to different words can bias the replies.

Measurement errors stemming from **instrument effects{** XE "instrument effects" **}** are common in marketing connections. Some causes of instrument effects include:

- "Double-barrelled" questions that measure several underlying variables at the same time, while the person using the question believes that it only measures a single variable.
- Ambiguous wording (Is "listening to the radio" the same as "having the radio on"?)

- Vague wording (such as "regularly" and "sometimes") will mean different things to different people.

Some causes of **respondent effects{** XE "respondent effects" **}** include:

- Inability to answer (doesn't know, forgot, cannot state reasons for inability).
- Unwillingness to answer (invasion of privacy, lack of time, fatigue).
- Reluctance to answer truthfully (prestige seeking and thus give socially acceptable replies, a desire to be polite and co-operative, etc.)

All of the measurement errors named above obscure the survey results. Things that may appear to represent very small differences in wording can lead to completely different results; for example as in the difference between "should forbid" and "should not allow." Ignorance of how these sources of error can bias the results translates into inability to correctly interpret the results. Finally, it must be recognised that one can never completely eliminate all sources of error, and thus the goal should be to eliminate as many as possible, specially the major ones.

Case Example: Evaluation of the Energy Efficiency Check

We found that we had used a "leading question" in our investigation, which appears to have given misleading results. The question was "Do you *remember receiving* an EE newsletter within the last 12 months?" Here 47% of Group 3 answered positively although they had not been sent the EE newsletter or other EE material from the EE Centre or others in the area within this period. The question was leading in that it gave the impression that the newsletter had been sent and the question therefore only concerned whether or not the interviewee could remember or not.

The order of questions is also incredibly important. An investigation can be ruined completely if "revealing" questions are asked too soon.

It is important that persons who know the EEC programme and the use of it are involved in the design of the questionnaire. Many phrases were changed and many questions corrected in the questionnaire used by the market analysis bureau. This has increased the total quality of the investigation.

Norsk Enøk og Energi AS, Norway

The pilot testing also creates the opportunity to fine tune the questionnaire wording and try out different phrases and sentence constructions. The checklist below points out several ways to **work with the language{** XE "language" **}**:

- Define difficult words and use sophisticated words carefully.
- Edit away unnecessary words and parts of words.
- Don't be inflicted with "noun-itis."
- Use personal pronouns and other short words.
- Avoid abbreviations.
- Mix long and short sentences.
- Write the same way as you talk. Read the questions out loud to yourself and others.

- Is the text to be read or heard?
- Try to measure the text's readability.

It is always the author's fault when the reader has difficulty understanding a text.

7.6 RESPONSE RATES

One should never expect a response rate{ XE "response rate" **} of 100%** when carrying out a survey. There are many reasons for lack of response. Prior to calculating the response rate in some surveys cases, commercial survey firms like SIFO[18] will exclude a large number of categories from the survey population, including the deceased, those residing abroad, the incarcerated, the hospitalised, non-speakers of the native language, etc. In addition to this, the percentage not responding to personal interviews is typically 25% due to no contact being made or refusals.

The response rate will be affected by the subject matter of the questions and the questionnaire's appearance, including the number of items. If the respondents feel that the subject matter is stimulating and relevant, then not only will the response rate be higher, but it will be possible to include a greater number of items. Another significant factor is how much the respondent trusts the party asking the questions.

A reasonable goal for evaluations of energy services is a response rate of at least 50%. Most households appear to be very interested in their energy costs, which means that a high response rate may be expected. You should also find out whether the response rate is the same among all groups. For example, if the non-response rate is especially high in the "major consumer" group, extra resources should be committed to acquiring the responses from this group. Unfortunately, there are often high non-response rates for certain subgroups in many surveys, which distorts the results (self selection bias, see Section 4.2.4 for more information).

7.7 INTERPRETING THE RESULTS OF INTERVIEWS AND SURVEYS

One of the most challenging tasks in a process or market evaluation is interpreting the results of the research. Those being interviewed or surveyed at times may try to answer questions in ways that they believe will:

- Please the interviewer.
- Make themselves seem intelligent.
- Make it seem that others are responsible for problems they may have created.

Research respondents may also often not know or remember the answer to questions the research must find answers to. The classic example of this problem is evaluators asking programme participants one year after they implemented a measure promoted by the programme what they would have done if there had not been a programme (the classic free-

[18] Svenska Institut för Opinionsundersökningar *(The Swedish Institute of Public Opinion Research).*

ridership question). Often, the respondents do not consider the measure implementation to be a defining moment of their lives. They may or may not remember what they were thinking one year ago. Even if their participation decision is more recent, it may be difficult for them to accurately describe what they would have done if there had been no programme.

Process and market evaluators address issues that may arise due to the **self interest{** XE "self interest" **}** of programme implementers by asking multiple parties involved in programme implementation similar questions and then thoughtfully weighing the responses they receive from each respondent type. They also address most of the above issues through careful questionnaire design.

Sources of information on how to address other process and market evaluation issues include the proceedings of the major EE conferences and the primary reference sources noted in Appendix B of this document.

8 APPLYING RESULTS

An important issue in relation to EE activities is the documentation of the process and the results together with the assumptions. The EE activities are often subject to public scrutiny and it is therefore wise to clearly document every activity including assumptions and choices to avoid unjust criticism. The same holds true for the associated evaluations.

8.1 PRESENTING RESULTS

The aim of presenting evaluation results may include one or more of the following:

- Proof/verification of estimated impact and costs;
- Basis for improved programme efficiency;
- Prepare grounds for new EE activities;
- Permission to continue programme efforts or initiate new programmes;
- Release payment for services rendered;
- Encouragement of new finance;
- Transfer know-how;
- Encourage the interest in energy efficiency EE (e.g., amongst non-participants).

A major issue in evaluations – and especially process evaluations – is how to present results. Programme staff, who are the most likely to be able to use the results of this research, may also be the most threatened by it, for it may expose ways in which the programme can or should be improved or terminated. For some programme implementers this may be **unwanted criticism**. For this reason, results need to be presented in a balanced manner, describing both the ways in which the programme is being operated successfully and the ways in which it can be improved. It is also helpful to provide immediate **feedback** on the programme, with regard to areas requiring improvement, as the process evaluation**{** XE "process evaluation" **}** proceeds. This offers the implementers an opportunity to make immediate improvements, which then can also be reported in the process evaluation results. In this way the process evaluation can be used as a tool of programme management.

When used strictly as an assessment of how well individuals are performing their jobs, the evaluation is likely to be perceived very negatively, limiting the willingness of programme implementers to share information, especially information about ways in which the programme is not living up to expectations.

For all types of evaluation, it might prove beneficial to arrange a review of the evaluation plan by several **interest groups** prior to the actual evaluation. This approach is likely to increase the general acceptance of the programme and the programme results. Furthermore (and this may be just as important) it may identify weak elements in the planned evaluation and allow timely improvement of the evaluation plan.

Target groups for dissemination of selected elements of evaluation results or all evaluation results include:

- Programme designers and implementers;
- Programme partners and allies;
- Political key-decision-makers;
- Finance providers;
- Participants and non-participants;
- General public;
- Other EE experts.

The target groups of the results will determine how and when results should be presented.

8.2 TIMING OF RESULTS

The usefulness of the results of many evaluations conducted in the past has been hindered due to poor timing{ XE "timing" }. Thorough research has been conducted, sometimes resulting in important discoveries about ways in which programmes should be refined, but the results have been presented after key decisions have been made about the next year of the programme. This has meant that programme changes based on the evaluation of the first year of a programme sometimes could not be made until the third year of the programme. This has devalued the evaluation to decision-makers, for they may have paid for a comprehensive evaluation and received valuable feedback on the programme too late for that feedback to be of use. More on this issue can be found in Section 3.7.

One way in which the cost of evaluations has been minimised and their usefulness maximised has been to tie specific evaluation activities to performance indicators. All major programmes should receive at least one comprehensive evaluation. However, for programmes lasting some years, evaluations can be linked to a set of indicators regarding programme performance, so that limited and very targeted research is conducted continuously but on an ad hoc basis when needed.

Performance indicators{ XE "performance indicators" **}** are typically quantifiable indices of how well a programme is performing, e.g., average expenditure per participant, number of participants per quarterly period, average tracking system estimated energy savings per participant, or average time between participation application and EE measure installation. An expected value is established for each performance indicator. If the programme does not meet this **threshold value** during the measurement period (e.g., quarterly), some form of evaluation research is triggered, such as telephone surveys with an appropriate sample of the participants. The research focuses specifically on the issue represented by the performance indicator, and its purpose is to determine why the indicator is not reaching its minimal threshold value.

Rather than wait until the end of a programme year to conduct the research, it is conducted – only if necessary – throughout the year, in short spurts. Programme implementation staff therefore receive rapid feedback so that they can alter programme components in time to affect programme performance in the same year. Performance indicators are thus a form of programme monitoring points designed to enhance programme performance *in a timely manner*, to focus the efforts of programme implementers, to minimise the cost of evaluations, and to maximise their usefulness to decision-makers.

8.3 TRANSFER OF PROGRAMMES

International exchange of experience can function as good inspiration for new and improved EE programmes. However, programmes cannot be transferred**{** XE "transfer of programme" **}** directly from one context to another and be expected to result in the same outcome.

The local context is determined by the characteristics of the energy market, the energy utility industry structure and ownership, the EE market and EE providers, and the regulatory framework. The history is also relevant to consider.

A sound understanding of the programme mechanisms and problem mechanisms (see Section 2.5.1) will help identify the characteristics of the energy end-use, which the programme aims to influence. Often the experienced EE programme expert knows to some extent intuitively what will work in his/her local context and what not. Sometimes he/she will even have a good understanding of why. But often this knowledge is not included in the reports on the programme design, implementation, and outcome. Therefore, it is very useful to contact the person responsible for the programme, which you consider copying, and discuss the details of the underlying basic assumptions – in particular about consumer and market motivations.

Are the investments in a new programme going to be significant, it might prove wise to test some of the basic assumptions, for example, by implementing a pilot programme first.

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APPENDIX A:

CASE EXAMPLES

CONTENTS

IMPROVING THE HEATING SYSTEM BALANCING SERVICES OF BUILDINGS (SF)

Submitted by:

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INTRODUCTION

The Information Centre for Energy Efficiency, since the autumn 2000 MOTIVA Ltd, started a market transformation programme for improving the heat balancing in buildings in 1993. The programme also had features from load management and customer retention type programmes. The programme aimed at improving living conditions in residential buildings and reducing heating costs by savings of 10% in energy consumption. The programme altogether with two follow-up studies lasted 4 years till 1996. During this period, heating systems were balanced in 3,600 buildings, 180 HVAC contractors, 200 engineers were trained and the systematic engineering tool was designed. The programme partners were MOTIVA, Oras Ltd (manufacturer), and Ensel Engineering Ltd. (Energy Service Company).

The total programme costs were 2,080,000 EURO. The Government's financial support was 20%; the programme partners covered 80% of the total budget.

The target of the programme evaluation was to assess the current market situation on heating system balancing after the programme and the governmental support was finished. The target was to estimate how many buildings were balanced, how many persons trained on the basis of the programme. The objective of the evaluation was to estimate total energy savings as well as the total reduction in CO_2 emissions, which were calculated by engineering methodologies using data from the Finnish District Heating Association. The methodologies used in the programme evaluation were interviews, questionnaires, and collection of consumption data in specific buildings from the utility companies.

In 2000, MOTIVA asked Finnbarents, University of Lapland, to co-ordinate the programme evaluation. Espoo-Vantaa Institute of Technology and Suomen Talokeskus Ltd. participated in the evaluation work.

BACKGROUND

Flat temperatures in multi-family building blocks and terraced houses connected to the district heating network varied within the range of 26°C to 18°C depending on the location of the flat. MOTIVA started the development of the programme in 1993. The basic idea was to create pleasant living conditions with even flat temperatures of 20-22°C and to justify the heating costs among the residences. A saving of 10% in energy consumption was a target. One of the objectives was to increase public awareness of energy saving potential in residential buildings. The programme aimed to overcome this market barrier of higher investment costs resulted of the new equipment and installations: the complete heating system balancing demands investments, approximately 0.7-1.4 EUR/m^3.

The Finnish Ministry of Trade and Industry supported the programme. Motiva, Oras Ltd., the manufacturer of equipment, and Ensel Engineering Ltd participated in the programme.

The first phase of programme started in May 1993 and it finished in 1994. The programme was followed by two follow-up studies during the years 1995 and 1996.

EVALUATION METHOD

The objective of the evaluation was to estimate the current situation of heating system balancing according to the programme or other methodology in the market. The eligible market i.e. the number of unbalanced buildings at the time being is approximately 80,000 buildings. Altogether this means a large potential for energy savings.

The evaluation can be divided into two phases: data collection and evaluation.

The first step in data collection was to get information of the programme and the follow-up studies and to interview partners involved in the programme.

The second step was to prepare two questionnaires for the house managers involved in the programme. The first questionnaire focused on information of the buildings of which heating system balancing was carried out during 1996-99. The objective was to get actual data on concrete buildings that have been renovated. Thus the questions related to the building itself and the renovation:

- Name of the building
- Location, address
- Type of building
- Type of heating system
- Total costs of the project
- What was renovated
- Has any other renovations made during 1996-99 e.g. ventilation, windows, insulation of walls, etc.

The second questionnaire focused on the programme and is presented below.

RESULTS AND CONCLUSIONS

The main results and findings of the evaluation are briefly discussed below. The detailed results of evaluation will first be presented to Motiva Ltd, which decides on the further activities, publishing and information dissemination.

Questionnaires were sent to over 500 house managers. The reply percentage was 25%.

One fourth of potential target group of buildings were renovated meaning that heating system balancing is still needed. Every house manager indicated that they intended to continue renovating the heating systems in their buildings. The most important driving force is the pleasant living conditions, not energy savings nor environmental aspects.

The investments were in most cases considered to be beneficial.

Information on the programme and more over the heating system balancing should be increased.

The 100 buildings with energy consumption follow-up data were studied in more detailed for estimating the savings. Savings and CO_2 reductions are estimated on an annual basis.

The reduction in CO_2 emissions was estimated as 77,500 t/a; the potential of 231,000 t/a. The gross primary energy saving was calculated to be 22,400 TJ/a; the potential of 67,200 TJ/a. The figures have been calculated on the basis of the total annual production of DH in 2000 /1/: 27.4 TWh, of which 77% produced by CHP and 23% by separate production. CO_2 burden in CHP production is 211 gCO_2/kWh and in separate production 217 $gC0_2$/ kWh.

REFERENCES

Information of the Finnish District Heating Association.

HEATING SYSTEM BALANCING ENQUIRY

	Yes	No	Don't know
1. Has the heating system of residential buildings managed by you been balanced?			
2. Do you allow your buildings' heating energy consumption figures to be used for this study?			
(Enclosed is a power of attorney for the acquisition of information from the local DH company)			
3. Has all the heating system balancing been carried out according to the Motiva quality standard?			
4a. Are you satisfied with the heating system balancing and with the Motiva quality standard as a whole?			
4b. Do you have any suggestions as to which area should be further developed?			
5. Has there been follow-up of the heating system balancing in the buildings managed by you:			
a) Measurement of room temperature?			
b) Were the measured temperatures within ±1°C range of the planned room temperature?			
c) Follow-up of the energy consumption?			
d) Enquiry about user satisfaction?			
e) Follow-up and regulation of the heating adjustment curve?			
f) Other follow-up			
6. Why has the heating system balancing been carried out in the buildings managed by you?			
a) Uneven temperatures in the apartments			
b) In order to save energy			
c) Leaking radiator valves			
d) Other reason			
7. Is the heating system balancing a profitable investment to the building?			
8a. Will there be in the future heating system-balancing projects in the properties managed by you?			
8b. If yes, will they be conducted according to Motiva quality standard?			
9. According to your estimate, in how many cases out of ten has the heating system balancing not been carried out because the state contribution (20%) was cut off?			
10. Should there be more public information about the heating system balancing?			
11. In your opinion, is there a need for training concerning the heating system balancing?			
a) for property managers			
b) for maintenance personnel			
c)			

12. Opinions/ experiences concerning the heating system balancing:

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EVALUATION OF THE ENERGY EFFICIENCY CHECK (N)

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INTRODUCTION

The Energy Efficiency Check (EEC) is a standardised EE audit for households, which was first introduced in a national EE campaign by The Norwegian Water Resources and Energy Directorate (NVE) in 1997. It was sent to 1.26 million households in 1997 and has continued to be an important element in several campaigns both locally and nationally. In a white paper from the Norwegian parliament, nr.58 (1996-97), regarding environmental politics for a sustainable future it is an expressed goal that all the households in the country (houses and semidetached houses) built before 1980 will undergo an EEC of their residence within a period of 5 years. The EEC is thus intended to be a main tool for EE in private households.

On the background that the EEC is one of the EE tools of the residential sector that has required the most resources in the last years, and that its goals and effect has been disputed, it is important to strike a balance for this activity. Both the use of public funding, organisation and implementation of this programme would benefit from being the subject of evaluation. The present "Ex-post Evaluation Guidebook for DSM and EE Service Programmes" and the assistance of an evaluation expert from the guidebook project team have been used to raise the quality of the evaluation strategy and the implementation of the evaluation work.

Furthermore, the organisation of all Norwegian EE activities is currently under revision by the Ministry of Petroleum and Energy. The authorities plan to establish a new administrative body with a freer position in relation to the public administration than what NVE as a directorate has today. The services and programmes that are offered by the Energy Efficiency Centres today will to a greater extent be exposed to free competition. It is therefore important to be competitive and able to show well-documented results. Hence evaluation of existing EE services and programmes is getting increasing attention.

The evaluation of the EEC includes impact assessment, cost-benefit analysis, and customer utility value. This, along with the potential consequences for the involved parties is presented in the following.

Of total of 1,200 telephone interviews was completed in September 2000. This is a relatively large evaluation of a full-scale EE programme in Norway. The findings are interesting and, by first glance, quite depressing for the parties that have put a lot of resources in this particular EE programme.

The following will give a general overview of the EEC programme and its goals. The evaluation strategy, the methods, and the survey will be presented along with the most important findings. Finally, it is discussed whether the goals of the EEC programme have been fulfilled and recommendations are given for further use of the EEC programme.

PROGRAMME DESCRIPTION

The EE Centres send the EEC by direct mail to end-users. It consists of a form with a number of simple questions about the building in relation to energy use. The questionnaire is filled in by the customer and returned to the EE Centre. Based on this questionnaire the customer will receive a letter where the specific building's consumption is compared to norms for how much energy a normal house should use. The letter also includes the estimated saving potential of the building and a recommendation of specific EE measures.

The EEC offer, which was distributed to the customers in Akershus in 1999, consisted of an introduction letter and the EEC form printed on the EE Centre's notepaper. A stamped envelope was also included. When the customer filled in and returned the EEC, it was processed manually by an energy adviser at the EE Centre. The resulting response from the EE Centre consisted of a letter stating simple EE measures that the customer could benefit from as well as a graph of the electricity consumption adapted to the individual house.

The **main goals** for the EEC programme and the EE Centre in Akershus were:

1. More energy efficient households.

2. The programme effects must exceed its costs.

3. The programme shall create possibilities for follow-up activities.

The goals are diffuse and not formulated with an ex-post evaluation in mind. They are not very precise or easy to verify and they say more about the thoughts and opinions of the EEC's role in the general national EE policy. The first goal could be about documenting kWh saved and would hence be possible to verify. The second goal says nothing about what the effect should be or who would benefit from it – the customers, the EE Centre or the authorities? This goal would have been good if there was a tracking or monitoring system that would provide comparable values. The third goal does not specify the follow-up activities. There is some doubt that the EE Centre in Akershus and other EE centres had specific goals as to what kind of follow-up they wanted at the end of the EEC programme. It is also likely that the various counties/centres has had different goals. To clarify this issue was outside the limits of this evaluation.

The evaluation itself and the Ex-post Evaluation Guidebook project have taught us a lot about the need to specify clear and precise goals that are possible to meter and evaluate.

THE EVALUATION

Evaluation Objectives

Initially the objective was defined as: "Document kWh saved for the participating households". This goal was redefined while working with the questionnaire. It proved to be too complicated and time consuming to answer this question through phone interviews. Also the effective output of an exact kWh number for each household is doubtful compared to the use of resources to prepare, design the questionnaire, the length of the interviews and the data processing. The questionnaire was hence redesigned to answer the following:

1. Describe **how many more EE measures** the participants in the programme have implemented and measure the value of these compared to norms.

2. Document possible **other effects** resulting from the EEC beneficial to the involved partied (national authorities, the EE Centre in Akershus, other EE centres).

3. Evaluate the **use of resources** against possible alternative use.

The first goal is the main focus of the evaluation. The questionnaire and the survey have been designed mainly to fulfil this goal. In addition questions were added to create a basis to evaluate whether the last two goals have been fulfilled. Redesigning the first goal to not include documentation of kWh savings has also resulted in changes to the last two as the kWh documentation was removed.

The evaluation has attempted to answer the above. In accordance with the project plan we will also make a recommendation for future use of the EEC intended for relevant decision-makers.

Evaluation Strategy and Method

Our choice of strategy is based on the European Ex-post Evaluation Guidebook. It has proven useful as an introduction to evaluation of EE programmes as it provides a description of various evaluation methods. We have focused on the methods that seemed relevant to the evaluation of the EEC. The following theory is taken from the guidebook to present a background for the chosen strategy.

Evaluation is particularly important when the EE programme is free of charge. The demand for a service will in these cases not be sufficient to defend the advantages, effects, or results. If the customer had to pay to participate, a high response would in itself be a good indicator of a successful programme. An evaluation of the EEC will make it easier to argue for or against the programme.

The goals for the EEC have been described above. We would however like to add that there have been several goals for the national EE policy in Norway including reduction of the energy import, increased employment, and promotion of the authorities or EE centres. The electric utilities have operated with customer retention goals to increase profit margins and profitability. We need good, clear and realistic goals and a precise EE policy to be able to meter the effect of EE programmes. If the goals are as described but the monitoring is focused on kWh savings we will soon end up with a lot of “failed” EE programmes and tools.

Key Areas of Uncertainty

We have focused the evaluation around the question of results and effect in the form of more implemented EE measures (kWh reduction) and the market response to the EEC. Evaluation of the process and implementation of the programme could have been interesting but was not included in this evaluation.

The questions below were formulated to answer the goals of the evaluation.

- **Did the participants energy use alter as a result of participating in the programme?** If not, why not? Recommended savings compared to actual savings? What parts of the savings did the EEC cause directly? Other causes for a lower energy use: weather, personal economy, increased energy price, changes in attitude, more electric devices, more inhabitants.

- **What would the energy use have been without the EEC?** Past and present consumption data, control sample, baseline studies.

- **What measures would the household have carried out without the EEC and why?** Free riders: the exact same measure with the exact same savings, partially the same measure, the same measure, but at an earlier date than planned.

- **Are the achieved savings larger than the costs of implementing the programme?** Cost/benefit analysis.

- **Have the participants carried out other or more EE measures than those recommended and advised by the programme?** Spill-over effects: increased awareness, change in attitudes, changes in habits, measures that do not require investments, household implementing measures because of the EEC without returning the EEC form.

- **Are there other benefits than actual reduction in energy consumption?** Rebound: comfort, higher indoor temperature, new electrical devices etc.

- **Self selection** Are the participants already “best in class” regarding energy? Are the savings due to the background of the participants rather than the EEC itself.

Investigating the lifetime of the implemented measures, delayed effects, and follow-up values would be interesting but was not part of our evaluation.

Vintage of Programme

The EEC programme is a second/third year programme. A thorough evaluation is hence right. The decision-makers will have to decide whether to continue, improve, alter, or terminate the programme. Surveys suitable for newer programmes were carried out in the earlier stages of the EEC programme. These showed a good response and sufficient customer satisfaction. It was assumed that the detected savings were due to the programme and thus indicated that the programme was on the "right track".

Level of Evaluation Effort

The funds available are a decisive factor in the choice of method. In general a more comprehensive evaluation like we chose is necessary when considerable resources have been used to develop and implement a programme, special findings are expected or the expectations to the programme is large and the programme is subject to discussion.

Our conclusion was that a different and more expensive data collection than what was done in the previous surveys was needed to provide answers to our questions.

Key Decision-Makers

Identifying the important decision-makers for continuation or development of the EEC was relatively simple.

The EEC was, as mentioned earlier, first introduced as a priority EE programme in a national EE campaign initiated by NVE in 1997. It has since been an important element in several campaigns. NVE is subordinate to the Ministry of Oil and Energy (OED) and responsible for administration of national water- and energy resources in addition to management of national EE activities.

The EE Centre in Akershus has used considerable resources on developing and implementing this EE programme and is hence the EE Centre in Norway with the longest experience with use of the EEC. We have used material from Akershus and based our survey on the goals set for the EEC in their area. Akershus is a county in Norway consisting of small and large towns and villages and should hence be representative of Norway as a whole.

The EEC is and has been part of the total service offer provided by the EE centres in Norway for some time. Documented results will be increasingly important in a new situation where the centres to a larger extent will be subjected to a free market. This will also imply a reconsideration of all the existing EE tools and programmes including the EEC.

Planning the Survey

Several possible data collection strategies were considered based on the details of the EE programme, existing data and investigations of former surveys and evaluations.

In brief, the former evaluations of the EEC performed by the EE Centre in Akershus have focused on market response and simple impact assessments. The response rate has been considered satisfactory and the customer satisfaction has been considered high. These evaluations have also shown an average saving per household of 450 EUR for the benefit of the programme. No control samples have been used. There have been made no attempts to check what the household would have done without the EEC. The documented savings were not compared to customers who did not participate in the programme and are hence merely assumptions of the effects of the programme.

As mentioned earlier, a low budget evaluation is correct at an early stage of a programme. Our initial strategy was a qualitative survey using 400 telephone interviews including a control group. Based on the new examination of the programme history we decided to perform a larger survey to ensure significant results. We chose a main sample and two "control" samples to answer our questions regarding effects related to "non-participants", self selection, rebound, free-riders and spill-over effects, etc. As a result we decided to use an agency specialising in market analyses and not an initially chosen agency focusing on psychology and depth interviews.

Sample 2 and 3 are comparison samples. A real control sample does not exist as this would mean two 100% identical samples where the programme is the only difference. Theoretically a baseline, i.e. a sample group with the same "starting point" as the participants, could have been established. This could only be done before the programme was implemented in this kind of programme and is better suited to evaluate technical EE measures. Comparison samples like the ones we have in this evaluation will provide a good indication to the situation without the programme.

RESULTS OF THE EVALUATION

The evaluation has given useful experience on several levels. Increased knowledge of evaluation theory and methods and the results of our evaluation have shown how crucial a systematic lifetime evaluation is to EE services and programmes.

Formulating the survey questions correctly and placing them in the right order to ensure that the respondents are not influenced to give the "correct answer" is in general a large and important task. Our experience is that co-operating with experts with thorough knowledge of the programme is crucial as even small errors can have relatively large effects.

We recommend that all types of EE evaluations should answer questions on self-selection and general social commitment. Such information will make it easier to differentiate between results caused by general energy and environmental attitudes and results directly due to the EE programmes and services.

The Survey and Important Findings

The survey was implemented in September 2000. It was carried out by the company Norsk Gallup on behalf of Norsk Enøk og Energi AS that is responsible for the Norwegian case project. Three groups of a total of 1,200 customers in Akershus were interviewed.

The three sample groups were:

1. Customers who participated in the EEC programme
2. Customers who received the EEC, but not completed or returned the form
3. Customers who did not receive the EEC (or other EE material from the EE Centre over the past year)

The most important findings of the survey are:

- The EEC has little effect on implementation of EE measures.
- Customers who did not receive the EEC (the third sample) seem to have implemented most EE measures overall.

Other findings are:

- The wish for a reduced energy bill and reduced energy use is the main cause for implementing EE measures.
- The main cause for not implementing new EE measures is that EE measures were already implemented in the past.
- The customers who have already implemented several EE measures in the past are the most likely to complete and return the EEC. The same people seem to be more interested in EE than the average person.

- There are significant differences between the three samples on the issue of behaviour. Customers who participated in the programme (Sample 1) have a higher score than the two other groups regarding EE behaviour. This again implies that this is the most EE aware part of the population.

- The participants of the programme are the people that are most eager readers of the EE newspaper and their general knowledge on EE is significantly higher for those who have not been exposed to any EE service or material the last year (Sample 3).

- Customers, who return the EEC, are generally more focused on their energy use, which may partly be due to the EEC.

- The EEC works, in combinations with other distributed material, as "name branding" for the EE Centre.

- Knowledge of EE is higher among the customers who have received or completed the EEC. These two samples have also received an EE newspaper and other material from the EE Centre.

- Installation of energy efficient light bulbs is the most common EE measure.

It seems like the problem of self-selection is more evident than anticipated in spite of the fact that people's attitudes towards EE and environmental issues seem to be almost the same. The EEC also seems to have been used as a tool to verify that measures already implemented are the right ones and truly are energy efficient.

Who Participates in the Programme?

The survey gives several characteristics of the participants. 72% of the 2,400 people that completed the EEC were men. This shows that men are most interested in implementing EE measures in general. There are no large differences regarding age, but it seems that older people are more interested. The number of people in the household does not influence the reaction to the EEC. The income, however, seems to make a difference in whether you use the EEC or not. People with high income are more likely to participate in the programme. It seems that the medium size households with a living area of 100-250 square metres are more likely to return the EEC. The heating system of the houses has little influence.

Other Interesting Findings

The main reason for implementing EE measures is to save energy and reduce electricity bills. More than 40% give this answer in all sample groups. 10% want increased comfort and about 10% say that general maintenance is the main reason. Women and people in older houses are more interested in increased comfort. The houses in the third sample group are in general older and hence they require more maintenance. In the same sample there are more young people in older houses. This can of course be a contributing factor to why this sample group has implemented more EE measures on the whole.

The reasons why people do not implement EE measures vary between the sample groups. In the first sample 71% said that they had already implemented the measures. In the two other samples only 50% gave the same reason. This shows again that the people who have used the EEC are already very aware of EE. Other reasons given are "no need", "new house", and "can not afford".

The survey also shows that very few people plan to implement EE measures over the first year. 74% of the participants in Sample 1 and 57% of the people in Sample 3 will not implement measures in this period.

When asked about EE habits people answer that they do things very "energy correct". About 90% of all the samples say that they switch off lights in empty rooms. 90% fill up the dishwasher and washing machine before they switch it on. The participants in the EEC programme are in general the best. As for age, the older you get the better your energy behaviour is according to the survey.

Exhibit 1: Survey of the Energy Efficiency Check
(Implemented by Norsk Gallup on behalf of Norsk Enøk og Energi AS, September 2000)

Approach (some examples from the survey)	**Sample 1** Participants Given other info	**Sample 2** Not participants Given other info	**Sample 3** No offer No other info
Number of implemented EE measures pr. household	**7.65**	**6.57**	**8.48**
Number of implemented EE measures in buildings built			
before 1900	0%	5%	1%
1900 – 54	16%	14%	11%
1955 - 69	23%	18%	23%
1970 - 83	36%	29%	33%
1984 - 97	18%	27%	26%
after 1997	7%	7%	7%
Implemented measures in % of total			
Installed photocell for outdoors lighting control	4%	4%	4%
Installed new windows	13%	15%	11%
Installed energy saving light bulbs indoors and outdoors	52%	51%	48%
Sealed air leakage around windows	8%	7%	11%
Sealed air leakage around doors	5%	3%	9%
Replaced balcony door	1%	1%	2%
Installed new door	2%	2%	2%
Insulated roof	1%	1%	1%
Insulated walls	1%	2%	2%
Installed energy saving shower head	4%	5%	4%
What are the main reasons for not having implemented EE measures?			
Have already implemented EE measures	71%	53%	50%
No need	19%	18%	15%
New building	18%	22%	13%
Do you have plans to implement any EE measures the next 12 months?			
No plans to implement any measures	74%	71%	57%
Will replace doors or windows	4%	8%	9%
Will start using energy saving light bulbs	4%	5%	3%
Behaviour: Do you do one of the following things?			
Turn off light during the night	21 %	17 %	21 %
Air out short and effective	82 %	76 %	78 %
Take short showers	41 %	36 %	41 %
Rinse dishes in cold water	29 %	22 %	21 %
Fill up dishwasher and washing machine before use	89 %	83 %	87 %
Reduce temperature in rooms that are not in use	74 %	73 %	74 %
Turn off light in rooms that are not in use	91 %	90 %	88 %
Can you remember to have received a newspaper about EE during the last 12 months?			
Yes	70 %	62%	47%
No	26%	33%	48%
I don't know	4%	5%	5%
Knowledge: Identification of EE measures. Four alternatives given - two were correct.			
Share that gave the right answer	78%	77%	67%
Do you follow up your energy use by reading the meter at least every month?			
Yes	42%	31%	30%
Do you know of the EE Centre?			
Yes	66%	48%	38%
Have you made use of one or more offers from the EE Centre during the last 12 months?			
Yes	12%	11%	4%

WERE THE EVALUATION GOALS REACHED?

How Many More EE Measures?

The evaluation aimed to describe how many additional EE measures the participants in the programme had implemented and then calculate the impact of these measures using to norms for energy use. Looking back we can see that even at the design of this aim we assumed that the customers who had implemented the EEC would have carried out more EE measures than the other two groups in the survey. This was, however, not the result of the survey. It was group 3, who had not even received the EEC, who had implemented most EE measures in total. We saw therefore no reason to perform these calculations.

Other Possible Effects

The involved parties are as mentioned NVE, the Ministry of Oil and Energy, the EE Centre in Akershus and other EE centres in Norway.

The initial programme goals seem to have resulted in too high expectations regarding the effects. Other goals could have been used. Building customer relations, name branding, marketing of other services by the EE centres as well as providing positive feed-back or “insurance” to energy efficient house owners could have been possible goals which would have resulted in more positive evaluation results.

Suggestions have been made that the EE centres had different goals and expectations to the programme. Not all the EE centres thought the main goal of the EEC to be kWh savings.

We think that it is important to be clear about programme goals and design the contents and implementations according to this. It seems that one expected the EEC to result in reduced energy consumption (kWh) while the programme was designed to give other results.

The EEC has been successful in transferring knowledge and in marketing the EE Centre. Knowledge of EE and where to obtain more information and advice are central goals for the national EE work in Norway. We think that this evaluation has documented that the EEC has made a positive contribution towards these goals and thus not been a total loss for any of the involved parties.

Use of Resources

The evaluation of use of resources against obtained savings for distribution and processing of EEC data are based on the campaign implemented by the EE Centre in Akershus in 1999 as this is the most resent mass distribution of the EEC. This distribution is the basis for the survey implemented by Norsk Gallup. All completed EECs were processed manually. The cost of producing and distributing 30,000 EECs was 1.6 EUR/EEC. Total costs divided on 2,300 processed EECs were 59.7 EUR/EEC.

In comparison a 16 page EE newspaper like the one distributed by several EE centres in Norway costs between 0.25 to 0.5 EUR delivered to the customer. An EE magazine like the one distributed by the EE Centre in Oslo and by some others will cost between 1.2 and 2.4 EUR. These are not directly comparable to the EEC, but the evaluation shows that the main impacts of the EEC are increased consumer knowledge of EE and promotion of the EE Centre. A comparison of costs can therefore be considered relevant. Based on the performed survey one can argue that every single EEC has a value and hence calculate the cost price to be 4.6 EUR/EEC distributed. This shows that the EEC is an expensive way of promoting EE and EE behaviour.

There is little evidence that the EEC as an independent programme has fulfilled its main goals. The customers who accept the EEC in a mass distribution campaign are already the most energy effective households. Further it is not possible to document any kWh savings for the participants. The programme, however, seems to have a marketing value and it can result in increased knowledge of the EE Centre. The EE Centre can also use the EEC as a basis for contacting households with particularly high energy consumption.

RECOMMENDATIONS

Although the evaluation has shown some negative results we are not all negative with regards to the future of the EEC. Positive results exist and it is possible to implement the EEC in a more cost-effective way in the future.

There is little evidence that the EEC as an independent programme has the desired effect based on the main goals of the evaluation. It is still the most energy efficient households who decide to participate in the programme when it is used as a mass campaign. It is not possible to document that the participants implement more EE measures than households in the two other sample groups do. On the contrary it is the third sample group that has implemented the most EE measures on a whole. The programme, however, seems to have a marketing value and hence it can increase the knowledge of EE and the EE Centre.

Who you reach with the EEC is crucial to the effect of the programme. The lack of results in the form of kWh suggests that the EEC does not reach the households with the highest energy consumption and/or the highest saving potential. We see no possibility of recommending the EEC as the main element of a mass campaign for households. The risk of providing the wrong customers with the wrong feedback is too large and the benefit is questionable. Indications that the most energy efficient households is the most frequent users of the EEC supports our conclusion that the EEC is unsuited as a service for all houses built before 1980.

Still, the EEC is a good EE tool for selected customers.

The EEC should be used in dialog with customers who have contacted the EE Centre as basis for giving individual EE advice. The energy advisers should first evaluate the total energy use of the customer compared to general norms. If the consumption is judged to be high, the EEC can be filled in by talking to the customer or by the customer himself. After processing the data the results should be reviewed face-to-face together with the customer. This use of the EEC can be a valuable tool in achieving more energy efficient households. Used this way one avoids the use of the EEC solely as a “proof” for the most energy effective customer (they want someone to tell them that they are doing a good job). Data errors are also avoided by filling in the form in co-operation with the customer and explaining the form. In addition, this form of communication builds positive relations crucial to ensure knowledge and motivation for implementing EE measure.

We recommend that an “EEC Online” would be considered used and marketed as this provides the customer with instant feedback. Still, the EEC may also require direct contact with an energy adviser, because the form itself can be complicated and data errors often result in the wrong feedback.

In the “aftershock” of this evaluation the EE Centre in Akershus has started a small national project of restructuring the EEC to be a data tool in a personal advice situation one-on-one with selected customers.

EVALUATION OF A CAMPAIGN FOR LOWER WASHING TEMPERATURES (DK)

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INTRODUCTION

This paper presents the successful experience of a Danish campaign regarding clothes washing. The aim of the campaign was to shift the clothes washing behaviour of consumers in an energy-efficient direction.

The overall purpose was to contribute to reducing Denmark's CO_2 emissions. More specifically the campaign was aimed at lowering the energy consumption of the household sector, which is a major source of CO_2 emissions. At the campaign's outset in 1995, electricity consumed in conjunction with washing and drying clothes accounted for approximately 18% of the Danish households' total electricity consumption. Washing alone accounted for 4.5%. Washing at 90°C or more accounted for 15% of all washing in 1997 - a high percentage in comparison with other European countries. This combined with the fact that washing at 90°C uses approximately twice as much electricity as washing at 60°C, and modern detergents make washing at temperatures above 60°C superfluous, motivated the campaign. The aim and message of the campaign was therefore that one could lower the washing temperature, and thereby improve the environment and save electricity, without lowering the cleanliness of the clothes or comfort of the consumers.

In 1995, a co-ordination group was formed on the initiative of the Danish Energy Agency. The group consisted of the Energy Agency, the Danish Environmental Agency, the National Consumer Agency of Denmark and the Danish electric utilities. The aim of the group was to find a campaign object within the area of household clothes washing. After examining the different possibilities it was decided to concentrate on reducing the amount of washing above 60°C. This target was chosen in spite of the fact that more electricity is used for tumbling-drying clothes, and hence the saving potential within that field possibly be bigger. But it was assessed that it would be easier to change the washing temperature, and that thereby the campaign would stand a greater chance of success. The main argument was that lowering the washing temperature does not impose extra work or other discomforts on the consumer.

Background for the Campaign

One or two generations ago washing at high temperatures was the only way to get the laundry clean. In those days detergents had little effect at low water temperatures. A copper or wash boiler was a labour-saving way of getting the washwater in circulation. The alternative was doing it by hand.

This situation has changed: Modern detergents contain a number of active ingredients, such as enzymes, which, even at low temperatures, are able to dissolve organic dirt, to loosen inorganic dirt trapped between fibres and to prevent dirt in the water from redepositing on fabrics.

It is becoming increasingly common for people to change their clothes daily and the number of people whose work involves their clothes getting heavily soiled is declining. Today most laundry is thus only lightly soiled and normally free from old, dried-up stains. This means that the demands on the washing effect, including the temperature, are not the same as earlier.

Due to the developments outlined above, the percentage of all 90°C wash cycles is declining. However, as washing habits are deep-seated, the population's washing behaviour seems to be lagging behind. It was thus estimated that 90°C wash cycles were used unnecessarily frequently.

It was also estimated that the biggest obstacle towards changing the washing habits in the target-group was objections that the clothes would not be completely clean, odours would not be removed or washing at lower temperatures is unhygienic.

As background and foundation for the campaign the National Consumer Agency therefore made a study together with the Danish Technological Institute, which showed that there were no health or hygienic problems connected with washing household clothes at only 60°C.

Starting Point

A qualitative study consisting of three focus groups with a total of 30 participants was carried out. This study showed among other things that the respondents were fully aware of the amount of laundry they washed per cycle. Nevertheless, two factors make people decide not always to fill up their washing machine:

- Small households do not have enough underwear, for instance, to fill their washing machine.
- In some households people sometimes have to wash one particular garment separately, for instance a child's outer garment.

It was judged that in these two cases it would be difficult to change people's behaviour.

The tumble-drying issue played an important part in the working group's discussions as the energy consumption used for tumble-drying is quite considerable and may in some cases be regarded as unnecessary. Also, the findings suggested that in all probability the potential energy savings would be moderate. Thus, although almost every second household has access to a tumble-dryer, the survey showed that only 14% of these households always tumble-dry their laundry. All others regard tumble-drying as one out of several alternatives and choose this method only when necessary. The qualitative study explained why: Apart from the fact that the Danish population is conscious of the necessity of saving energy, the average housewife regards tumble-drying as only the second best solution. She believes that tumble-drying causes wear and tear on clothes as well as creasing. Furthermore, clothes that have been tumble-dried do not feel as fresh as clothes dried on a line.

Although a campaign might bring about a certain change in people's behaviour in this respect, the individual consumer would regard it a sacrifice and therefore would need to be constantly reminded to keep up the new habit. It was therefore decided to concentrate the campaign on lowering the washing temperature.

Before starting the campaign, the Danish washing habits were assessed. The first survey was done already in 1995, and the second was done in the summer of 1997, just before the campaign start.

The survey in 1997 showed that washing at 90°C or more accounted for 15% of all washing. The earlier assessment in 1995 showed a higher percentage (21%), but the figures cannot be compared directly, as the people who were interviewed in the first assessment where not always the persons responsible for clothes washing in the households. Nevertheless, it can be assumed that already before the campaign started there was a tendency toward, washing at lower temperatures.

According to the 1997-survey, the best estimate of the total number of wash cycles in private households in Denmark per year was around 318 million, corresponding to 1.2 per week per capita. The distribution between the different washing temperatures and the corresponding electricity demand was as shown below.

Washing temperature	Electricity consumption	Frequency (1997)
90°C	2.00 kWh	15%
60°C	1.20 kWh	38%
40°C	0.65 kWh	47%

The aim of the campaign was to change the population's attitudes and habits. More specifically, over a period of three years the objective was to convert approximately one fourth of all wash cycles at 90°C or more to 60°C. In addition it was presumed that the message of the campaign would have a rub-off effect, resulting in conversion of some of the 60°C wash cycles to lower temperatures. It was estimated that each time two 90°C wash cycles are converted to 60°C, one 60°C wash cycle will be converted to 40°C.

As the energy saved per wash cycle converted from 90°C to 60°C amounts to 0.8 kWh and the corresponding figure per wash cycle converted from 60°C to 40°C is 0.55 kWh, the potential energy savings were expected to amount to 13-17 GWh.

Campaign Design – Clean Washing at 60°C

After these preliminary actions an advertising agency was assigned and it was decided to run a three-year campaign combining a mass media strategy with a network strategy. The budget for the three-year period was set at EUR 1.1 million. In 1997 tenders were invited for the campaign. A total of 40 companies showed an interest and three of them were pre-qualified to tender for the contract. EUR-RSCG in co-operation with Kommunikationskompagniet won.

The overall campaign message was simple: *Clean washing at 60°C*. Where "clean" refers to both the clothes being clean and to the environment being less polluted. As an eye-catcher a washing label with the simple message was used on all campaign material.

Campaign message: Clean washing at 60°C

It was chosen that the main argument for changing washing habits should be the effects on the environment while less attention was drawn to the potential savings on the electricity bill. One reason for this priority was that the message, that less electricity is used when lowering the temperature, was expected to be accepted straight away. Environmental aspects were expected to be less well-known and therefore more interesting.

The main target group for the campaign was women between 25-49 years with private washing machines in the household. This group represents the largest amount of washes, as women are often the ones who are responsible for washing in the family, and women in this age group often are part of families with children still living at home. It was also concluded that changing the habits of older women would be more difficult. Women do 74% of all washes. 86% of all households have their own washing machine.

Mass Media Campaign

The mass media strategy consisted of two parts. The first part was advertising in newspapers, women's magazines and local papers. This was aimed at creating interest in washing habits and getting the topic on the agenda in the households and among other parties. The other part of the mass media strategy was public relations work aimed at getting press coverage of the campaign and thereby increasing the exposure of the message. Also an Internet site was created.

Network Campaign

The aim of the network part of the campaign was to use electricity utilities, NGOs (e.g. local environmental groups) and local Agenda 21-workers as ambassadors for the campaign. This was done in order to spread the message more effectively and in order to catch the consumers in situations where washing was on the agenda, anyway. In addition to these ambassadors also libraries and pharmacies were used for distributing campaign material.

Special educational material was made for schools, with the aim of teaching the schoolchildren about environmentally friendly washing and through the children putting the message on the agenda in the families.

Collaboration with commercial parties was another element in the network part of the campaign. Contacts were made with producers of washing machines and detergents, traders and electricians/service mechanics working with washing machines and retail traders. The general idea was to get the commercial parties to include the campaign message in sales information about washing machines and detergents.

This mix of activities created a strong synergy and the fact that the message was communicated through many channels gave it much more strength and credibility. The participation from the networking organisations and companies was clearly positive as the visibility of the campaign and the possibility of combining it with their own activities inspired them.

The campaign started in the autumn of 1997 and measurements of the development have been carried out during the summers of 1998 and 1999. Each survey included about 1,000 persons selected at random and interviewed by telephone. All surveys were done in late July/early August. The response rate was high, e.g. 73% in the 1999-survey.

The objective of the campaign was to lower the proportion of washes at 90°C or more from 15% to 11%. Towards the end of the campaign the proportion of 90°C washes had decreased to 9%, which is regarded as highly satisfying. Another measurement of the effect of the campaign is the percentage of the population, which say that they never or seldom wash at temperatures above 60°C. Also this percentage has increased, as has the percentage of people who agree, they do not boil laundry as often as they used to. Likewise the share of people who agree that underwear must be boiled has decreased. The figures are shown below.

	Survey 1997	**Survey 1998**	**Survey 1999**
Share of washes at 90°C	15%	12%	9%
Share of washes at 60°C	38%	42%	39%
Share of washes at 40°C	41%	44%	49%
“Never wash at temperatures above 60°C”	33%	46%	51%
“Underwear must be boiled”	45%	44%	27%
“Do not boil laundry as often as used to.”	55%	69%	70%

With the realised savings the campaign is highly profitable, even if only half of the change is due to the camp aign. The consumers' annual savings in energy costs of e.g. 3% of the washes moved from 90°C to 60°C exceed the total costs of the campaign.

The share of consumers who knew about the campaign was about 45-50% in 1998 and 1999.

It can be interesting to comp are the development in the Danish washing habits with other sources. In Norway washing at 90°C is rare. Data from Germany show a declining rate of washing at 90°C. The level of washing in Germany is the same as in Denmark. The intensity of hot washing decreased by 5% over 5 years, or 1% per year. In Denmark the reduction was 3% per year.

Comparative data from Germany	Survey 1991	Survey 1996
Share of washes at 90°C	19%	16%
Share of washes at 60°C	39%	38%
Share of washes at 40°C	42%	46%

VDEW-Haushaltskundenbefragung 1991 and 1996, Auswertungsbericht

The savings generated from the campaign are substantial and prove that a campaign with a relatively low budget can be successful if the right strategy is chosen.

Why did the Campaign Succeed?

In addition to the surveys a more thorough evaluation of the campaign was made in 1999 by PLS Consult. The evaluation team concluded that the campaign was well planned and carried out in all aspects.

The fact that the campaign message was repeated often throughout a fairly long period of time is important for the success. Changing habits demands prolonged and continuous activities in order to have impact and in order to maintain the new habits after the campaign is over. Especially the combination of mass media and network campaigns is emphasised as a reason for the success. The many different campaign parts set focus on the message from many different angels and supported each other.

A common campaign-identity – the washing label – increased the attention to the campaign. The fact that the message was both simple to understand and simple to comply with is also important.

Another very important aspect was the co-operation with the National Consumer Agency, which ensured the credibility of the message that 60°C is enough for hygienic washing.

The mass media campaign was successful as it resulted in a high exposure, which is important for putting an issue on the agenda among the consumers. Without using television advertising it was still possible to get a high exposure through women magazines, newspapers and especially through local papers. The public relations activities were most successful with the local papers – resulting in 813 press releases in 1997 and 1998.

The network campaign was useful as it resulted in contact with the consumers in situations where washing was on the agenda, and as the many different ambassadors resulted in the message being repeated frequently.

In the network campaign especially the role of the electrical utilities was a success. Many utilities had a very active role as ambassadors, while it was more difficult to involve the NGOs and local Agenda 21 workers in the campaign. This is partially explained by the fact that the campaign message fits naturally into the normal activities of the electric utilities. Most Danish electricity utilities have practical experience in advising consumers about energy efficiency (Benediktson and Hein, 2000).

Also the collaboration with the commercial partners was successful as a number of the largest retail and electrician chains in Denmark used the campaign in their sales activities. Commercial partners are in general positive towards taking part in public information activities if they can see a synergy potential for their own products and because a “green” profile is regarded as something positive both ideologically and commercially.

By combining mass media activities with local activities in electric utilities, schools and among sellers of relevant products, it was possible with a fairly small budget to maintain focus on the issue over a period of three years and thereby possible to influence the behaviour of the Danish consumers.

Discussion of the Evaluation Method

The evaluation method can be described as monitoring (or gross impact, see Section 5.1 of the guidebook). The washing habits were monitored before, under, and after the campaign. This was done by telephone interviews with a representative number of people.

The surveys showed a remarkable decrease in the frequency of washes at 90^{o}C or more and that the general shift was from 90^{o}C towards 40^{o}C washes. It is difficult to conclude what part of the change is caused by the campaign. A background trend towards reducing the frequency of 90^{o}C washes does exist. When a trend already exist it is imprecise to use the start year (1997) as the baseline.

German data indicate a trend towards reducing the number of 90^{o}C washes by 1% per year. During the campaign the reduction was 3% per year in Denmark. However, it is close to impossible to determine which cultural differences exist between Denmark and Germany concerning washing habits.

In 1995 (two years before the campaign) a survey was made, but the methods were not comparable to those applied in the other surveys. If the same methods had been used here, an indication of the trend could have been calculated (assuming a constant trend).

A survey in 2000 or later could indicate the long-term impact of the campaign.

All surveys were done at the same time of the year (late July/early August). The evaluation report indicates that the weather in 1999 was unusually hot, and that this may have influenced both the actual washing activities and thus the responses.

CASE RELEVANT REFERENCE MATERIAL

Benediktson, H. H. and M. Hein (2000): Ambitious DSM activities in a liberalised market.

2nd International Conference on Energy efficiency in Household Appliances and Lighting, Naples.

Changing the Danes' Washing Habits (http://www.ens.dk/Vask/Rapwash.htm).

PLS Consult (1999): Evaluering af kampagnen “Vask rent ved 60°”.

Hein, M. and B. Jacobsen (2000): Influencing consumer behaviour - Danish clothes washing as an example. 2nd International Conference on Energy Efficiency in Household appliances and lighting. Napels.

Jysk Analyseinstitut A/S (1999): Vask rent ved 60 grader. Effektmåling.

ENERGY EFFICIENCY STANDARDS OF PERFORMANCE (UK)

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INTRODUCTION

Energy Efficiency Standards of Performance (EESoP) were introduced in 1994 in England and Wales as part of the Public Electricity Suppliers' (PES) Supply Price Controls, and a year later in Scotland. These standards ran until March 1998 and gave obligations to each of the 14 PESs to achieve specified energy savings and the ability to fund them through a special revenue allowance, equivalent to 1 GBP per franchise customer per year. The aggregate target for the 14 PESs for the first phase was 6,103 GWh in accredited savings, with an allowance of 101.7m GBP. subsequent to that, a similar programme was launched for a 2-year period from April 1998 to March 2000, with an aggregate target of 2,713 GWh and an allowance of 48.1m GBP.

Energy suppliers undertake a variety of energy efficiency measures in residential and small non-residential properties, including the supply and installation of:

- low energy lamps;
- energy efficient domestic appliances;
- cavity wall insulation;
- loft insulation;
- condensing boilers;
- heating control systems;
- combined heat and power installations.

Energy suppliers are responsible for delivering all aspects of the scheme including design and development of programmes, marketing, installation of measures, monitoring and reporting. However, there is flexibility in how energy suppliers fulfil these tasks, for example they may:

- Contract out the design or management of the programmes; and/or
- Enter into collaborative arrangements with other energy companies, local authorities, housing associations, energy efficiency or other charities, local organisations and commercial companies.

But in all circumstances responsibility for delivering the scheme remains with the energy company.

The EESoP programme maintains a strong focus on providing energy efficiency services to disadvantaged customers, particularly the fuel poor, the elderly and the sick. The energy efficiency measures are usually installed free of charge in these properties. However, in other homes the customer normally makes a contribution towards the costs.

Energy suppliers are required to design their programmes to ensure that the risk of free-ridership is minimised. This occurs where a customer takes advantage of a financial incentive to install a measure, but would have done so with or without the incentive. The most common approach used for, say, owner-occupier insulation schemes is to direct mail to customers within a specific geographical area, with the offer open for only a limited period.

</DIV>An essential part of the programmes has been to monitor the energy efficiency projects in three fundamental areas:

- Energy monitoring.
- Customer satisfaction monitoring.
- Quality monitoring.

MONITORING

Energy Monitoring

In order to compare the actual energy savings with predicted savings, a methodology was devised in which the first step was to estimate how much energy could be saved from various measures in each property type, assuming standard heating patterns. This was derived from the Building Research Establishment's BREDEM computer model of residential energy consumption, then, an assumption was made about how much of the savings would be taken in increased comfort:

- 50% for lower income households (one third of all UK households).
- 20% for others.

This gave a weighted average for the UK across all income groups of 30%. In reality, the low-income sector accounted for around two-thirds of measures, giving an average comfort uptake of 40%.

For each project, a sample of at least 5% of properties was selected for monitoring. Meter reading data for a year before and after installation of insulation measures were analysed, taking care to eliminate estimated readings or other anomalous data. Readings were adjusted to take account of weather variations nationally and from year to year. For smaller projects the sample size of 5% was insufficient for a high confidence in the results, accordingly the sample size was scheduled as shown below:

Number of Properties in Project	Minimum Sample Size
Up to 100	10 properties
100 – 300	10%
300 – 600	30 Properties
Over 600	5%

Results show that individual properties may save much more or less energy than the average predicted by the computer model. The reasons for this depend upon a wide range of factors including occupancy, heating patterns, ownership of electrical appliances and construction details. However, although individual differences may be large, on average they are not significant enough to demand modifications to the existing model. Furthermore, the variations do not relate to customer perception or acceptance of the programme and do therefore not justify a modification of the programme (e.g. alternative marketing approach or different target group). Please consult Section 2.5.1 in the Ex-post Evaluation Guidebook for information related to variations.

Customer Satisfaction Monitoring

Energy suppliers undertake and report on the monitoring of customer satisfaction in a minimum of 5% of homes for all measures installed, with the exception of CFLs.

For each type of CFL scheme undertaken (e.g. bulk delivery/mail order CFLs etc) customer satisfaction monitoring includes 1% or 1,000 customers, whichever is the less.

So that some collective analysis of the results of this monitoring can be undertaken, energy suppliers include, where appropriate, a standard set of questions in their customer satisfaction questionnaires (presented at the end of this case description). This standard list is added to, as is considered appropriate.

Quality Monitoring

The installation of energy efficiency measures through Standards of Performance schemes are carried out to very high standards. It is considered important that standards are maintained and are part of a “quality culture”' that energy suppliers adopt in their approach to delivering energy efficiency. With this in mind, energy suppliers include within the written description of the scheme the quality assurance approach they intend to adopt when undertaking the scheme. Issues such as the quality of materials used, products installed and working practices are addressed.

During the EESoP programmes energy suppliers survey and report on the quality of installation in a minimum of 5% of homes receiving fixed 'fabric' measures such as insulation or heating measures. This quality monitoring checks whether or not the measures have been installed in line with approved British/European Standards etc. For CFL schemes, quality criteria are fulfilled if lamps included on an approved list are used.

For appliance schemes, assuming that all products used have relevant CE marking, there are no additional quality monitoring requirements.

When energy suppliers undertake schemes in conjunction with local authorities it is often the case that the local authority will undertake quality monitoring themselves. Should this be the case, energy suppliers provide an outline of the quality assurance procedure adopted by the local authority to the Energy Regulator.

National Audit Office

In addition to monitoring carried out within the scheme itself, the Government’s National Audit Office (NAO) has examined the cost-effectiveness of the initiative. The NAO considered that the energy companies had done well to introduce, without serious problems, a scheme that is the first of its kind. They made the following specific comments:

- **Customers saved energy** – Total energy savings over the life of the energy efficiency goods and service supplied to customers up to 31 March 1998 totalled some 6.8 billion units of electricity (kilowatt hours), 12% more than the total of the targets set for companies by the Energy regulator. These savings are equivalent to around 1.5% of the electricity used by domestic customers since the start of the scheme;

- **The bills of three million customers were reduced** – The bills of the 3 million customers that have benefited from the scheme were reduced by an average of around £120 each;

- **Customers benefited from warmer homes** – Insulation installed through the scheme provided some 173,000 customers with extra warmth. Low-income customers have benefited particularly from the scheme - half of expenditure has gone to help such customers; and

- **The environment has also benefited** – By saving electricity, the scheme helps to reduce the amount of carbon dioxide emitted by power stations by around six million tonnes over the life of the energy efficiency goods and service supplied to customers. This amount is equivalent to around 0.25% of United Kingdom carbon dioxide emissions since the start of the scheme.

THE FUTURE

In the light of the experience gained in the first two phases of the Energy Efficiency Standards of Performance programme the Energy Regulator also consulted extensively on the issue of future Standards, with the main conclusions being that:

- the first two EESoP programmes proved effective in delivering energy efficiency improvements for electricity customers;

- EESoP can make a useful contribution to reducing CO_2 and other emissions in line with the Government's Climate Change objectives;

- in terms of social considerations the EESoP programmes can help to tackle fuel poverty;

- increasing convergence in gas and electricity supply markets make it desirable to adopt a common approach for energy efficiency in gas and electricity; and

- the EESoP programme, set on a reasonable scale, is fully consistent with the development of competition in supply.

In light of these considerations a third EESoP programme (EESoP III), operating from April 2000 to March 2002, was set for gas and electricity companies on the basis of an assumed annual cost of £1.20 per customer per fuel. EESoP III requires companies to achieve gas savings for customers of 6,200 GWh and electricity savings of 5050 GWh.

Following on from the success of the programmes, the Government is currently consulting on a fourth phase of the scheme with the size of the programme effectively being trebled, resulting in an assumed annual cost of £3.60 per customer per fuel.

The fundamental structure of this phase is the same as its predecessors. However, from the lessons learned over the years of implementing energy efficiency schemes and because of the development of the competitive fuel supply market, energy suppliers will be able to undertake energy efficiency schemes in any household, not just their own customers. They will also be able to save any fuel, not only that which they supply. These two developments will make the task of energy suppliers more straightforward.

What has become evident during the course of the EESoP programmes is the lack of awareness of householders of the need for energy efficiency, which forms a significant barrier to the take up of even very heavily subsidised offers from energy suppliers. The Government is now considering a publicity campaign to increase awareness of the issue and to promote the activities of energy companies.

It is anticipated that the EESoP programme will continue until at least 2010.

Customer Satisfaction Survey

for Energy Efficiency Standards of Performance

Your name:
Your address:

CFL Schemes

Q1 **Where were the lamps installed?**

Hallway	
Kitchen	
Living Room	
Bathroom	
Bedroom	
Other (please state)	

Q2 **Were you already using energy saving lamps before installing low energy lamps?** (please circle how many)

1 2 3 4 5 6 Other ___

Q3 **Do you use your lighting more or less than Before installing low energy lamps?**

Much less	
A bit less	
About the same	
A bit more	
Much more	

Q4 **Are you likely to fit another energy saving lamp when the current one(s) fail?**

Yes	
No	
Don't know	

Q5 **What do you think are the main advantages of energy saving lamps?**

Save energy	
Save the environment	
Save money	
They last longer	

Q6 **What do you think are the main disadvantages** (tick any that apply)

Different tone of light	
They are ugly	
Take time to brighten up	
Other (please specify)	

Q7 **What is your overall level of satisfaction with the lamps you have received?**

Very satisfied	
Quite satisfied	
Neither satisfied nor dissatisfied	
Not very satisfied	
Not at all satisfied	

Customer Satisfaction Survey

for Energy Efficiency Standards of Performance

Your name:
Your address:

Heating/Insulation Measures

Q1 **How satisfied were you with the quality of work undertaken by the installers?**

Very satisfied	
Quite satisfied	
Neither satisfied nor dissatisfied	
Not very satisfied	
Not al all satisfied	

Q2 **Is your home warmer than before the Energy saving measure(s) were installed?**

Yes	
No	
Don't know	

Q3 **Are your fuel bills lower since the energy Saving measures(s) were installed? (may not be applicable if no bill received since installation)**

Yes	
No	
If yes, please comment	

Q4 **Were you given energy saving advice at the same time as the work was carried out?**

Yes	
No	

Q5 **How would you rate this energy advice?**

Excellent	
Good	
Satisfactory	
Poor	
Very Poor	

Q6 **Overall, how would you rate the energy Saving scheme?**

Excellent	
Good	
Satisfactory	
Poor	
Very Poor	

EVALUATION OF A CFV PROGRAMME – POWERSHIFT (UK)

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INTRODUCTION

This paper presents the experiences of UK Energy Saving Trust mainly between 1996 and 1999 regarding the ongoing and successful PowerShift programme. The programme seeks to transform the markets for vehicles which run on alternative, clean fuels and which are practical and available today. These include vehicles running on such fuels as liquefied petroleum gas, natural gas, and electricity (including hybrids).

PowerShift is funded by the UK Government through the Department of Environment, Transport and the Regions (DETR) and the Scottish Executive (SE), it has also received support from a range of industrial sponsors including General Motors, Ford, Peugeot, Toyota, Volkswagen, Transco, BG Plc, British Gas, Shell, Calor, and Powergen.

The programme budget (excluding sponsorship) for the first three years (1996-99) was £6m in total. In 1999-2000 and 2000-2001 it was raised to £3.6m and £10.4m respectively. For the period 2001-2004 a budget of £33m has been secured.

The Energy Saving Trust (EST) is required to evaluate and publish results of its programmes by the EST's primary funder the DETR. The results of these evaluations are published in the EST's Annual Report and are also to be made available on the EST's website.

A methodology for programme evaluation has been agreed with DETR for all government funded programmes. In the past this methodology was based around the direct energy and carbon saving impacts resulting from programmes such as condensing boiler and insulation grant schemes. The savings have been calculated using engineering data supplied from sources such as the Building Research Establishment (BRE). Other analysis looking at the effects of rebound (comfort) etc have been undertaken and these have been taken into account. At present a full impact evaluation is being undertaken to assess the overall impact of EST programmes in terms of indirect savings made and the full market transformation of the EST's activities.

The context of evaluation is also changing; in previous years the EST provided a significant proportion of energy efficiency activity in the UK in terms of priming and incentivising the market through grant schemes. This role however is changing. The EST will continue to raise awareness etc., and will facilitate the delivery of energy efficiency and develop infrastructure. The Energy Efficiency Commitment run by the energy suppliers will be delivering the vast majority of installed energy efficiency measures through the subsidy of measures and the provision of energy services. In this way EST evaluation is moving away from quantitative carbon savings that are directly attributable to EST activity and moving towards the evaluation of facilitation and the development of the infrastructure for the delivery of energy efficiency via other mechanisms. It is this shift in emphasis in programme activity, which presents the new evaluation challenge to the Energy Saving Trust.

BACKGROUND

Transport accounts for approximately 25% of energy/fuel use in the UK and is one of the only sectors in which energy use continues to grow each year. It is responsible for more than 90% of the UK's urban air pollution and around 25% of greenhouse gas emissions. Consequently, clean fuel vehicles have a significant role to play in reducing these emissions from the transport sector.

In 1995, the clean fuel vehicle market in the United Kingdom was virtually non-existent. A very limited number of vehicles were being sold and registered and these were mainly demonstration vehicles or conversions. These demonstration projects were sponsored by organisations such as British Gas, Ford, the European Union, and a number of local authorities. The scale of these operations was modest and there was no co-ordination between different initiatives. Consequently, PowerShift acts to bring all such demonstration projects together and co-ordinate activity.

The PowerShift programme promotes three clean fuels: liquefied petroleum gas (LPG), natural gas (NG) and electricity (EV). Subsequently, the programme has been extended to cover hydrogen fuel cell and hybrid vehicles. These alternatives produce significantly less air pollution and greenhouse gas emissions than conventional vehicles and at present, are the most economically viable of the wide range of alternative fuels for vehicles.

PowerShift aims to transform the markets for clean fuel vehicles in the UK by breaking down the barriers to their development. The main barriers identified were:

- The lack of refuelling infrastructure;
- The extra initial capital cost of vehicles;
- Misconceptions about vehicle safety;
- Low awareness of the benefits of Clean Fuel Vehicles (CFVs);
- Limited numbers and choice of vehicles available.

To address these barriers, the programme objectives were to:

- demonstrate CFVs in a variety of operations across the UK;
- expand the infrastructure for refuelling and recharging CFVs;
- encourage CFV manufacturers to reduce the cost of vehicles by increasing the number of sales and improving economies of scale and encouraging competition;
- ensure appropriate information was available for vehicle operators, to promote the benefits and standards of CFVs;
- monitor emissions and energy consumption of CFVs to test the extent to which energy savings can be achieved by switching to alternative fuels.

The programme addresses these barriers by the activities Demonstration, Stimulation, PowerShift Register, and Information and Awareness Raising.

Demonstration

The technical and economic viability of alternative fuelled vehicles was demonstrated through 14 pilot programmes, while 138 CFVs were tested, ranging from small electric cars and vans to 32 tonne articulated lorries running on LNG.

The programme provided £700,000 for these first year activities. The level of each grant was set on a case-by-case basis, and most ranged from 20% to 50%, with several grants being for slightly more than 50%.

Stimulation

To stimulate the supply of vehicles, the EST liaised with stakeholders to form procurement groups called PowerShift Funding Partnerships. These groups consisted of private companies and local authorities, and by 'pooling' their orders for CFVs, they were able to approach manufacturers and negotiate the purchase of CFVs. These procurement groups stimulated £20m in vehicle orders, from grant funding of just £700,000. Eight separate contracts were awarded for the supply of 351 clean fuel vehicles – this included almost 200 work vans, 22 refuse collection vehicles, 17 buses and a range of cars and trucks.

To develop refuelling infrastructure, the programme targeted depot based fleets, where refuelling infrastructure could most easily be supplied. Originally it was planned to secure agreement from depot based fleet operators to allow access for third parties to refuel at their sites, as well as their own depot fleet. However, this third party access has developed more slowly than expected, due to problems relating to access rights to sites. This has been an issue mainly for the natural gas market. However, public access to LPG sites has developed more quickly with a number of fuel suppliers investing in LPG dispensers on petrol station forecourts.

Significant efforts were also made to increase the supply of clean fuel vehicles to non-depot based fleets. Considerable progress has been made on this front, as commercial operators have made important public commitments to bring LPG to public garage forecourts. Shell has committed itself to having 200, and BP 300, by 2002.

PowerShift Register

In response to the needs of the growing CFV market, The PowerShift programme initiated a number of important quality control mechanisms. As the clean fuel vehicle market started to develop over the past three years, it became apparent that some vehicle manufacturers and converters were supplying products, which had not been designed and built to the best standards and in some cases, produced worse emissions than petrol or diesel.

The programme responded by creating the PowerShift Register, to identify the best clean fuel vehicles and to encourage vehicle manufacturers to optimise the CFVs they offer.

The Register is a list of quality-approved clean fuel vehicle suppliers and products. It includes companies and products, which meet approved safety and technical standards as well as providing emissions benefits compared with conventional vehicles. To be listed on the register, a manufacturer or converter must satisfy European, national, and industry standards. The EST will only provide grants for clean fuel vehicles listed in the register, unless an application is for vehicles supplied for the first time to the UK and accepted as a demonstration project. Once listed, products receive an EST 'Clean Seal of Approval'.

As a minimum requirement all vehicles awarded the Seal of Approval must:

- Produce no more carbon dioxide than the equivalent diesel vehicle and 10% lower than the equivalent petrol vehicle. (In the case of diesel vehicles this is a 'well to wheels' calculation based on a tailpipe emissions test or, for petrol, a straight tailpipe test), and

- Produce no more regulated emissions than the equivalent petrol or diesel vehicle.

Grants are then awarded according to how much the Euro III Emission Standard is exceeded:

- Band 1 - Failure to meet minimum standard or emissions not proven (ENP) (no grant funding);
- Band 2 - 0-49% reduction over Euro III (grant of 40% of premium costs);
- Band 3 - 50-64.5% reduction over Euro III (grant of 60% of premium costs);
- Band 4 - 65%+ reduction over Euro III (grant of 75% of premium costs).

Originally there were only three bands; Band 4 was introduced in recognition of the tightening emission standards for petrol and diesel vehicles when Euro III came into force.

The creation of the Register has been an important mechanism for ensuring confidence in the growing CFV market and the Register is fast becoming the standard reference for CFV buyers seeking safety, build quality, and enhanced emissions performance. The Register now maintained on the Internet lists in excess 350 vehicles. It can be accessed at http://www.transportaction.org.uk/.

Information and Awareness Raising

As part of the strategy to increase awareness of CFVs and demand for them, the programme runs 6-7 regional workshops per year, spread geographically across the country. These workshops were specifically targeted at appropriate decision makers – for example, transport and fleet managers and 'Local Agenda 21' staff within local authorities.

PowerShift programme managers have been invited to provide speeches about the programme and the CFV market to a wide range of targeted events, including the following:

- National Society for Clean Air Conference (24/2/99);
- Motor Industry Local Authority Network Seminar (10/2/99);
- G8 Alternative Fuel Summit (25-26/1/99);
- Innovation in Urban Transport, Graz (25-26/11/98);
- Natural Gas Vehicles, Belfast (18/11/98);
- Gatwick Seminar on Cleaning Transport (3/3/99);
- Transco Launch of 40 CNG Vans (15/3/99);
- NEI Conference – Clean Green Vehicles (18/3/99);
- World Natural Gas Vehicle Conference, Sydney (4/99).

The internet is also heavily utilised with a dedicated website providing the ability to apply to access the PowerShift Register, apply for a grant or workshop place, and of course gain more information regarding alternative fuels. A telephone hotline (0845 602 1425) has also been set up to provide information.

DISCUSSION OF EVALUATION METHOD

To date the main emphasis with regard to the evaluation of the PowerShift programme has been monitoring the programme results as well as some analysis of programme cost effectiveness. As the programme has grown, this methodology has continuously evolved in order to meet the requirements of Government. Consequently, in collaboration with DETR, a new evaluation methodology is currently under development. This methodology will also include the complex mathematical modelling of the CFV market to use as an additional baseline against which performance of the programme can be judged. The European Ex-post Evaluation Guidebook is being used as a tool in this process.

The initial baseline for the evaluation was chosen to be the state of the CFV market in the UK during 1995. This was chosen, as it was the first full year prior to the launch of the programme. As has already been stated, the UK clean fuel vehicle market was virtually non-existent so the effects of the programme could be readily monitored.

The evaluation currently employs a number of **key criteria** as performance indicators. These indicators range from purely quantitative carbon and regulated atmospheric emission savings and cost-effectiveness indices to more qualitative (non-emission) indicators such as awareness, cost differentials and the development of refuelling infrastructure.

The Energy Saving Trust is required as to report to Government annually on the total savings and policy cost per tonne of the following:

- CO_2 ;
- Total Green House Gas (GHG);
- CH_4;
- NO_x;
- Particulate Matter (PM).

Both savings and policy cost are calculated on an annual and a lifetime basis. The policy cost equates to government funding and is effectively the total programme expenditure less partner and customer contributions. Emission factors used are sourced from the report of the alternative fuels group of the Cleaner Vehicles Task Force (CVTF).

Apart from emission indicators, which are required as part of Government reporting, a number of other **prime indicators** for the success of market transformation of PowerShift are monitored. These are listed as follows:

- CFV sales per year;
- Total vehicle populations;
- Number of refuelling stations;
- Financial price premiums between CFVs and conventional equivalents;
- Residual values of vehicles.

Other **secondary indicators** are also employed. These include, for example, data reflecting attitudes and the level of information dissemination. Such as:

- Number of grant applications;
- Number of workshop delegates;
- Number of press articles;
- Number of hotline calls;
- Number of website visitors;
- Number of approved vehicle manufacturers;
- Number of approved converters;
- Number of fuel suppliers.

These indicators are monitored using market research involving vehicle manufacturers, converters, and fuel suppliers. An indication of the results can be seen in Exhibit 2.

Annual surveys of participants are undertaken to determine the extent of any ‘drop-out’ from participants. Further investigations into free driver and free-rider-ship are also planned as part of the developing methodology.

OTHER ACTIVITIES

Alongside PowerShift, other government mechanisms for the promotion of CFVs include the fuel duty differential, changes to vehicle excise duty, and the proposed introduction of Low Emission Zones. Of these the fuel duty differential is by far the most important initiative; the latter two are not yet in operation but will undoubtedly have some effect on the market. While the lower fuel duty on LPG (the predominant cleaner fuel) is significant, the availability of fuel, awareness of technology, and the lowering of prices to transform the market have been driven by PowerShift. It is for this reason that to date that additionality and the impact of fuel duty has not been accounted for. This is, however, changing, as the new methodology will address additionality in greater detail.

RESULTS AND CONCLUSIONS

The PowerShift programme has directly funded approximately 10,000 vehicles since its launch in 1996. The programme has also stimulated the growth of the CFV market in the United Kingdom to the extent that the CFV stock has increased to over 32,000 vehicles resulting in annual carbon savings of 8,300 tC/a.

The results of this and other evaluations are disseminated in the first instance to Government and then to the general public through mechanisms including the EST's Annual Report and other literature as well as the EST website.

Exhibit 1: Current CFV UK populations and carbon savings.

Fuel	Vehicle type	Stock at Q1/01	Clean fuel (CO2 g/km)	Replaced fuel (CO2 g/km)	km/a	tC/a avoided
LPG	Car	20,680	188	229	16,000	3,699.84
LPG	LCV	9,762	188	229	16,000	1,746.51
LPG	Bus	167	1,309	1,472	48,000	356.35
LPG	HCV	640	1,480	1,644	40,000	1,145.02
CNG	Car	15	176	229	16,000	3.47
CNG	LCV	207	217	223	16,000	5.42
CNG	Bus	30	1,343	1,472	48,000	50.66
CNG	HCV	419	1,574	1,644	40,000	319.96
EV	Car	333	130	229	16,000	143.86
EV	LCV	318	130	229	16,000	137.38
EV	Bus	85	850	1,472	48,000	692.12
Total		**32,571**				**8,300.58**

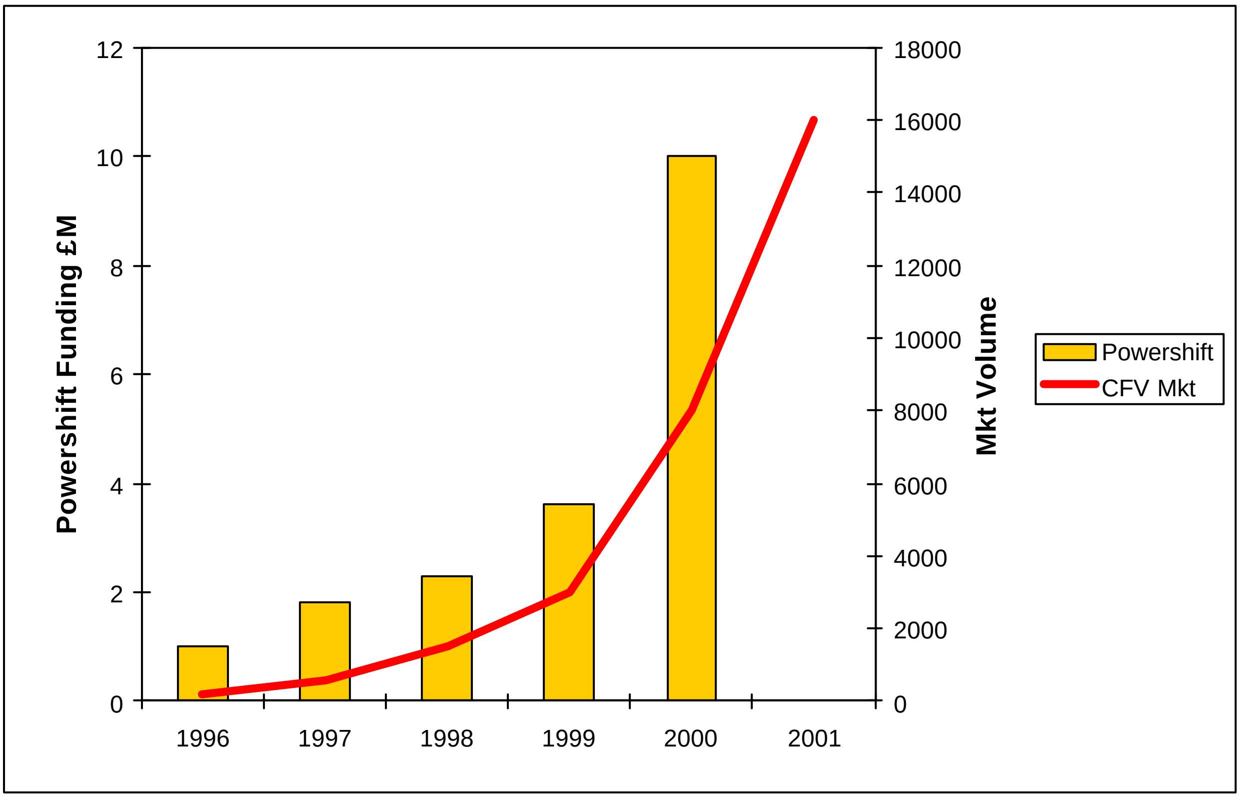
Sources: (1) Vehicle populations survey carried out for EST by Transtech Consultancy Services; (2) Emission Factors sourced from CVTF; and (3) Vehicle travel distances were estimated from national travel statistics published by DETR.

Exhibit 2: Market indicators (PowerShift Scenario).

Market Transformation Indicators	Baseline	To date			Forecasts			
	1995	1996	1997	1998	1999	2000	2001	2010
Market share								
CFV registrations	200	280	511	1,200	3,500	13,000	40,000	723,000
CFV population	12,500	11,700	11,300	11,600	14,000	26,000	65,000	2,641,000
Market penetration								
No of refuelling points	170	170	188	250	350	500	700	6,650
Premium price								
LPG cars	2,000	2,000	1,700	1,500	1,200	1,000	700	500
NG trucks	-	20,000	18,000	18,000	16,000	14,000	12,000	8,000
Electric vans	-	10,000	8,000	5,000	5,000	5,000	5,000	5,000
Market players								
No. of vehicle manufacturers	2	4	6	9	11	13	16	25
No. of converters	4	5	7	20	30	30	25	10
No. of fuel suppliers	3	4	5	7	8	9	10	12
Attitudes and information								
no. workshop delegates	-	-	230	642	515*		-	-
no. of press cuttings			78	492	298*		-	-
No. hotline calls	-	-	-	1,400	600*		-	-
no. website users	-	-	390	5,179	1004*		-	-

** - As at March 1999.*

Exhibit 3: Growth in DETR funding for PowerShift.



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Useful Websites

www.est.org.uk

www.transportaction.org.uk

www.detr.gov.uk

NATIONAL ENERGY EFFICIENCY PROGRAMME (CZ)

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SUBJECT OF EVALUATION

The subject of the present evaluation is the state programme for supporting energy efficiency in the Czech Republic. The programme has the following objectives:

- Decreasing the primary energy consumption.
- Air pollution abatement.
- Increasing the effectiveness of energy project financing.
- Demonstration of economically effective, progressive, and replicable solutions.

Since 1996, the Ministry of Industry and Trade annually authorises the Czech Energy Agency (CEA) to arrange, promote, and manage the programme. The main task of the CEA is to encourage activities leading to energy conservation and reduced energy intensity. Financial support to greater utilisation of renewable and secondary sources of energy and minimise environmental burdens from emission is in compliance with these aims.

The state programme is divided into subprogrammes:

- Schools,
- Hospitals,
- Public sector buildings,
- Housing estate supplies,
- Industry, and
- Renewable energy sources and cogeneration.

Important elements of the state programme are promotion, consulting, and education in the area of energy saving and environmental protection. In recent years, emphasis has also been put on the support of energy performance contracting and processing energy concepts for cities and villages.

Each subprogramme contains a detailed set of requirements that must be met to obtain support. These requirements concern the technology involved and the targeted energy savings of the proposed projects.

Subjects applying for CEA support are obliged to carry out an energy audit, describing the actual state of energy consumption and the energy saving possibilities. Demonstration projects approved by the CEA receive 40% support while replicated projects receive 15% of investment costs.

MONITORING

Supervision of the supported projects is carried out through direct inspections that check that the performed technical measures, the physical installations, and the operation are in compliance with the original project proposal.

The recipients of support are obliged to inform CEA about their annual energy consumption after implementation of the technical measures. An annual monitoring report specifying the energy consumption by type of energy for the past year must be submitted to the CEA. A list of simple questions guide the recipients in making their monitoring report. Part of the contents of the monitoring report is based on the recipient's energy bill (which in the Czech Republic contains information on energy units consumed, unit price, and total cost per energy type).

THE OBJECTIVES OF THE EVALUATION

The applications for financial support under the state programme were earlier evaluated by SEVEn to determine whether the proposed projects were economically and technically sound and likely to achieve the proposed energy savings. The evaluation was based on the assumed input data presented in the required application documentation.

The present evaluation, also carried out by SEVEn, was carried out ex-post to the actual implementation of the proposed projects. The objectives of this evaluation were:

- To determine the actual savings achieved and compare them to the potential estimated in the tender documentation.
- Collect information on the monitoring process with the aim to improve the support programme.

The object for comparison of estimated and achieved savings were the subprogrammes II and III aimed at implementation of energy savings measures in schools and hospitals. Subprogrammes II and III were chosen because a suitable number of projects had been completed within these sectors, the project had relatively high estimated savings per project, and had verifiable results of the implemented measures.

The implementation of the projects takes a relatively long time and some projects are granted support more than once. This means that the values of the indicators necessary for evaluation are usually not available until at least one year after granting of financial support. Consequently, the projects subsidised in 1997 were chosen for evaluation. The main declared objective of the projects granted in 1997 was to demonstrate new innovative and replicable solutions. The technical measures implemented in these projects particularly concerned improvement of space heating and hot water heating, including regulation, metering, grid reconstruction, fuel switch, and thermal insulation.

EVALUATION RESULTS

The table below shows the estimated parameters of the subsidised projects in subprogrammes II and III in 1997. The values are based on energy audits, which are an integral part of the contracts.

	Number of supported projects	Total investment costs	Subsidy	Estimated energy savings
		1,000 EUR	*1,000 EUR*	*GJ*
Schools	17	1,555	529	10,336
Hospitals	14	2,518	743	53,191
Total	**31**	**4,073**	**1,272**	**63,527**

1 EUR = 34,6 CZK (December 2000)

The following table shows the evaluation results of the projects, which were possible to evaluate by virtue of documents obtained during the monitoring process. The change in hospital occupancy and the number of children at schools before and after implementation was adjusted for in the evaluation to recognise the changes in building utilisation. In most cases, there were no changes. Projects, where significant changes in building utilisation occurred against the tender documentation (e.g. a sanatorium changed to a bathhouse with a completely different energy consumption pattern), were excluded from the evaluation. Furthermore, monitoring reports, which contained incorrect values of the investigated parameters, were excluded from the evaluation.

	Number of evaluated projects	Total investment costs	Subsidy	Estimated energy savings	Achieved energy savings	Achieved energy savings
		1,000 EUR	*1,000 EUR*	*GJ*	*GJ*	-
Schools	11	1,199	410	6,489	6,191	95%
Hospitals	12	2,270	673	51,393	47,496	92%
Total	**23**	**3,469**	**1,083**	**57,882**	**53,687**	**93%**

1 EUR = 34,6 CZK (December 2000)

The investigation indicates that achieved energy savings met 93% of estimated savings. The achieved energy savings of the evaluated projects represent a 30% decrease in the energy consumption in schools and 22% in hospitals – a satisfactory result. The results show that the projects supported in 1997 demonstrated efficient technical solutions.

Considering the fact, that it was only possible to evaluate 75% of supported projects using the annual monitoring reports, it is clear that some improvement must be made to the monitoring process. The 23 evaluated projects represent 85% of the investments spent in both subprograms. In particular less attention is paid to monitor relatively small projects. Importance of monitoring small projects increases in regard of increasing share of small projects.

LESSONS LEARNED

The correctness of the values of the indicators in the monitoring reports is questionable:

- Some mistakes were caused by incorrect conversion of energy units (e.g. m^3 of natural gas conversion to GJ). The monitoring requested conversion to GJ, which appeared not to be a straightforward task.
- There was irregular application of weather adjustment in the monitoring reports. It was sought corrected using standard formulas and local weather data in the evaluation.
- The price of fuel was not filled in correctly taking into account the different prices of fuel in the individual districts and the price changes over time.

Overall, the level of information about technical aspects and parameters of the projects registered via the monitoring report is relatively sufficient. However, most projects lacked or provided incorrect information about economic parameters such as energy costs. Therefore, no calculation of for example the reduction in total energy expenditures as a result of the projects could be made.

The ex-post evaluation thus clearly proved a need for improvement of the monitoring system.

The guiding questions for the monitoring must be further simplified and reassessed. The monitoring reports are not prepared by professionals (contrary to the tender documents). The indicators to be included in the annual monitoring report should therefore be simple, so that the project responsible does not have to carry out the slightest recalculations or adjustments.

It is also recommended that the final monitoring report be replaced by a comprehensive energy audit describing the final state of realisation and operation one year after implementation of energy efficiency measures. Projects supported since 1999 should prove their savings and other benefits in the comprehensive energy audit. An independent auditor should verify the achieved savings and economical benefits and establish the reasons why the targeted savings differ from the anticipated. This would prevent many errors and omissions in the monitoring and make participants to fulfil the criteria specified in the contract for subsidy.

CASE RELEVANT REFERENCE MATERIAL

Evaluation of State Program for Supporting Energy Efficiency in the Czech Republic 1997. SEVEn, Praha, December 1997.

EVALUATION OF IPMVP GUIDE (DE)

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INTRODUCTION

The International Performance Measurement and Verification Protocol (IPMVP) is the evaluation method proposed for monitoring and verification of energy service company projects. It is described in Section 6.6 of the European Ex-post Evaluation Guidebook. Two examples are presented below. Both the following examples tested the relevance and usefulness of IPMVP.

The first example concerns a DSM bidding pilot programme that was carried out by the municipal utility of Düsseldorf (Stadtwerke Düsseldorf AG). The Wuppertal Institute gave scientific support for the development and implementation of the pilot programme, and evaluated the pilot programme. In particular, the Wuppertal Institute proposed the methods for verification of the savings of the individual projects that were bid into the programme based on the IPMVP. It is thus an example of the application of the IPMVP in energy efficiency services or similar projects.

The second example summarises the key findings of a study undertaken by the Wuppertal Institute for the Government of North Rhine-Westphalia. This study examined the importance of monitoring and verification of energy service company projects, as well as the need for, and the usefulness of an IPMVP guide or a similar M&V guidebook based on interviews with both energy service companies and their customers.

EXAMPLE 1: DSM BIDDING PILOT PROGRAMME

Background

In the competitive market, the Stadtwerke were not interested in buying conserved energy and funding this via their electricity prices, as in the "classical" DSM bidding. Rather, they were hoping to

- improve their understanding of the needs of their customers,
- gain experience in technology fields attractive for third-party financing (TPF),
- gain customers interested in TPF projects, and projects for these customers,
- present themselves as a provider for energy efficiency services,
- in short, to give their TPF business a kick-start.

To this purpose a DSM bidding programme was developed. The concept of this programme was as follows:

- Stadtwerke Düsseldorf thought that shortly after the introduction of competition their large customers were only looking for price reductions and would thus not be interested in energy efficiency services. Therefore, Stadtwerke Düsseldorf focused on medium-sized industrial and commercial customers as the main target group.

- The programme was communicated to these customers as a joint effort to realise cost-effective CO_2 reductions.

- The target for the DSM bidding was therefore expressed as reducing CO_2 emissions by **at least** 2,000 tons/year, not in terms of energy (kW or kWh).

- There was no upper limit for the energy conservation or CO_2 reductions, which may be reached: In principle, Stadtwerke Düsseldorf AG offered to realise any cost-effective project with third-party financing.

- The project was not restricted to electricity savings. However, since TPF for electricity conservation is more innovative and more cost-effective than heat conservation (e.g. by installing new boilers in TPF), each tenderer had to allocate at least 50% of the investment to electricity conservation measures; pure load management was excluded. The remaining share of the investment budget could be for innovative heat conservation (i.e. not just renovation of boilers and not CHP) or renewable energy sources.

- To make the project easier to manage, each tender had to have as target at least 100,000 kWh/year electricity savings.

For the awards to the ten best proposals, a total of 150,000 DM (76,700 EUR) was offered by Stadtwerke Düsseldorf AG. One of the awarded projects is described below.

Illustrative Project Example

Bidder (ESCO): Building management unit of the client

Proposed Client: Large service sector company

Energy Conservation Measures:

1. Reduction of air leakage by closing "short-cuts" between air inflow and air outflow;

2. Closing down 7 fans that are no longer needed after the reduction of the leakage;

3. Installation of variable speed drives in the remaining 12 ventilation fan motors to reduce the circulating air quantities as well as the electricity demand further.

The case study was evaluated with the aim of testing the applicability of the IPMVP. Therefore, the Wuppertal Institute proposed the methods for verification of the savings based on the IPMVP.

The bidding company implemented the measures itself, so no TPF took place. Hence, the applicant had to verify the savings to Stadtwerke Düsseldorf to get the full award payment.

Results of the Project Evaluation

To recall, the IMPVP offers four different M&V options, as shown in Exhibit 1 below.

Exhibit 1: IMPVP options.

Measurement & Verification Option	How Savings Are Calculated	Cost
Option A: Focuses on physical assessment of equipment changes to ensure the installation is to specification. Key performance factors (e.g., lighting wattage or chiller efficiency) are determined with spot or short-term measurements and operational factors (e.g., lighting operating hours or cooling ton-hours) are stipulated based on analysis of historical data or spot/short-term measurements. Performance and proper operation are measured or checked annually.	Engineering calculations using spot or short-term measurements, computer simulations, and/or historical data.	Dependent on no. of measurement points. Approx. 1-5% of project construction cost.
Option B: Savings are determined after project completion by short-term or continuous measurements taken throughout the term of the contract at the device or system level. Both performance and operations factors are monitored.	Engineering calculations using metered data.	Dependent on no. and type of systems measured and term of analysis/ metering. Typically 3-10% of project construction cost.
Option C: After project completion, savings are determined at the "whole-building" or facility level using current year and historical utility meter or sub-meter data.	Analysis of utility meter (or sub-meter) data using techniques from simple comparison to multivariate (hourly or monthly) regression analysis.	Dependent on no. and complexity of parameters in analysis. Typically 1-10% of project construction cost.
Option D: Savings are determined through simulation of facility components and/or the whole facility.	Calibrated energy simulation/modelling; calibrated with hourly or monthly utility billing data and/or end-use metering.	Dependent on no. and complexity of systems evaluated. Typically 3-10% of project construction cost.

Source: IPMVP, December 1997, www.ipmvp.org.

For the case study, the Wuppertal Institute proposed a mix of Option A and Option B.

1. For the measurement of the situation before measures, Option A was chosen. It was proposed to measure for a short term the actual value of the power input and the air volume of a representative of each of the three types of fan/motor systems that were present among the 20 fans in total. This was justified because the motors were the same type and size and running continuously before the refurbishment.

2. For the measurement of the situation after measures, Option B was proposed and chosen by the bidding company. The original proposal was to make short-term measurements of the power input and the air volume, and to monitor the operating hours of each of the fans over a longer period. This was needed because the 7 fans, which were closed down, still remained in place as back-up for defects or exceptional heat loads. However, the company found an even cheaper and better way to monitor the energy consumption: It simply installed 2 meters into the 2 electric circuits that exclusively feed the 19 fan/motor systems, and continuously measured the consumption using the building automation system in place.

The following table summarises the findings from the measurements.

Exhibit 2: Measurement findings.

Circuit (Room) 19		**Circuit (Room) 23**	
Before		***Before***	
Number of fans	10	Number of fans	9
Nominal air flow/unit	7,100 m^3/h	Nominal air flow/unit	7,500 and 10,000 m^3/h
Measured power/unit	7.2 kW	Measured power/unit	9.5/10.2 kW
Measured air flow/unit	6,400 m^3/h	Measured air flow/unit	7,500 and 10,000 m^3/h
Operating hours	8,760 h	Operating hours	8,760 h
Electricity consumption	631,000 kWh/a	Electricity consumption	774,000 kWh/a
After		***After***	
Number of fans	6	Number of fans	6
Measured power/unit	3.3 to 5.9 kW	Measured power/unit	2.0 to 3.0 kW
Measured air flow/unit	average 6,400 m^3/h	Measured air flow/unit	average 5,000 m^3/h
Electricity consumption	264,000 kWh/a	Electricity consumption	145,000 kWh/a
Electricity saving	373,000 kWh/a	Electricity saving	629,000 kWh/a

In total, these measures saved approx. 1 GWh/a, equivalent to 70% of the electricity that was consumed before the measures. The investment needed was no more than 30,000 EUR, so the cost of conserved energy was only 0.37 cEUR/kWh (at 4% societal discount rate and 10 years residual life of the fans, which is a conservatively low estimate, based on the fact that used fan/motor systems were upgraded with the VSDs). Simple payback was just 7 months.

The M&V method based on the IPMVP proved reliable in the sense that it produced consistent and reliable results for the energy savings that were achieved, with a moderate M&V effort. The bidder had the technical and management capacity to carry out the necessary measurement. Stadtwerke Düsseldorf accepted the M&V results and paid out the award to the bidder. Furthermore, the method can be used by non-experts, i.e. without a “clearing house” such as the Wuppertal Institute.

EXAMPLE 2: IPMVP GUIDE FOR EPC/TPF PROJECTS IN NRW

In North Rhine-Westphalia, the state government is promoting the use of energy performance contracting (EPC) and third party financing. Among other things, a working group called "Energy Services" exists, which brings together energy service companies (ESCOs) and other interested parties, and is co-ordinated by the Director of the Energy Division of the Wuppertal Institute.

In the context of this working group, the need and usefulness of a guidebook for monitoring and verification of savings from EPC and TPF was discussed, as an instrument to increase the credibility of EPC and TPF projects, and of the ESCOs that offer them to possible EPC/TPF customers. Therefore, the state government commissioned a study to the Wuppertal Institute and the working group, to examine the need for such a guidebook as well as the appropriateness of the IPMVP under German conditions.

To this end, 30 interviews with suppliers and customers of energy services were carried out. The results are summarised in a report in German (Wuppertal Institute 2000: Möglichkeiten und Grenzen eines Effizienzprotokolls bei der Entwicklung und Förderung von EDL-Märkten). Here, we just want to give a short summary of the main findings on the IPMVP guide in the general perspective of a policy to promote the development of energy services markets.

One main finding is that general guidebooks on EPC/TPF are not sufficient for potential customers to gain confidence and to carry out an EPC/TPF project. The interviewed customers expressed a need for project specific methodological support during the course of their projects such as:

1. Specification of contributions needed from the customers in preparation and implementation of an EPC/TPF project (e.g., documentation of buildings and energy uses);

2. A guideline for the implementation process;

3. Specifications for calls for tenders for EPC/TPF projects;

4. Methods for control and assessment of the engineers/consultants, who assist the customer in the development of an EPC/TPF project, e.g., in launching a call for tender, or in selecting an ESCO for the implementation of the EPC/TPF project;

5. Support in legal questions related to formulating the EPC/TPF contract;

6. Support in promoting the idea of EPC/TPF towards third parties (seniors, customers of the customer, authorities, etc.);

7. Checklists for identification and assessment of factors that may influence the amount of savings reached (e.g., fluctuations in operation or weather).

As can be seen, an IPMVP guidebook for monitoring and verification of the savings would certainly be helpful, but by far not the only thing that is needed to increase the confidence of possible customers in EPC/TPF, or to enable customers to handle EPC/TPF projects. An IPMVP guidebook can directly or indirectly meet some of the need indicated in bullets 2, 3, 4, and 7, but it would have to be specific to the customers' needs, depending on the technology focus. EPC/TPF projects are so complex that the potential customers also need personal assistance in managing the EPC/TPF project. What customers would like to have is **a coach**, who guides them through the process, from the choice of the ESCO and the conclusion of the contract, through the implementation of the energy efficiency project to the management of the contract. This would, however, require coaching programmes that can be costly and need time to be implemented, e.g., for training the coaches.

Therefore, as an alternative, the NRW study proposes **a set of tools for strengthening the capacity of possible customers to manage EPC/TPF projects**. This could include an internet-based "guidebook" on project management know-how, with different levels of detail for different users at different stages of a project, and bifurcations to, e.g., technology-specific contract details, monitoring and verification details, check lists, and examples. An EU-wide database of successful examples could also be helpful, as well as a co-ordination of, e.g., the SAVE agencies on common guidelines for coaching customers through EPC/TPF projects.

Only when potential clients are able to assess whether the technological solutions offered to them would satisfy their production requirements (as well as saving a certain amount of energy), will they feel a need for M&V methods that can verify the energy savings. The interviews showed that, at that stage, an agreed methodology for monitoring and verification of ESCO projects would be considered helpful, as a part of the overall set of tools.

The methodologies described in the IPMVP are certainly state of the art for monitoring and verification of the savings of ESCO projects, and therefore also applicable in the EU. They are, however, very general, and require project-specific adaptation. In many EU Member States, technical rules, norms, or guidelines for assessing the energy consumption of buildings, heating, ventilation, air conditioning, lighting, production plants, etc., do exist, but may not be known to potential customers of EPC/TPF projects.

Therefore, the present **European Ex-post Evaluation Guidebook** should maintain the reference to the IMPVP as an example of guidelines for monitoring and verification of the savings of ESCO projects. The IMPVP may be especially useful for international EPC/TPF projects, e.g., in the context of the Clean Development Mechanism or Joint Implementation.

But the European Ex-post Evaluation Guidebook should also recommend that each Member State compile a national common set of existing or new technical rules, norms, or guidelines for assessing the energy consumption of buildings, heating, ventilation, air conditioning, lighting, production plants, etc. This common set should then be promoted to both ESCOs and potential customers as the national "reference guideline" for monitoring and verification of the savings of ESCO projects.

However, this process should be co-ordinated at the EU level at least in the sense that as far as harmonised methods for measurement or calculation of the energy efficiency and performance of appliances, components, and buildings (e.g., EN 832) exist, these should be included in each of the national "reference guidelines". Furthermore, the need for further harmonisation should be examined.

ENERGY PERFORMANCE STANDARD IN THE DUTCH BUILDING DECREE (NL)

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INTRODUCTION

At the end of 1995, an Energy Performance Standard (EPS) was introduced in the Building Decree of the Netherlands. The aim of this legal instrument was to reduce the energy use in new houses, but give freedom to architects, developers, and house owners regarding how they prefer to reach the required performance level.

As of December 15th, 1995 all new houses were to have an energy performance of 1.4 or lower. As of January 1st, 1998, the maximum level was lowered to 1.2 and as of year 2000 to 1.0. A house with an energy performance equal to 1.0 consumes 30% less energy than a house with an energy performance level of 1.4.

The EPS is regarded as an energy efficiency programme, which uses a legal instrument for its implementation. Prior to deciding whether or not to lower (or even continue the programme) the EPS level, the Dutch Government evaluated the programme. Novem was involved in these evaluations; first to find out at what moment the results of the EPS would become visible in the market and later to assess the real energy consumption of the new houses. The following focuses on the energy consumption evaluation (impact evaluation, the calculated ex-ante compared to the real energy use). At the end of this paper, comments on the use of the evaluation guidebook for this kind of programme are presented.

THE ENERGY PERFORMANCE STANDARD

During the 1970's and 1980's, the Dutch policy on energy savings in houses was implemented by increasing the insulation standards for roofs, walls, glass, etc. for existing and for new houses. In the 1990's, the approach was changed for new constructions. Instead of targeting single elements, the standards were replaced with an overall energy performance standard for the entire house in question. An overall standard leaves the choice of energy-saving measures to the market. Still the existing insulation requirements were retained as basic requirements.

A calculation model for determining the energy performance level of a house therefore had to be developed. A "typical" new house (i.e. average) was defined for each of the categories: Semi-detached house, end-house, one-family house, and multi-family house. An "energy budget" related to the EPS level, i.e. a maximum allowed consumption, was then defined for each category. The calculation model not only included energy consumption related to space heating, cooling and ventilation, and lighting. It also included the water heating as well so as to provide additional stimuli for use of residential solar hot water systems. Using the calculation model it is then responsibility of the architect to prove that the designed house does not exceed the allowed energy budget.

The "typical" house was used in the calculation (ex-ante) of the expected energy savings resulting from the EPS relative to new houses built before the introduction of EPS, i.e. before 1995.

Exhibit 1: Overview of EPS.

Period	EPS	Energy budget for a one-family house	Estimated savings relative to 1995
From Dec 15th, 1995 to Dec 31st, 1997	Max. 1.4	-	-
From Jan 1st, 1998 to Dec 31st, 1999	Max. 1.2	1,200 m3	15%
From Jan 1st, 2000 to …	Max. 1.0	1,000 m3	28%

An energy performance level of 1.2 (or lower) as required for building construction commenced after January 1st, 1998 was estimated to result in 15% energy saving compared to houses built before 1995. This equals a gas consumption of about 1,200 m^3. An energy performance level of 1.0 (or lower), as required as of January 1st, 2000 was estimated to result in 28% energy savings (= 1,000 m^3 gas). These assumptions were used in models for scenarios on energy consumption and policy impact.

ENERGY PERFORMANCE STANDARD IN NEW HOUSES

End 1994, Novem researched the situation for energy saving measures in new houses. This was just before the introduction of the EPS in December 1995. A substantial part of the houses, designed by architects in 1995, had at that moment already more insulation measures and/or measures on a higher level than the level required by law.

On behalf of the Ministry of Economic Affairs, Novem started in 1998 a survey to research the EPS. This study was targeted at houses that were completed by the end of 1997. It showed several important issues. Two are mentioned here:

- The building process had already started for 46% of the houses before the EPS was included in the Building Decree at the end of 1995;
- Of the houses built under the EPS programme little over half met the maximum 1.4 requirement while 30% met the 1.2 requirement, which became the new maximum level as of January 1st, 1998;

In 1999, the survey was repeated for houses completed by 1998:

- Of these houses, 92% obtained a building permit under the EPS 1.4 regime while the remaining 8% started the building permit process before January 1st, 1995. Thus none of the investigated permits were issued under ther EPS 1.2 regime.
- About 42% of the houses held an EPS value of 1.4 (the maximum allowed); 29% of the houses held an EPS value of 1.2; and only 3% of the houses held values of 1.0 or below. The remaining 26% were in the interval between 1.2 and 1.0.

HOW TO RESEARCH THE REAL ENERGY USE?

At the end of 1997, a first attempt was made to compare the estimated energy use (based on the EPS calculation model) and the real energy use. The investigation concluded:

- The EPS is not intended to calculate real energy consumption, but just to calculate the difference between the allowed energy budget for a specific house and the estimated energy consumption prepared by the architect using the calculation model. Although the EPS model should not be utilised on an individual level, it does however on a national level arrive at energy savings estimates comparable to the realised saving (15% for EPS 1.2);

- The impact of behaviour and the penetration of new appliances in real households should be included in the analyses. Furthermore, the energy consumption data for just one year is too little information to allow a good analysis.

In 1998, Novem started a study on energy use in new houses. Using the information from the studies mentioned earlier, it was clear that a representative survey on real energy consumption, related to the introduction of the EPS could not be done. So the research concentrated on two items:

- An indication of the real energy use, related to the EPS for a smaller number of dwellings;
- A research layout for structural monitoring of energy use in new houses at national level.

As real energy use for two or three years are needed to have at least some confidence in the results, the survey on the energy use had to be for houses build before 1997. But for these houses no EPS calculations are available, and it would be much too expensive to inspect houses to sample for all relevant variables for the EPS. So it was decided to use demonstration projects for the survey since building information (and in several cases also EPS calculations) was available for these projects.

Three demonstration projects with 474 houses in total were included in the survey. The structure of the data collection process was as follows:

- **Information related to the construction and the EPS** - Project documentation, collected by desk research and additional information from (former) project managers;
- **Household and behavioural information** - Written questionnaire for households;
- **Energy data** - Collected by the energy distribution companies, using a permit from the households to do this.

At present, a study is ongoing for a greater number of demonstration projects with houses that meet an EPS level of 1.0 or lower. In this study more emphasis is given to behavioural elements. The results are foreseen ready by the end of 2001.

REAL ENERGY USE, THE FIRST INDICATION

It was possible to collect the needed information for about 45% of the 474 houses. The non-response by households to the questionnaire was 49%; missing energy use data only caused a 6% drop out.

The average gas use was almost the same for 1997 and 1998, namely 1,291 m^3 and 1,251 m^3, respectively (the values have been adjusted for the outdoor temperature using the degree days method). Most of the houses had an energy performance of about 1.2.

The use of gas showed a great variation: The lowest value was 422 m^3 and the highest 3.048 m^3. As showed in Exhibit 2, the use differs by type of house, but the standard deviation within each type is also interesting. The gas use of houses with a solar hot water system is not included in Exhibit 2, as these have a lower EPS value.

Exhibit 2: Gas use in 1998 (m^3)

	Average	Modus	Standard deviation	Minimum	Maximum
Semi-detached house	1.709	1.622	411	943	3.048
End houses	1.479	1.160	749	532	2.931
One family houses	1.179	1.110	390	422	2.292
Multi family houses	1.002	932	221	658	1.434
Total	**1.331**	**1.217**	**496**	**422**	**3.048**

Only a small portion of the electricity use is included in the EPS calculations (lighting, ventilation, and boiler pump). It was not possible to establish these specific uses in the survey although the general electricity use gives some indications. But more important is that the gas and electricity use combined give the total real energy consumption of a new house. The average electricity use was almost the same in 1997 as in 1998, namely 2,996 and 2,967 kWh, respectively. (3.000 kWh is equal to 852 m^3 gas). As showed in Exhibit 3, the spread of electricity use is much higher than the gas use. Although also here the variation over the type of houses is evident, the differences between the lowest and the highest users within each category are great.

Exhibit 3: Electricity use in 1998 (kWh)

	Average	modus	Standard deviation	Minimum	Maximum
Semi-detached houses	3.956	3.696	1.412	1.844	7.583
End houses	3.008	2.815	1.252	1.299	6.125
One family houses	2.816	2.675	1.091	1.007	6.904
Multi family houses	2.575	2.465	948	1.427	4.563
Total	**3.107**	**2.939**	**1.281**	**1.007**	**7.583**

The general conclusions on the energy use were:

- The real average gas use in new houses with an energy performance of about 1.2, is in line with the estimated gas use of a standard one family house, but the variation in the gas use within the categories is high;
- The variation in the electricity use is much higher than that of in the gas;
- The variation in the electricity use is strongly linked to the kind of appliances in the household (especially with high electricity consuming appliances like waterbed and cloth dryers);
- In about half of the houses the people do additional ventilation independently of whether the house has a controlled ventilation system or not;
- Also houses with a hot water solar boiler system show a great variation in gas as well as electricity use.

THE USEFULNESS OF THE EX-POST EVALUATION GUIDEBOOK

The EPS programme uses as most import instrument the legal situation, but also additional instruments as calculation tools for developers and architects, information material (brochures, papers, and workshops) and an Internet site were used.

The evaluation presented above was just on the overall impact of the EPS programme on the energy use, so the comments on the evaluation guidebook should be seen in this framework.

Section 2.4.1 of the guidebook deals with the practical impact question: "How accurate are the programme initial assumptions regarding specific impact parameters?"

For the EPS programme there was a longer discussion between the policy makers and the researchers on whether the EPS calculation could be used on an individual level. They more or less agreed that it should be on an aggregated level of a country or of a type of house and on the mean values. This discussion proves in our opinion the importance of the practical impact question.

Chapter 3 on evaluation planning

The overall evaluation of the EPS programme is related to the lowering of the EPS levels in the Building Decree. In this case description only the impact is included, but from the personal involvement in several other elements of evaluation it became clear that an (overall) evaluation planning was not well developed before starting the evaluation process. The importance of overall planning should be stressed in the report.

As for the energy evaluation itself, an evaluation planning was used and so from the beginning it was clear what the evaluation goal was, which studies for what elements should be done and what kind of (survey method) should be used.

Chapter 4 on overall impact evaluation strategies

The elements are in general well described, but people should realise that basic knowledge from statistics and survey techniques is assumed and that for specific questions it is better to ask for help by an advisor. From the elements mentioned in the draft guide book we used:

- Primary data sources:
  - New group: survey with houses, not included in the programme, but with elements that make it suitable as a reference group;
  - Energy use/billing data;
- Evaluation techniques: only the random sampling;
- Statistical methods: the weather adjusted comparison/adjustment.

Chapter 5 on key impact evaluation concepts

The net and gross programme impact estimations are not used. The realised energy performance in the houses, used in the sample are all caused by demonstration subsidies, and not by the EPS programme. The element of ‘persistence of savings’ was included in the survey and the conclusions on ventilation and users behaviour.

Chapter 6 on selecting impact evaluation strategies

As the EPS programme mainly uses the legal instrument it could be defined as a market transformation programme, targeted to reduce the direct energy use. The survey indicates energy savings, and the research included a framework for structural monitoring. As the survey was only on the real energy use and the expected energy use, other elements indicated in Section 6.2.3 as market indicators were not relevant.

Chapter 7 on process and market impact evaluation

Market evaluations were conducted in studies for improving the knowledge on the EPS systems by architects, builders, real estate developers etc. In the survey described earlier, a mail survey was used, but with two special elements. The first was a present (a lottery formula) not after the questionnaire was sent back, but already when the questionnaire was mailed to the households. The second one was that the filled out questionnaires where collected in person.

For the questionnaire design, several elements from other available questionnaires were re-used. This saved time and money as a pre-test was not necessary.

CASE RELEVANT REFERENCE MATERIAL

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USE OF ELECTRONIC VSDS IN MOTORS IN THE PORTUGUESE INDUSTRY (P)

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INTRODUCTION

Electric motor driven systems account for 67% of industrial electricity consumption in Portugal, which means about 8,700 GWh/year or an annual cost of about 516 million EUR. Given the significant share that motive power constitutes in the energy consumption, interest in realising some of the potential EE improvements would seem natural. However, in reality several factors prevent a more intensive search of techniques and equipment to reduce the energy consumption by motor drives.

The design and size of the motor, the motor load, the motor efficiency, and the maintenance level of the equipment the motor all influence the electricity consumption for motive drives. Some process variables (e.g. pressure and flow) still continue to be regulated by devices like throttles, adjustable inlet vanes and by-passes, that waste energy and are cumbersome in operation or complicated to control. In many industries, efficient technologies like high performance electronic frequency converters or variable speed drives (VSDs) are still unknown or not widespread to the desired extent – mainly pumps, fans, compressors and even in other kinds of process and/or ancillary services equipment, requiring speed control. An electronic VSD controls the speed of the motor to match the load imposed on it under varying process and environmental conditions. This reduces power consumption for this equipment. For instance, for a pump or a fan power consumption is proportional to the cube of the motor speed and significant savings can be achieved through speed reduction (e.g., reducing the speed 20% will reduce the power consumption to half).

Depending on the application, an electrically controlled drive is composed of a motor, a variable speed drive (VSD) with a control and a power section, a gear as a torque converter, and other electromechanical and mechanical components. The key component is without doubt the VSD. It controls the speed, among other things, and ensures that a machine only receives the energy it needs for its current task. This minimises power losses and is an advantage for the environment. In the lower power ranges, motors with integrated VSD are increasingly being offered as so-called "intelligent compact drives". These have additional advantages with regard to cabling, space requirements, and electromagnetic compatibility.

Electronic VSDs are able to continuously change the speed of an AC motor. Most VSDs convert the 50 Hz alternating current to direct current and then run the current through a series of electronic power switches (transistors or thyristors) that switch on and off at a controllable rate to form a power supply of variable frequency and voltage, from nearly 0 Hz up to over 100 Hz. This variable frequency permits a motor's speed to be controlled, because the speed of the induction and synchronous motors varies directly with the frequency of the power supply. Provided that the motor and its load are sufficiently mechanically balanced, VSDs allow motors to operate at speeds both far below and well above their normal rated speed.

PROJECT OBJECTIVES

The present project was developed in the scope of PEDIP II programme, Measure 4.9 (energy efficiency missions), supported by the Portuguese General Directorate for Energy (DGE), and was inserted in a DSM perspective. The main aims were to identify the energy savings potential in electric motors in the Portuguese Industry by the use of VSDs and to sensitise the industrial top level decision makers for the application of the VSDs technology as a management priority and for the advantages of a DSM practice.

The project encompassed a pilot action, where electric/electronic equipment, like electronic variable speed drives (VSDs) and soft starters, were installed in several selected industrial installations, allowing “in field” evaluation - trough monitoring - of the resulting energy savings. The target groups of the project were DGE – Portuguese General Directorate for Energy, Industry, manufacturers and suppliers of VSDs and soft starters equipment, installers, electric equipment associations and other technologic infrastructures.

Summarising, the project included the following actions:

- Identification of energy savings potential for the different subsectors of the national transforming industry;
- Selection of enterprises (industrial factories), that belong to industrial subsectors with high energy savings potential;
- Installation of electrical equipment (VSDs and soft starters) in one or more productive sections of the selected enterprises; monitoring of energy consumption before and after the equipment installation, allowing an objective evaluation of the obtained savings.

SELECTION CRITERIA FOR VSDS INSTALLATION

The project consisted of a pilot action, where electronic variable speed drives and soft starters were installed in various industrial plants to allow measurement of the resulting energy savings. The pilot results were then scaled up for each industrial subsector to arrive at an estimate of the national potential for energy savings (ratio estimation). The sample of industrial enterprises selected for pilot testing of VSD technology was, however, not representative of the whole industrial sector since preference was given to the following:

- Enterprises currently employing young technicians in an energy traineeship. CCE is currently conducting an EE programme, which provides 2 months training in EE to newly educated engineers followed by a 9 months traineeship in industrial enterprises with high electricity consumption. Furthermore, the two activities are likely to strengthen one another;
- Industrial sites listed in proposals prepared by VSD technology suppliers and where the suppliers appeared willing and able to provide e.g. the data and co-operation requested by CCE;
- Sites which had the highest possible variety of equipment sizes and types within its industrial branch;
- 50% of the total equipment cost for the pilot project was financed by the government (PEDIP II Programme) and the remaining 50% by the involved industrial sites. However, the budget limit for contribution from PEDIP II was 39,904 EUR in total. Therefore a suitable mix of industries had to be construed which avoided exceeding the permitted co-financing limit of 39,904 EUR;
- The selected projects should allow testing of a great range of motive power (between 11 and 200 kW), types of equipment (drum mills, compressors, fans, etc), and types of industries (ceramics, agro-food sector, cork, textiles, and chemicals);
- The distribution of pumps, fans, compressors, and other motors varies between but also within the different industrial subsectors – mainly due to differences in manufacturing processes even for similar products. Therefore, extrapolation of pilot results to a national level does not necessarily lead to trustful values.

- The consequences of this was not investigated since the aim was to estimate the approximate size of the energy saving potential of VSD introduction on a national level and not to obtain exact values for each industrial subsector.

CHARACTERISATION OF INDUSTRY MOTORS DRIVES END-USE

The following graphic represents the share of electric consumption for Portugal, in 1996, for the main activity sectors; 12,864 GWh for the industrial sector, 9,037 GWh for the tertiary sector, 10,198 GWh for the residential sector and 643 GWh for Agriculture.

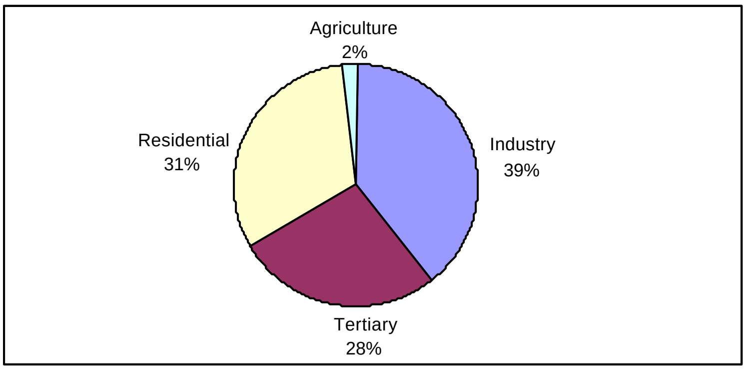

Fig.1 - Electric consumption desegregation for Portugal (reference [8]).

At Industrial level, the following table shows the electric energy consumption desegregation , for the reference year 1996.

Table 1 – Electric energy consumption (GWh) by industrial sector for Portugal in 1996(source: DGE)

Industrial Sector	Consumption (GWh/yr)
Food, drinks and tobacco	1,344
Textiles, footwear and tannery	2,118
Wood and Cork	783
Paper, graphic arts and publications	1,806
Chemical, plastics and rubber	2,290
Mineral and non-metallic products	1,858
Base metallurgy	758
Manuf. of metal prod. and mach., equipm. e transport. mat.	1,200
Other transforming industry	177
Extractive Industries and others	530
Total	12,864

The next graphic shows the consump tion desegregation by the main loads in industry, where is notice that 6% of electricity is used to feed motive power (essentially in tri-phase induction electric motors – about 90%, and 10% for the remaining, mainly DC motors).

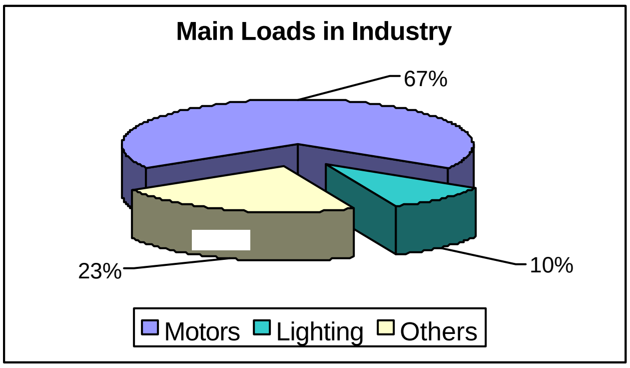

Fig. 2 – Electricity consumption desegregation by the main loads in the Portuguese Industry (Reference [8]).

Electric motors are used in a wide range of applications, mainly in pumps for fluid movement, compressors and fans. The next picture presents the electric motors consump tion desegregation by final uses in industry.

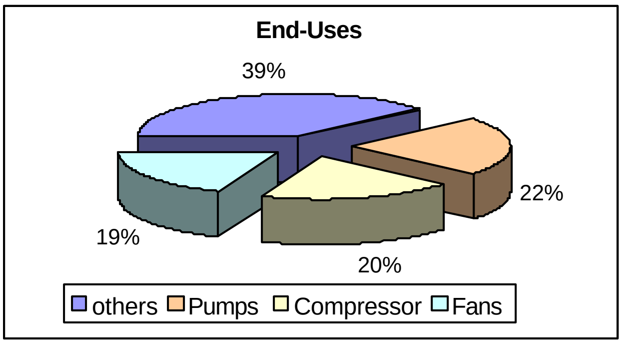

Fig. 3 – Electric motor consumption desegregation by main end- uses in Industry(Reference [8]).

The distribution of pumps, fans, compressors and other motors is very variable in the different industrial subsectors, mainly due to different manufacture processes adopted by the several industrial entities. Therefore from this situation, the extrapolation results for an industry in the same subsector or industrial sector, not always lead to trustful values, due to the enormous variety of manufacturing options to produce similar products.

The figure 4 presents the installed capacity, electricity consumption, losses and average operating hours of motors, by power range, in the Portuguese industry. As a remark, the number of operating hours varies from values higher than 8,000 hours per year in industries with continual processes (as for instance, in chemical and pulp industries), to values near 2,000 hours per year, for light industries with just one shift.

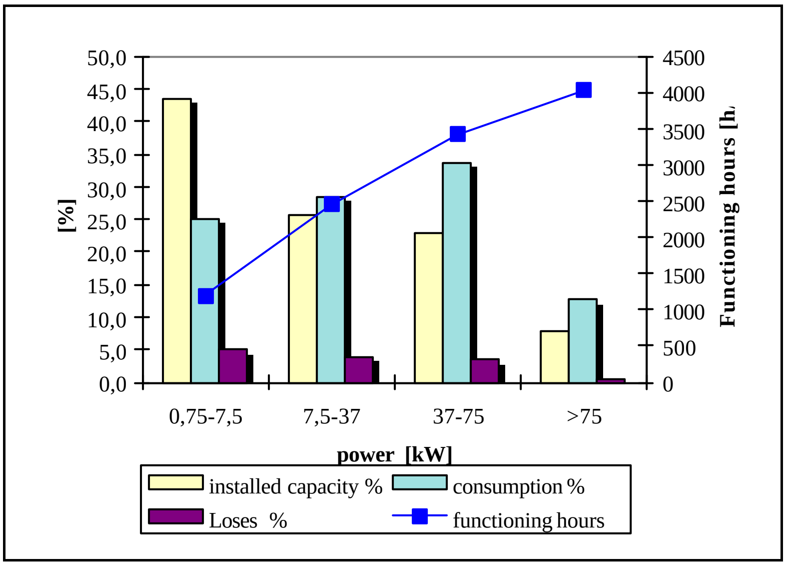

Fig. 4 – Percentage of electricity consumption, installed capacity, losses and average operating hours of electric motors, by power ranges, in industry (Reference [8]).

ENERGY SAVINGS POTENTIAL IN ELECTRIC MOTORS

The very different examples of applications that follows, shows how consumption, and therefore energy costs as well, can be drastically reduced by upgrading the drive solutions on offer. In the examples of calculation, different power prices in PTE/kWh were used. In practice, other factors such as the load cycle and operating hours must be considered from case to case and can lead to deviations in both directions in the result.

Electronic VSD application in an electric motor from one exhaustion fan of a steam boiler in a cork plant industry

The 6 years old fan with an electric motor (45 kW) is responsible for the exhaustion to the atmosphere of the combustion gases from one steam boiler that uses powder cork as fuel. Before the tested application, there did not exist any control in this circuit, i.e., the motor was acting in a nominal regime. It was supposed that it was oversized, conducting to small values of power factor (cosφ) in the circuit.

Actually, an analogue sensor of air stream, installed in the boiler, acts in the velocity regulation of the motor, adapting continuously the rotation velocity to the exhaustion needs. The variation range of velocity is between 45-100% (30-50Hz).

Table 2 – Obtained savings with the electronic VSD application in the exhaustion fan.

Fan's Motor	Average consumption of active energy (kWh/day)	Average consumption of reactive energy (kVArh/day)	Starts (nº /day)
With electronic VSD	489.5	247.3	1.87
Without electronic VSD	363.2	176.7	1.74
Savings (%)	25.8	28.5	7.0

According to the stated results, we can conclude that it was obtained a considerable electric energy savings, nearly 25%, with the installation of an electronic VSD in the exhaustion circuit of the boiler.

The electronic VSD had caused a reduction of about 7% in the daily number of starts of the electric motor, which changed from 1.87 to 1.74 starts/day. We have also verified a better power factor of this motor, caused by the reduction of reactive energy consumption, as consequence of operation nearly to the nominal mechanical regime of the machine.

Table 3 - Synthesis of economic analysis for the VSD installation in the exhaustion fan.

Average consumption without electronic VSD	Average consumption with electronic VSD	Energy savings		Investment			Payback time
				VSD	Software	Total	
kWh/day		KWh/year	10^3 PTE/year	10^3 PTE	10^3 PTE	10^3 PTE	years
489.5	363.2	28,672	293	860	242.5	1,102.5	3.8

In this case the obtained payback time is 3.8 years. We consider this a little bit high value because it is more than 3 years. Nevertheless, if we take into account other savings that result from the electronic VSD application, the payback time will reduce a little, to approximately 3 years, that attests the technical-economic viability of this kind of application.

Electronic VSD application in an electric motor from an exhaustion fan in a spray-dryer of a chemical plant

The equipment with a 200 kW motor, which was the target of our study, was the exhaustion gases fan from the dryer tower (spray-dryer). The asynchronous motor (15 years old) works 5,000 hours/year and it is oversized. The equipment belongs to production sector of detergent powder (drying tower), and contributes for the exhaustion of nearly 70,000 kg/h of air, that transports within the evaporated water in the drying process.

At the outset of this study, the air flow control was achieved with a damper modulation, standing the motor permanently at the synchronism velocity which resulted in significant waste of energy. The introduction of an electric VSD allows the continuous adjustment of motor velocity (motor consumption) to the required power. The introduced variation of velocity permitted a range of motor rotations between 350-1,500 rpm.

The obtained results show that a considerable saving can be achieved by the installation of an electronic VSD. The percentage average values of the obtained savings are listed below in table 4.

Table 4 - Obtained savings with the electronic VSD application in the exhaustion fan.

Fan's Motor	Average consumption of active energy (kWh/h)	*Average consumption of reactive energy* (kVArh/h)
Before the introduction of a VSD	83.7	53.4
After the introduction of a VSD	49.6	9.2
Savings (%)	40.7	82.8

A significant reduction in active and reactive power consumption can be achieved. With the electronic VSD we assisted an alteration in the rotating regime and to smaller values in the maximum demand power. The most important advantages are the effectiveness control of the ventilation adapted to the process requirements, the visualisation in real time of the process variables (flow, velocity, power, torque, etc...), the energy saving higher than 35%, the very important reduction of reactive energy, and the complete elimination of energy relative to the starts tip (5 to 7 In) – providing soft starters with decrease in mechanical stress, and consequently reduction in maintenance costs, that were evaluated in 600 x 10^3 PTE/year.

Table 5 - Synthesis of savings analysis for the VSD installation in a fan's motor.

Cons. without VSD	Cons. with VSD	Savings			Investment			Payback time
		Energy		Maintenance	VSD	Installation	Total	
(kWh/h)		kWh/year	10^3 PTE/year	10^3PTE/year	10^3 PTE	10^3 PTE	10^3 PTE	Years
83.7	49.6	170,500	2,078	600	3,750	550	4,300	1.6

Considering the analysed application, the payback time is 1.6 years, a very interesting value, once eventual savings that result from the diminishing of the maximum demand power on the industrial installation are neglected. As consequence we can conclude that the introduction of the electronic VSDs is worthwhile from a technical and economic stand point of view in similar applications.

The high viability of this application is a consequence of the high power motor. And also from the very significant number of hours in operation, and of course by the inefficient way of control used before.

Electronic VSD application in an electric motor from an extruder in the ceramics industry

The analysed equipment was the extruder located in the slip preparing section (preparation of row materials). The electric motor with a rated power of 75 kW and 10 years old, works 16 hours/day. Some previous tests showed that the motor works continuously, in a constant speed, independently of the charge (load) and with an average power of 33.5% of its nominal power.

VSD application was thought to be able to minimise tariff penalisations (connected to some "peaks" of power resulting from the several starts of the extruders), reduction in the electric consumption of the machine, optimising its operation and all the process. Other benefits like the operation automation, reduction of the operation time (and manpower associated), the expected increase of the useful life time of the motor and the possibility of informatisation of the functioning of the production chain through additional sensors and appropriated software, reinforced the interest on its implementation.

The results of the consumptions monitoring proved a considerable oversize of the motor, the frequent oscillations in the load, with significant savings in active energy and a better power factor. The load variation was detected by the electronic VSD, activating the mode "energy saver", responsible for the obtained savings.

Table 6 – Obtained savings with the electronic VSD application in the extruder's motor.

Extruder's Motor	Average consumption of active energy (kWh/day)	Average power factor
Before the introduction of a VSD	257.85	0.40
After the introduction of a VSD	121.01	0.77
Savings (%)	53.1%	

After the installation of the electronic VSD, it was verified a significant reduction in average power, and consequently a substantial savings of active energy, approximately 53%, which exceeded the initial expectations.

Another reason that justify the application of this kind of technology will be the reduction of electric tariff penalisations, the increasing of the useful life time of the motor and of its associated equipment and the consequent maintenance with lower costs.

Table 7 - Synthesis of economic analysis for the VSD installation in an extruder motor.

Average consumption without VSD	**Average consumption with VSD**	**Savings**		**Investment**			**Payback time**
		Energy		**VSD**	**Installation**	**Total**	
kWh/day	kWh/day	kWh/year	10^3 PTE/year	10^3 PTE	10^3 PTE	10^3 PTE	years
257.85	121.01	32,842	360	1,175	140	1,315	3.6

In this application the obtained payback is 3.6 years, which is an acceptable result, since only the energetic parameters were taken into account (if other economical advantages were accounted for, this result would improve).

Electronic VSD application in a discontinuous mill's electric motor from a ceramic tiles industry

The electric motor belongs to a discontinuous balls mill, type "alsing", located in the slip preparation section. It has a total capacity of 35,000 litres and it works at full load.

The motor is from ABB with a rated power of 110 kW. It is 4 years old and works 5,824 hours/year. The mill's annual electric consumption represents, in average, 17% of the global electric energy consumption, and 23% of the motive power consumption.

As a consequence of the electronic VSD application, it was expected that an adjustment of the rotation speed of the mill according to the grinding curve of the raw material would be possible. The main advantages obtained from the application of a frequency invertor (VSDs) to the discontinuous ball mill are the following:

- Gradual starting up of the mill;
- Adaptation of the grinding action to the dimensions that the material takes as the grinding process progresses.

The variation in the speed of the mill throughout the grinding allows the mill to grind at the appropriated speed for each part of the grinding curves, optimising the grinding process and reducing energy consumption and grinding time with respect to the initial conditions.

Energy savings and reduction of grinding time depend mainly on the row material to be ground and the relation between the load of the material to be ground and the load of the grinding media. Besides these advantages it were also expected an increase in the production capacity of the grinding division (due to the reduction in the time of the grinding cycle), as well lower operation costs (associated to a less wear of the grinding media and of the internal covering of the mill) and lower maintenance costs (of the motor).

The electronic VSD implementation introduced substantial energetic advantages with reduction in active and reactive energy consumptions, including a reduction in the consumption at start. It was also verified an improvement in power factor (0.81 to 0.92) by adjusting the operational conditions of the motor.

Table 8 - Obtained savings with the electronic VSD application in the mill's motor.

Mill's Motor	Average consumption of active energy (kWh/mill's cycle)	Average consumption of reactive energy (kVArh/mill's cycle)	Power factor
Before the introduction of a VSD	933.59	675.29	0.81
After the introduction of a VSD	833.22	358.52	0.92
Savings (%)	10.75	46.91	

By adjusting the mill motor speed as a function of the material grinding curve it was been optimised the granulometric distribution relation, with reasonable energetic gains. The electronic VSD contributed to the reduction of the electric invoice saving approximately 11% in active electric energy. We also refer the diminishing of 8.2% detected in the total grinding time, having as consequence an increase in productivity.

The foreseen costs reduction associated to with the motor maintenance, in addition to others advantages reasons not specifically energetic ones were not quantified by the industrial users.

Table 9 - Synthesis of economic analysis for the VSD installation in a mill's motor.

Average consumption without VSD	Average consumption with VSD	Savings		Investment	Payback time
		Energy		VSD (incl. installation)	
KWh/mill cycle		kWh/year	10^3 PTE/year	10^3 PTE	years
933.59	833.22	48,680	570	3,850	6.8

The obtained payback period of 6.8 years, taking into account only the energy savings, is very high. However the economical viability of such application can't be analysed in this way. According to this, the payback time must be calculated including all the benefits associated to the technology, including the ones referred before. We estimate that if taken into account all these benefits, it would be obtained a value of payback of about 3 years.

Electronic VSD application in a granulator´s fan from an agro-food industry

The equipment analysed was located in the granulation section of a factory that produces food (rations) for animals, i.e. the electric motor coupled to the cooling fan of the granulate in a granulator machine. The 30 kW asynchronous motor, 6 years old, works 2,600 h/year. Before the introduction of the electric VSD the airflow control was achieved trough a valve actuated manually according to the temperature in the final product granulated. The expected savings would be caused by the frequent oscillation of the load (that was thought it would be significative), which activates an optimisation function integrated in the electronic VSD, causing the permanent adjust of the torque to the conditions required.

Table 10 – Savings obtained with the electronic VSD application in the granulator´s fan motor.

Granulator Fan	Average consumption of active energy (kWh/h)
Before the introduction of a VSD	30.96
After the introduction of a VSD	28.69
Savings (%)	7.33

The obtained charge diagrams revealed only a small diminishing, which is not sensitive in the maximum demand power after the installation of the electronic VSD. As a result, the savings are not as significant as expected, with a value of 7.3%. The motor operating mode, nearest of the nominal regime that was verified before the introducing of the electronic VSD justifies this result, besides the inexistence of load variations of the motor as expected, as well .its oversize.

The savings detected are probably a consequence of the better conditions in the start and stop of the motor; due to mechanisms of soft-start and soft stop integrated in the VSD, that limit the current peaks (diminishing the mechanical stress).

Table 11 - Synthesis of economic analysis for the VSD installation in a fan's motor of a granulator machine.

Average consumption without VSD	Average consumption with VSD	Energy savings		Investment			Payback time
				VSD	Installation	Total	
kWh/h		kWh/year	10^3 PTE/year	10^3 PTE	10^3 PTE	10^3 PTE	years
30.96	28.69	5,902	60.26	610	79	689	11.4

Here, the payback time of 11.4 years is not reasonable, once it is extremely high, which makes the investment not viable economically. Another fact that contributes to the value obtained in the payback time is related to the payback calculation that not takes into account other economical advantages resulting from this technology, like the reduction in the maintenance costs of the motor. However, even if taking these benefits into account, it wouldn't be enough to the investment be worthwhile in this particular case.

Electronic VSDs applications in an electric motor of a tank's agitator and in an electric motor of a dust removal system of a porcelain ceramics industry

The tested applications involved the analysis of two pieces of equipment, namely:

- 1 fast agitator, moved by an electric motor of 32 kW, located in a tank with a capacity of 50 m^3 installed in the slip preparation section, for the raw-materials dilution;

- 1 dust removal dry system, involving a cyclone separator, where the centrifugal force generated by a ventilator, moved by an electric motor of 55 kW, is responsible for the cleaning of the polluted air (with powder provenance of different machinery). This system was responsible by 5% of the electrical energy consumption of the factory, when regulated by a damper (before the introduction of the VSD).

In the original motor of two velocities, which moves the agitator, the programmed automate (PLC) and electronic VSD introduction has caused a reduction in velocity until 25 Hz (in the lower speed).

In the dust removal system, the electronic VSD introduction influenced the rotating speed of the ventilator's motor, which remains constant at 40 Hz.

Table 12 - Obtained savings with the electronic VSD application in the agitator and ventilator motors.

Agitator motor	**Average consumption of active energy (kWh/cycle)**	**Average power factor**
Before the introduction of a VSD	155.19	0.75
After the introduction of a VSD	108.65	0.88
Savings (%)	30.0	
Ventilator motor	**Average consumption of active energy (kWh/h)**	**Average power factor**
Before the introduction of a VSD	35.58	0.83
After the introduction of a VSD	20.66	0.77
Savings (%)	41.9	

Concerning the energy savings obtained in the turbo-dilution tank, it was about 30% by cycle of operation. This involves a time reduction per operating cycle (that involves one dilution and one discharge phases), that becomes 12.0 hours, contrasting with the 16.3 hours observed before the introduction of VSD. The eradication of a human error that controlled the duration of the cycles before the VSD installation, was the main factor to the obtained results, once actually the duration of the cycles are smaller with a reduction proportional in electric consumption. It was also verified a better power factor by optimising the motor working.

With respect to the ventilator, the electronic VSD introduction caused immediately a decrease in the maximum demand power and consequently in the registered active energy consumption. The result was a significant decrease in energy consumption, i.e., 42%, confirming the initial expectation.

Table 13 - Synthesis of economic analysis for the VSD installation in the ventilator and agitator motors.

Equipment	**Average consumption without VSD**	**Average consumption with VSD**	**Savings**		**Investment**			**Payback time**
			Energy		**VSD**	**Others costs***	**Total**	
	kWh/cycle		**kWh/year**	**10^3 PTE/year**	**10^3 PTE**	**10^3 PTE**	**10^3 PTE**	**Years**
Agitator	155.19	108.65	12,100	136	570	120	690	5.1

Equipment	**Average consumption without VSD**	**Average consumption with VSD**	**Savings**		**Investment**		**Payback time**
			Energy		**VSD**	**Total**	
	kWh/h	**kWh/h**	**kWh/year**	**10^3 PTE/year**	**10^3 PTE/year**	**10^3 PTE/year**	**Years**
Ventilator	35.58	20.66	65,648	739	860	860	1.2

**Instalation+swichboard*

According to the results it was proved that in similar applications, namely in ventilators, it is possible to obtain considerable energy gains, which can give a payback time extremely attractive (lower than 1.2 years), taking into account other beneficial effects not quantified.

The VSD application in the agitator of the turbo-dilution tank demonstrated to possess a payback time not very attractive (higher than 3 years) as a consequence, in this case, of the reduced consumption registered. We think that in cases where the power involved is higher we get better results.

Electronic VSD applications in electric motors of 4 centrifugal pumps, 2 of water-supply and 2 of dyeing equipment of a textile plant

The tested applications involved the analysis of 4 pieces of equipment, namely:

- 1 superficial pump moved by an electric motor of 11 kW. It is located in the supplying water central of the factory, and it has the distribution function to the consumer equipment. It has a continuous working regimen (24 hours/day), equivalent to 6,300 hours/year.
- 1 submersible pump moved by an electric motor of 15 kW. It also belongs to the supplying water central of the factory, having the same function and working regimen of the previous pump.
- 1 pump of dyeing equipment (jet), moved by an electric motor of 30 kW. This equipment is located in the finishing jersey section. The maximum annual operating hours are 5,760 hours/year.
- 1 pump of dyeing equipment, moved by an electric motor of 15 kW. This equipment is equally located in the finishing jersey section. The maximum annual operating hours are also 5,760 hours/year.

The electronic VSDs installed in the water-supply central were programmed to operate in a frequency regimen between 25-50 Hz (connected to a pression transducer), varying continuously the operation frequency by adjusting to the load.

At the dyeing equipment the VSDs were also programmed to a variation speed in the range between 25-50 Hz, but the adjustment of the speed is not regulated automatically, depending on the rotation speed of the type of jersey involved in the dye-work process. This operation is handled and regulated by a potentiometer.

Table 14 – Obtained savings with the electronic VSD application in the tested equipment.

Superficial pump	**Average consumption of active energy (kWh/h)**	**Average consumption of reactive energy (kVArh/h)**	**Power factor**
Before the introduction of a VSD	7.61	4.23	0.87
After the introduction of a VSD	5.98	0.64	0.99
savings (%)	21.4	84.9	
Submersible pump	**Average consumption of active energy (kWh/h)**	**Average consumption of reactive energy (kVArh/h)**	**Power factor**
Before the introduction of a VSD	9.73	9.14	0.73
After the introduction of a VSD	7.51	1.66	0.99
Savings (%)	22.8	81.8	
Jet pump	**Average consumption of active energy (kWh/h)**	**Average consumption of reactive energy (kVArh/h)**	**Power factor**
Before the introduction of a VSD	11.65	8.06	0.82
After the introduction of a VSD	2.52	0.34	0.99
Savings (%)	78.4	95.8	
Other dyeing pump	**Average consumption of active energy (kWh/h)**	**Average consumption of reactive energy (kVArh/h)**	**Power factor**
Before the introduction of a VSD	14.48	--	0.88
After the introduction of a VSD	9.40	--	0.90
Savings (%)	35.1	--	

The introduction of the electronic VSDs in the pumps of water supply conduct to similar results, with the decreasing of consumptions of active energy (22%) and reactive energy (≈80%). The power factor suffers an increase. These results provide a potentiality application of VSDs in similar equipment.

The results in the jet application demonstrate a better energetic utilisation in this equipment, in all the points analysed. It was registered an oversize in the motor's capacity and a frequent start/stop of the motor, with very frequent load oscillations. These situations are adequate and justify the application of this technology.

In the other dye-work pump it were observed similar results to the other equipment, as reduction in active energy and increasing in power factor. The reactive energy was not measured because the analyser model involved in the monitoring did not allow this kind of measure.

The monitoring results proved to be very attractive (see table 15), once the obtained savings were substantial, with repercussions very favourable in the payback time period, (lower than 3 years in all projects). The results would be more attractive if we taken into account all the savings generated by the electronic VSD, which were not considered (motor maintenance, eventual power factor and maximum demand power of the plant, ...). All the equipment demonstrate a potential for savings through application of VSD.

Table 15 - Synthesis of economic analysis for the VSD installation in the tested equipment.

Equipment	Average consumption without VSD	Average consumption with VSD	Energy savings		Investment			Payback time
					VSD	Installation	Total	
	kWh/h	kWh/h	kWh/year	10^3 PTE/year	10^3 PTE	10^3 PTE	10^3 PTE	years
Superficial pump	7.61	5.98	10,254	129	291	25	316	2.45
Submersible pump	9.73	7.51	13,986	176	384	25	409	2.32
Jet pump	11.65	2.52	52,584	663	384	25	409	0.62
Other dyeing pump	14.48	9.40	29,212	368	608	25	633	1.72

CONCLUSION

Electric motors represent the largest end-use in the Portuguese industry, i.e., about 2/3 of the total consumption. The main applications are pumps (25% of industrial electricity consumption), ventilators (20%), compressors (20%), transporting systems (8%), and other machinery (17%).

The electricity savings that can be obtained by introduction of electronic VSDs depend of the specific application, once possible savings are conditioned by some factors. We stress that reduction of oversizing of the systems and the load variation requirements can lead to energy savings up to 50% in average.

The biggest savings are obtained when the application requires a torque that increases with the square of the speed of the motor. Typical examples are ventilators, centrifugal pumps and compressors. Overall the estimated savings for pumping and ventilation systems as a result of VSDs application are about 30-35%, for compressors and refrigeration systems 18-23%, and for machinery and transporting systems approximately 7%. In average, a potential of 25% saving can be assumed for the process industry with the application of electronic VSDs in loads where this technology is well succeeded.

The cost of electronic VSDs depends of the range of power of the motor, which is controlled by the VSD. Nevertheless, there are other factors that influence the acquisition of a VSD, like the number of operating hours and the type of charge. Almost all VSD suppliers claim high efficiency for their products varying between 95-97% for the more recent models.

The application of electronic VSDs is however limited to only a part of the existing motors in industry taking into account the viability of a project, not only in terms of technical but also economical aspects.

The number and use of motors in pumps, ventilators, compressors, and other equipment varies within the different industrial subsectors due to differences in production processes. Consequences of this was not taken into consideration in the evaluation (it was assumed that the situation observed in the factory is representative of the average of its correspondent subsector).

Table 16 presents the potential electricity savings related to the application of electronic VSDs in the Portuguese transforming industry. The values for the various industrial subsectors are "theoretical potentials", not taking into consideration economic aspects and/or the expected real penetration of the technologies, which both are functions of specific barriers existing in the market that will influence the dissemination and implementation.

The global data of electric consumption in each subsector (more recent values) was obtained from DGE (the Portuguese General Directorate for Energy), using 1996 as reference year.

Table 16 – Potential electricity savings in motors in the Portuguese process industry.

Industrial Subsector	Total electric consumption (MWh/year)	Motive power Electric consumption in		Potential for VSDs application	Electric energy savings	Maximum energy saving potential (MWh/year)
		%	MWh/year	%	%	
Food compounds for animals	105,572	70%	73,900	17%[(a)]	25%	3,141
Textiles	1,349,378	92%	1,237,733	17%[(a)]	35%	73,645
Wood and cork	638,520	70%	446,964	17%[(a)]	25%	18,996
Pulp and paper	1,632,078	70%	1,142,454	33%[(c)]	25%	92,824
Soaps, detergents and cosmetics	22,217	70%	15,552	17%[(a)]	25%	661
Ceramics (excluding earthenware pottery)	244,479	67%	163,907	20%[(b)]	20%	6,556
Earthenware pottery	39,377	70%	27,564	17%[(a)]	25%	1,171
Cement	832,719	70%	582,903	18%[(c)]	25%	25,502
Others	7,469,367	70%	5,228,557	17%[(a)]	25%	222,214

(References: (a) ABB- Espanha, (b) CCE- Estudo Sectorial, 1995; (c) ISR – Universidade de Coimbra)

Some of the average savings presented for the subsectors do not correspond precisely to the obtained values in the referenced projects, once they are reduced or by the perception that they are anomalous, or exceptionable, not being representative for the subsector average. More credible values have therefore been created based on a comparison with other subsectors.

We estimate that 444,710 MWh/year could be saved in an actual consumption universe of approximately 12,334 GWh/year. Then, we obtain a reduction of 3.6% in the national perspective of total electric consumption in industry, that is equivalent to a saving of about 5% relatively to the motive power consumption - a value that corresponds to five billions and three hundred millions PTE (with a basis price of 12 PTE/kWh).

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COMMENT ON THE PARTICIPATION IN THE GUIDEBOOK PROJECT (EE)

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The Regional Energy Centre (REC) of Viljandi participated as a “sleeping” partner in the project team for "A European Ex-post Evaluation Guidebook for DSM and EE Services - Phase II". As a sleeping partner, the REC did not test the guidebook methodology on a case example but instead participated actively in the project meetings and the review of the project material prepared by the team including the guidebook itself. The information that this effort provided was used in the daily work of the REC. In this way the collaboration in this project was welcome opportunity to obtain evaluation know-how and experience.

The lack of ex-post evaluation projects is an acute problem in Estonia as in the other Baltic States. As a rule, all energy efficiency projects are evaluated before implementation, but feedback about real results is sparse. For example, do all applications from municipalities to obtain financing from the national Energy Saving Fund need to be evaluated by a regional energy centre. However, results after implementation are not compared with the estimates. Comparison of benefits and costs would help assess and improve the effectiveness of the projects.

It is not always clear which method is the most appropriate for a given project in need of evaluation. It is therefore very useful to learn from applied real-life examples as the illustrative cases presented in the guidebook. The guidebook helps generate ideas on to how evaluate different Estonian energy efficiency programmes. The selection of cases in the guidebook are very relevant seen from an Estonian perspective. An example, the case on “Improving the Heating System Balancing Services of Buildings” (Motiva, Finland) contains good ideas on how to approach yet weak homeowners associations and achieve a noticeable energy consumption decrease in residential buildings.

Ex-post evaluation is a good tool for determination of what kind of energy saving activities bring about true savings at a reasonable cost and what activities should be given higher priority in Estonia. Observance of the guidebook recommendations would thus consequently save money, which could be used for additional energy saving activities.

The participation of the REC of Viljandi offers a unique opportunity to introduce ex-post evaluation and the existence of an ex-post evaluation methodology guidebook to the staff of other RECs. The RECs will in turn be able to disseminate the concept and methodology of ex-post to local consultants, public organisations, and municipalities evaluation via different seminars and training arranged by the RECs. There is reason to hope that in this way ex-post evaluation will be used to a much greater extent in the future.

The energy efficiency problems facing all the Baltic States are similar. Specialists from Latvia and Lithuania would thus also stand to gain from the existence of this guidebook.

APPENDIX B:

FURTHER READING

CONTENTS

EVALUATION AND DSM/EE INFORMATION SEARCH ON THE INTERNET

When searching for information, the Internet is a powerful tool, however, it is also undiscriminating on quality.

Below you find some short descriptions and URLs. It is by far not comprehensive and only included for inspiration. Due to the dynamic nature of the Internet, the sites might have moved, the content changed, or the address closed since the publication of this guidebook. The Guidebook takes no responsibility for the content of these external sites. The European Commission does not endorse or sponsor these sites, is not necessarily affiliated to the organisations, and does not attest to the accuracy of the information given on these sites. The CORDIS and the EUROSTAT areas are exceptions.

GENERAL EVALUATION WEB-SITES

Over the last two decades, evaluation has become a major issue for academics, governmental and public organisations, and private businesses throughout the world. This has, however, resulted in a body of knowledge scattered across disciplines, professions, and countries. The following is a short presentation of evaluation bodies and journals.

A number of evaluation societies, associations and units exist on local, national international, and supra-national level. They encompass a variety of sectors, a.o. energy, but a lot of non-sector specific experiences can be drawn upon in general.

The **European Evaluation Society** (EES) was founded in the Hague in 1994. The first official board was elected in autumn 1995 and started its work in January 1996. The internet address for this society is http://www.europeanevaluation.org/.

The society´s primary goal is to promote theory, practice and utilisation of high quality evaluation especially, but not exclusively, within the European countries. This goal is obtained by bringing together academics and practicians from all over Europe and from any professional sector, thus creating a forum where all participants can benefit from the co-operation and bridge building.

Examples (some not available in English) of other evaluation societies are:

- American Evaluation Association http://www.eval.org/
- Canadian Evaluation Society http://www.evaluationcanada.ca/
- Danish Evaluation Society http://www.danskevalueringsselskab.dk
- German Evaluation Society http://www.degeval.de/degeval.htm
- Italian Evaluation Society http://www.valutazione.it
- French Evaluation Society http://www.sfe.asso.fr
- The UK Evaluation Society http://www.evaluation.org.uk/ (where it is possible to post an evaluation-related question on their noticeboard)
- OECD - Public Management and Governance (PUMA) http://www.oecd.org/puma/index.htm
- The World Bank Operations Evaluations Department http://wbln0018.worldbank.org/oed/oedevent.nsf/htmlmedia/Interhome.html
- UNDP Evaluation Office http://www.undp.org/eo/

- Electronic Resources for Evaluators: http://it.usu.edu/itrs/AEA/index.html

A number of journals are devoted to evaluation, some are thematic others inter-disciplinary.

Evaluation and Program Planning http://www.elsevier.com/inca/publications/store/5/9/3/ is based on the principle that the techniques and methods of evaluation and planning transcend the boundaries of specific fields and that relevant contributions to these areas come from people representing many different positions, intellectual traditions, and interests. In order to further the development of evaluation and planning, Elsevier Science publishes articles from the private and public sectors in a wide range of areas. The primary goals of the journal are to assist evaluators and planners in improving the practice of their professions, to develop their skills and to improve their knowledge base.

Evaluation: The International Journal of Theory, Research and Practice publishes original evaluation research, both theoretical and empirical, as well as reviews of relevant literature and overviews of developments in evaluation policy and practice. http://www.sagepub.co.uk/frame.html?http://www.sagepub.co.uk/journals/details/j0137.html

New Directions for Evaluation, http://www.josseybass.com/ JBJournals/nde.html. A quarterly journal where each edition is a collection of articles focused on a topic of current interest to evaluators and their clients.

WEB-SITES WITH INFORMATION ON ENERGY EFFICIENCY AND DSM

The **World Energy Council** (WEC) is a global multi-energy organisation. It has committees and activities in approximately 100 countries, including most of the largest energy producing and consuming countries in the world. The Mission of the WEC is to promote the sustainable supply and use of all forms of energy for the benefit of all. http://www.worldenergy.org is their URL address. The site contains technical papers on energy efficiency and a database on GHG reduction projects where a major category is energy efficiency. The publication Energy Efficiency Policies and Indicators (1998) can be found at
http://www.worldenergy.org/wec-geis/global/downloads/1998Report.pdf.

The activities of the **International Energy Agency** (IEA) intended to assist member countries in monitoring and improving their present energy efficiency policies in identifying and exploiting new opportunities for improving energy efficiency. The energy efficiency work is initiated, discussed, and supported by the Energy Efficiency Working Party of the IEA, which can be found under http://www.iea.org/ select Energy Efficiency. A major part of the energy efficiency activity of IEA is in the CADDET's sphere.

The International Energy Agency **Demand-Side Management Programme** - http://dsm.iea.org works to clarify and promote opportunities for DSM, including load management and strategic conservation. The objective is for DSM technologies to reach their full market potential; to stimulate energy systems to function more efficiently whilst adding value to the energy system investment for gas and electricity customers.

The activity of the **CADDET** Energy Efficiency http://www.caddet-ee.org is analysis and dissemination of information on demonstrated new energy efficiency technologies. Register database containing demonstrated energy efficiency projects, analysis reports, workshop reports, maxi brochures, technical brochures, and newsletters are available on-line. The Website also provides an electronic news service. The **link section** http://www.caddet-ee.org/links/home.htm of the website contains links to a total of 200 other relevant websites of organisations specialising in energy-efficiency technologies. To help you browse through the list, the links have been sorted according to energy supply/end-use technology, and include short descriptions.

The **Greenhouse Gas Technology** links section, http://www.greentie.org/links/gr_links.htm, of the Greentie website contains links to a total of 200 other relevant websites of organisations specialising in greenhouse gas mitigating technologies. To help you browse through the list, the links have been sorted according to energy supply/end-use technology, and include short descriptions.

The **Energy Efficiency Toolkit** of the CADDET Energy Efficiency website contains links to all sorts of energy efficiency related tools, such as databases, decision support tools, fact sheets, conversion tables, calculation programmes, analysis tools, etc. You can find the Toolkit at http://www.caddet-ee.org/ee_tools.htm.

The **OECD** has, in co-operation with the **European Commission**, prepared a database on the use of **environmentally related taxes** in Member countries. The database provides detailed information on tax-bases, tax rates, exemptions to the taxes, refund mechanisms, the degree and purpose of earmarking of revenues, etc. More information: www.oecd.org/env/policies/taxes/index.htm.

The **Intergovernmental Pannel on Climate Change** (IPCC) - http://www.ipcc.ch has the role to assess the scientific, technical and socio-economic information relevant for the understanding of the risk of human-induced climate change. The IPCC produces reports, technical papers, guidelines and methodologies, and supporting material. The reports are published commercially and are available from publishers or leading bookshops.

The **World Energy Efficiency Association** (WEEA) was founded in June 1993 as a private, non-profit organisation composed of developed and developing country institutions and individuals charged with increasing energy efficiency. WEEA has been formed to (1) serve as a clearinghouse for information on energy efficiency programs, technologies, and measures, (2) disseminate this information world-wide, and (3) publicise international co-operation efforts in energy efficiency. http://www.weea.org gives access to the Technical Library, a collection of reports made available to the World Energy Efficiency Association for electronic dissemination. The goal of this ongoing effort is to provide access to high-quality, full-text technical reports on energy efficiency in a variety of file formats. The site also contains international directories on energy efficiency institutions and energy service companies.

EPRI (Electrical Power Research Institute, USA) is a non-profit organisation, focusing on knowledge, tools, and expertise to help build competitive advantage and address environmental challenges. Participation in EPRI's program is open to all organisations involved in the energy industry throughout the world. EPRI has developed over 6,000 hardware, software, and information products that can be purchased individually. http://www.epri.com/

The **World Business Council for Sustainable Development** (WBCSD) is a coalition of some 140 international companies united by a shared commitment to sustainable development, i.e. environmental protection, social equity, and economic growth. One initiative of the WBCSD is in the electricity sector, see http://www.wbcsd.org/sectoral/electricity/index.htm.

The following three British links contain useful information on energy efficiency and links to further web-sites: http://www.est.org.uk, http://www.dti.gov.uk/energy/index.htm, and http://www.energy-efficiency.gov.uk

CONFERENCES AND PROCEEDINGS

When searching for inspiration and information about evaluation of DSM and energy efficiency programmes, conferences are evident sources. They provide state of the art information on their respective subjects as well as ideal circumstances for networking and establishing contacts with other experts to share experiences.

Most conferences offer documentation on the subjects in the form of conference papers or proceedings.

The following examples of conference proceedings are only intended to be illustrative of the vast information available.

- SAVE Conference *For An Energy Efficient Millennium* Proceedings Volume I & II, and Supplement Backgrounds & Results, Energieverwertungsagentur, Vienna, 2000.
- International Energy Program Conference. *Evaluation in Transition: Working in a Competitive Energy Industry Environment*. Proceedings 1999 (CD-ROM).
- International Energy Program Conference. *The Future of Energy Markets: Evaluation in a Changing Environment*. Proceedings 1997 (CD-ROM).
- Book of papers, ECEEE conference 1997, Spinleruv Mlyn 1997.
- Proceedings of the 1993 ECEEE Summer Study: The Energy Efficiency Challenge for Europe, Volume I & II, Oslo, 1993. R. Ling and H. Wilhite (eds.).
- DA/DSM 94 Europe. Distribution Automation & Demand Side Management Conference Papers Book I (Keynote session, Distribution Automation, Demand Side Management) & Book II (Information Technology, Special Issues, Case Studies), PenWell Conference & Exhibition.

Examples of recommended upcoming conferences:

- ECEEE Summer Study, June 11-16, 2001, Mandelieu, France – http://www.eceee.org/Summer/summer.html
- International Energy Program Evaluation Conference, August 21-24, 2001, Salt Lake City, Utah - http://www.iepec.org

BIBLIOGRAPHIC SUMMARIES

REALISTIC EVALUATION

Author(s):	Pawson, R. and N. Tilley
Time:	1997

- Programmes have an impact through the action of actors, which receive arguments and resources. Success happens when the context is favourable. Programmes are not things that work. It is people that have reasons to act. The individual choices are often rational or at least sensible. The resources can be individual (skills, possibilities, knowledge, money) or social (what is legitimate, culture, structure).

- "CMO": Context + Mechanisms = Outcome. Description of CMO's can be the starting point of an evaluation. The CMO's can be refined throughout the process, e.g. with interviews with decision-makers and persons involved in the programme, as well as those who receive the results of the programme (e.g. audit, or information). The CMO's can also be a central part of the final result. CMO's can be regarded as "micro-theory".

- The evaluation should not only focus on average (or aggregated) impact. A large amount of information (about mechanisms) exists in the details, the winners and losers. If we do not understand why the programme was successful in one situation and not so in another – then we do not understand the programme.

GUIDELINES FOR DEFINING AND DOCUMENTING DATA ON COSTS OF POSSIBLE ENVIRONMENTAL PROTECTION MEASURES

Author(s):	I. Marlowe, K. King, R. Boyd, R. Bouscaren, and J. Pacyna
Time:	1999

These Guidelines are published by the **European Environment Agency** in order to promote good practice in the documenting and use of data on the costs of possible **environmental protection measures** in the context of international data comparisons.

Many users of such cost data have experienced problems when trying to compare data from different sources – in particular, data users do not always know whether comparisons are valid. For example, it is often not clear whether the data are comparable in term of:

- The *environmental protection measure(s)* described;
- The source(s) to which the measures are applied;
- The year(s) when data were valid;
- The method(s) by which data have been annualised, inflated or otherwise processed.

These Guidelines aim to establish a common framework and vocabulary for documenting and using data on the costs of possible *environmental protection measure*s.

The Guidelines are divided into two parts:

Part 1 contains a set of Guidelines on defining and documenting data for single *environmental protection measure*s. These Guidelines aim to define a minimum set of information, which will enable data users to understand the contexts in which data comparisons are valid or not valid. These Guidelines are aimed at the following people:

- Managers of technology databases – to help them to design or improve their databases.
- Authors of reports and other studies, which draw on cost data – to help them to document the raw data prior to any data processing or modelling.
- Originators of cost data, such as industrial installations, equipment suppliers and engineering consultants – to help them to provide the context for cost data.

Part 2 contains Guidelines on some key issues related to processing the raw data. These Guidelines are descriptions of various methods of data processing and contain suggestions for good practice for documentation in instances when these methods are used.

A number of previous guidelines from other organisations are reviewed in Appendix 2.

The following are minimal requirements. For further guidance and an extensive glossary please consult the report

Guideline 1

Pollutant definitions and assumptions regarding scope of pollutant categories should always be given wherever there is any possibility of ambiguity.

Guideline 2

Sufficient detail of the pollution source should be given to enable comparison with similar processes and to avoid ambiguity. It is recommended that published source sector classifications should be used wherever possible.

Guideline 3

Sufficient detail of the environmental protection measure should be given to avoid ambiguity, to define its performance characteristics, and to clarify any special circumstances limiting applicability of the measure.

Guideline 4

It is essential that reported costs are defined: what is included, what is excluded, how they have been attributed or apportioned. It is recommended that costs are also explained in physical terms such as quantity of materials, and as unit prices.

Guideline 5

As a minimum, all data should have a background discussion of the key uncertainties related to the data.

Guideline 6

The year in which the following data apply should always be given:

- Cost data;
- Currency exchange rates;
- Data describing control technologies (efficiency, applicability) and process technologies;
- Emissions to the environment.

Guideline 7

The sources and origins of all data should be recorded as precisely as possible so that data may be traced at a later date if necessary.

Guideline 8

As a minimum, any discount/interest rates used should be recorded.

Guideline 9

If cost data are adjusted for inflation or changes in price through time, then the method used should be recorded and any index used should be recorded and referenced.

Guideline 10

If determining annual cost data, the approach, which has been used to derive the annual costs should be recorded, along with all underlying assumptions.

EVALUATION, VERIFICATION, AND PERFORMANCE MEASUREMENT OF ENERGY EFFICIENCY PROGRAMMES

Author(s):	D. Violette
Time:	Prepared for the International Energy Agency, April 25, 1996

RATIONALE FOR IMPLEMENTING AND EVALUATING ENERGY EFFICIENCY PROGRAMMES

The author presents several rationales for IEA members to implement energy efficiency programmes:

- Reduce energy costs and improve quality of life for customers.
- Improve the overall economic competitiveness of the country.
- Enhance export of energy efficiency services, skills and products to the international community, especially to those countries facing environmental problems and needing to address the economic competitiveness of their industries.
- Improve local environmental conditions.
- Implement plans developed through the Framework Convention on Global Climate Change.

The overall rationale for performing evaluation of energy efficiency programmes is to “provide the information required by energy planners and policy makers to make good decisions regarding investments in energy efficiency programmes.” More specifically, evaluations can:

- Ensure that expected energy efficiency improvements are actually attained.
- Provide management with feedback on specific assumptions regarding energy use, measure effectiveness, etc.
- Improve programme performance through enhanced accountability. Evaluation “sends the right message” internally, helps to focus implementors on cost effective use of their time, and offers them feedback on how to improve their performance.
- Help to profile and describe programme participants and non-participants, so that the cost effectiveness of programme expenditures can be improved (e.g., through better targeting or better understanding of who participates and why).
- Identify market barriers to programmes and the technologies/products they promote.

Drivers for increasing the rigor with which IEA member countries conduct evaluations include the increased scrutiny of all public expenditures for cost-effectiveness, and the intensified interest in energy efficiency programmes from the international community to the extent that these programmes are part of a country’s formal plans to reduce greenhouse gas emissions.

Objectives of energy efficiency programme evaluations may include the estimation or assessment of:

- Energy reductions.
- Changes in energy service quality or reliability.

- Cost, programme delivery effectiveness, and customer satisfaction.
- Relative cost effectiveness of the programme compared to other options for addressing the same objectives.
- Greenhouse gas emissions reductions.
- Non-energy benefits and costs.

KEY TRENDS IN EVALUATION

For impact evaluation:

- An increased use of engineering estimation to lower the cost of estimating programme impacts
- A decline in the cost of metering and monitoring equipment
- Increased rigor in the performance of evaluations (better implementation)
- Increasing use of evaluation data collection during programme implementation.

For process evaluation:

- Increased integration of process evaluation with impact evaluation
- Increasingly *technical* process evaluations with regard to market assessment
- Increased emphasis on estimating market transformation and other indirect programme effects.

For evaluations in general:

- A shift in the types of methods employed as programmes mature.

The author presents general guidelines for conducting evaluations and then provides detailed case studies to illustrate the selection of methods, as summarised below.

GENERAL GUIDELINES FOR EVALUATION

Steps to an Evaluation

- Assess the availability and quality of data resources.
- Define the evaluation method(s) to be used.
- Determine additional data that are required.
- Collect necessary data.
- Conduct data analyses.
- Compile and report study results.

Planning

Quality of data may be maximised and data collection costs minimised if evaluation needs are incorporated into programme design and key evaluation data are collected during programme implementation. For example, implementors can collect data on equipment replaced and on which meters are affected. They can inform metering staff about the timing and location of measures that will soon be installed so that pre-installation meter readings can be taken. However, it is important to examine the incentives and goals of implementation staff, to ensure that these activities are consistent with their self-interest. Focusing incentives on verifiable savings (rather than number of measures installed or number of participants) can help align implementor self-interest with the goals of the evaluation and the overall programme.

Tracking systems for the programme should capture at least key parameters that can be used to estimate programme impacts, and it is preferable that they generate an impact estimate for each installation (which later evaluation would confirm or refine). Generating impact estimates from the tracking system can help to target programme implementation, by indicating market segments (business types, geographic areas, etc.) that are resulting in the largest per-installation impacts. Such estimates can also serve as inputs to statistical models (e.g., in statistically adjusted engineering estimation methods) and help improve the efficiency of evaluation sampling strategies.

CASE STUDIES OF EVALUATION APPROACHES

Case Study: Commercial Lighting Programme

Programme description — Replacement of inefficient lighting equipment with high-efficiency equipment at facilities of existing customers

Tracking system — Assume the tracking system is collecting data on:

- Number of each type of lighting equipment installed
- Installation data
- Location of installation, including account number (meter affected)
- Preliminary estimate of impact for each installation, based on the engineering algorithm: Estimate of kWh impacts = ($WATTS_{before}$ - $WATTS_{after}$) X (operating hours) X (number of fixtures).

Impact evaluation options:

- Simple engineering methods using actual participant data — No on-site data are collected, but participant/installation-specific data (from programme application forms or the self-reports collected from participants in telephone/mail surveys) serve as inputs into the engineering algorithm. Provides an estimate of gross savings. This method is useful for programmes having a low number of participants, low savings, and/or in their start-up year — i.e., situations in which more rigorous evaluation methods would not be cost effective.
- Enhanced engineering estimates — On-site visits are used to gather detailed information on a random sample of participating customers, so that better estimates can be made for specific impact parameters (e.g., operating hours for affected lights, changes in lighting service levels, interactive effects of lighting modifications on heating and cooling system energy use). More sophisticated engineering algorithms/simulation models can then be used. The savings estimate of the rigorously analysed sample is then compared to the estimate produced by the tracking system (or simple engineering method above), so that a "realisation rate" (more sophisticated estimate as a percentage of the tracking system savings estimate) can be determined. This realisation rate is then applied to the entire population in the tracking system, to estimate programme savings.[1]
- Billing analysis — If impacts are expected to be larger than about 10% of the customers' bills, these impacts should be observable in customers' energy bills. Bills before and after the efficiency retrofit are compared and normalised to account for changes in weather. Bills of a sample of non-participants are similarly analysed and the results are compared to those of participants, to account for changes in consumption common to all customers.

[1] Issues of the randomness of the sample and heterogeneity of the participant population must be accounted for.

- Multivariate billing analysis — If bill savings are a substantial percentage of the energy bill, a more rigorous billing analysis approach can be applied. The multivariate billing analysis uses customer survey data to build statistical models with variables that account for non-programme factors affecting energy use (e.g., plant expansion, increases in production, changes in staffing or operations, building remodelling, or financial performance). Regression equations are developed so that the changes in energy use associated with the programme-induced retrofit can be isolated from other changes in energy use.

- Metering and monitoring — Metering and monitoring can provide excellent information about selected impact parameters, and also can be used in estimating changes in demand. Possible options include the metering of a sample of affected lighting circuits before and after installation of the efficient equipment, run-time metering to collect data on hours of use, and pre- and post-installation kW measurements to estimate demand the programme's impacts. The use of metering to estimate measure impacts is limited if no pre-installation metering is possible (e.g., if programme staff are not notified prior to measure installation).

- Combination approaches and leveraged data approaches

  - Statistically adjusted engineering methods —The outputs of engineering models can be used as inputs to statistical models in statistically adjusted engineering analyses. In a typical usage of this approach, a regression model is used to estimate changes in energy usage as a function of engineering model estimate of the impact, facility characteristics, and certain behavioural attributes. The regression model produces realisation rates that can be applied to the total tracking system population as a measure of the percentage of expected savings "that can be verified with a given degree of confidence."

  - Ratio estimation methods — A ratio estimation method can leverage the use of costly but valuable site-specific data. In such an approach metered data for a small sample (e.g., 25 sites) is combined with both detailed engineering study results for a larger sample (e.g., 75 sites) and survey and billing data for large samples of participants and non-participants. (The author refers the reader to discussions of this technique in reports authored by Violette and Hanser (1991) and Buller, et al. (1993).[2]

Case Study: Residential Informational Audit Programme

Programme description — An on-site audit of a home reviews the customer's appliance holdings and energy usage and makes recommendations for cost-effective energy efficiency activities such as installation of efficient equipment or changes in energy-using behaviour.

Tracking system — Assume the tracking system is collecting data on:

- Customer identification (account number)

- Equipment holdings such as appliances, HVAC system type and size, efficiency of energy-using equipment, other energy-using devices, etc.)

- Behavioural characteristics, such as patterns of use (time and duration) for energy-using equipment, thermostat setpoints, number of people home and time periods when they are home

- Auditor recommendations (e.g., replacement of incandescent bulbs with CFLs, cleaning of furnace filter, weather-stripping, etc.)

- Customer reports on intended actions to be taken as a result of the audit

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[2] See (1) Daniel Violette and Philip Hanser, "Utilizing Information from Multiple Sources of DSM Impact Evaluation," *Proceedings of the 5th National Demand-Side Conference,* Boston, MA, July 1991, EPRI CU-7394; and (2) Susan Buller et al., "Combining Monitoring, Engineering Analysis and Billing Analysis to Evaluate PG&E's Commercial/Industrial Retrofit Programme," *Proceedings of the 1993 International Energy Programme Evaluation Conference,* Chicago, IL, August 25-27, 1993, CONF-930842.

- Estimate of impacts for each recommended measure

To determine what actions were actually taken by participants, a brief mail survey to a large sample of participants and on-site surveys with a smaller sample of participants can form the basis for a three-tiered nested sample analysis (on-site survey estimate, mail survey estimate, and tracking system estimate).

Impact evaluation options:

- Enhanced engineering methods of using actual participant data — Results of customer surveys are used to adjust engineering estimates from audit recommendations (details such as number and location of measures installed).

- Billing analysis — If substantial impacts relative to energy use (>about 10%) are expected, billing analysis can be useful in estimating energy impacts of the programme, using the same approach as with commercial lighting. Pre- and post-*installation* (time of audit recommendation being implemented , not time of audit) billing data are compared and normalised to account for weather-driven energy usage differences between the billing periods, for participants and (optionally) non-participants. Changes among non-participants in energy usage between the pre- and post-installation periods represent the natural change that would have happened to participants had they not participated in the programme.[3]

- Multivariate billing analysis — If additional data can be collected from participants (and, optionally, non-participants), regression billing analysis can be conducted, to control for confounding effects (e.g., changes in occupancy or usage of equipment).

- Metering and monitoring — As a supplement to the enhanced engineering methods described above, spot monitoring of selected measures can increase the accuracy of engineering estimates of measure impacts. Examples of monitoring targets include attachment of run-time monitors to affected lighting circuits, measuring water flow rates on faucets and showerheads, or conducting blower-door tests, to address lighting, low-flow faucet aerators/showerheads, and infiltration measures, respectively. On-site visits are required, at least for a sample of participants.

Case Study: Government/Industry Partnership Programme

Programme description: Government negotiates Long-Term Agreements (LTA) with industry to improve energy efficiency.

Tracking system: Data available may include audit results, such as an inventory of equipment, details of how energy is used, and identification of cost-effective energy efficiency measures.

Impact evaluation options:

- Detailed engineering analyses — Impacts estimates are based on engineering models and calculations, using site-specific data and spot monitoring of the loads of energy-using equipment. Annual or biannual updates take into account persistence of savings and process changes.

- End-use metering — If expected savings are very large and/or if the plant has existing submetering on specific processes, end-use metering may be a viable option. Estimates of savings associated with specific processes or end uses (motor drives, air handling, lighting, etc.) can be generated by measuring the changes in energy usage of these activities with end-use meters. It is very important, however, to adjust savings estimates for non-programme factors such as changes in environmental requirements leading to process changes, changes in the production process due to changes in market/marketing strategies, or other events.

- Use of an energy use metric — In negotiating the Long-Term Agreement, a reduction in energy use per unit of production or some other metric may be specified. Baseline values are measured/estimated (e.g., using metering

[3] Author's Note: Self-selection bias would have to be accounted for.

and engineering calculations) and then recalculated periodically. Calculations are subject to review by the government.

The LTA negotiation generally includes the evaluation activities, so that the evaluation process is similar to verification protocols negotiated between energy service companies and their business clients.

Case Study: Market Transformation Programme

Programme description: Inducements are provided to lighting equipment manufacturers to produce new products of higher quality. The government works with manufacturers to develop specifications for the product and with purchaser groups to ensure the existence of a market for the final product.

Evaluation strategy: Develop detailed information on customer groups and competitors, and use that information to make judgements about market response to the programme. Key to the analysis is identification of the aspect of the market targeted for change, including its baseline conditions and future baseline (without-programme) conditions.

Impact evaluation options:

- Market baseline study — This research, often conducted during the planning stages of the programme, sets the baseline for the programme and can determine where programme efforts might have the greatest leverage in moving the market. Therefore, an "exploration of the vertical market structure from manufacturer to end-user provides insight into which areas of the product distribution cycle are most receptive to programme efforts." The research may include:

  - "Characterisation of the product value chain
  - Identification of the key actors along the product value chain
  - Characterising the various market segments
  - Documenting product efficiency and availability
  - Studying manufacturer behaviour
  - Assessing the quality and content of available industry sales data."

  Data sources for this information include:

  - "Interviews with representatives of manufacturers, distributors, retailers, and contractors
  - Various statistical resources, including manufacturers sales reports, government reports, or private data series
  - Interviews with key customers
  - Review of trade, academic or professional literature, or
  - Review of business data sources such as product catalogues, price lists, and product reports."

- Trade ally interviews and focus groups — The purpose of this method is to gain an understanding of common practice with regard to the targeted measure/product, as well as how the distribution process works. As with the market baseline study above, baseline perceptions/practices are documented and compared to later research with the same groups. Conducting similar research with trade allies in non-programme areas allows an assessment of the natural change occurring in the market (i.e., without the programme).

- Sales tracking studies — Tracking sales information provides the evaluator with accurate information on the distribution of various types and efficiencies of products at specific points in time. Comparison of these data with data from a non-programme area allows estimation of natural change occurring in the market. These non-programme area sales data can be obtained by negotiating with manufacturing associations, or "by tracking and integrating existing sales data from disparate source."

Steps to obtaining sales data from manufacturers/trade associations include the following:

- "Assess the content, format and quality of data currently collected."
- "Assess whether tabulations by efficiency *and* region are possible under current data collection procedures."
- "Identify issues that would need to be negotiated with the association prior to release of further data."
- "Formulate a work plan for developing the system."

Key issues to address in building a sales tracking system through integrating existing sales data from multiple sources include the following:

- "Recruitment of participating retailers."
- "Appropriate sampling of retailers."
- "Standardisation of reporting format."

- Customer equipment surveys — Periodic surveys with customers interested in purchasing lighting equipment can provide data on what equipment is being installed, how it is being used, what equipment is being replaced, and what equipment would have been installed had there been no programme. This research augments sales data studies, to provide a more comprehensive picture of how the market is responding to a programme.

MARKET VERSUS CONSUMER-SPECIFIC EVALUATIONS

Market-directed programmes (e.g., market transformation programmes) require a different focus than consumer-directed programmes (such as consumer rebates for specific products, audit programmes, facility retrofit programmes). One key difference is that consumer-directed programmes typically identify programme participants as part of the programme, while market-directed programmes may not (since they are focused on transforming an entire market rather than the purchase decision or practice of individual customers). Evaluation data required for these different programme types must also differ.

Examples of market evaluation data requirements:

- Changes among manufacturers with regard to:
  - Product lines, including design improvements, changes in the number of models offered, etc.) and manufacturer reports on attribution of these changes to the programme
  - Prices and product discounting
  - Labelling of energy efficiency characteristics
- Changes among dealers, distributors, and contractors with regard to stocking practices, pricing, promotion or enhanced services.
- Estimates of how the market would have evolved without the programme (future baseline):
  - Self reports of manufacturers, and other market actors

- Analysis of recent industry trends
- Understanding of industry structure and roles of various market actors in influencing the targeted purchase decision or practice
- Analysis of non-programme factors (e.g., health of the economy, technical innovations, etc.)

Methods for collecting these data, as mentioned above, include market baseline studies, annual interviews/focus groups with key market actors, and sales tracking and other market studies. Market evaluations can sometimes benefit from collection of consumer-specific data, to ensure that installation assumptions are accurate[4] and to address failings in available sales data.

Examples of consumer-specific data requirements:

- Billing data;
- End-use metered data;
- Site data (building and equipment characteristics);
- Survey data;
- Programme tracking data.

PROCESS EVALUATIONS

The authors present a brief description of the purpose and research options associated with process evaluations.

The purpose of process evaluations is to assess the overall effectiveness of the programme, provide feedback on performance to decision-makers, and guide future programme refinements and development. Topics to address (for a lighting programme evaluation) might include:

- Delivery mechanisms
- Customer satisfaction with programme and programme components
- Barrier to programme penetration
- Effectiveness of marketing materials
- Market penetration levels
- Market segmentation profiles of participants and non-participants

Research options include a review of programme documentation, an analysis of the programme data base/tracking system, in-person interviews, focus groups, site visits, and customer surveys.

[4] Targeted equipment might not actually be installed or may be installed in a different location than assumed. Manufacturer energy ratings may be inaccurate; assumptions about the efficiency of replaced equipment may be wrong.

BASIC IMPACT EVALUATION APPROACHES

General Observations

- "The programme tracking system is the foundation of the evaluation process."
- "Common reasons to conduct on-site surveys are to provide the data inputs for building simulations for a site, to estimate measure persistence . . . or to estimate site-specific energy-usage behaviour."
- Problems in using end-use metering to estimate programme impacts include the following:
  - It is expensive and sample sizes must therefore be small.
  - Improving the estimation of programme impacts generally requires both pre- and post-measurements, and it is often difficult to identify participants before they install programme measures.
  - Due to (1) the need to pre-identify participants, (2) the need to gain customer permission for metering, and (3) technical difficulties which make metering impractical at some sites, obtaining pre-/post-installation metering samples that are representative of the participant population can be difficult.

Approaches

- Engineering methods are typically of two types — engineering algorithms and engineering simulations. Common uses for engineering methods include the following:
  - "Engineering estimates may be used to provide independent, stand-alone estimates of programme impacts. . . As a primary evaluation methodology, however, [they must] be benchmarked against forecast and load research data and subjected to a regular and ongoing programme of verification and refinement using billing data analyses and end-use metering studies."
  - "Engineering estimates may serve as a backup to and a means of verification of statistical methods."
  - "Engineering methods are sometimes the most cost-effective method . . . when the value of information does not justify more expensive evaluation approaches."
  - "Engineering methods can provide time differentiation of impacts."
  - "Engineering approaches can estimate savings for all fuels, even if billing data is not available."
  - "Engineering methods can offer measure-specific resolution of impacts . . . [allocating] savings to individual measures or groups of measures including interactive effects."
- Statistical methods include:
  - Basic statistical methods (billing analysis), which may be misleading and can have hidden complexities, but which are typically inexpensive and use data that are usually readily available.
  - Multivariate statistical methods, which better isolate programme impacts from those of other non-programme factors. Typically, these approaches use regression methods (such as conditional demand analysis models and statistically adjusted engineering models) or discrete choice models (which control for systematic differences between participants and non-participants). One trend has been the use of two-equation models — one to model the decision to participate in the programme and one to estimate the change in energy use, holding constant those factors that influence participation.

PRACTICAL ISSUES TO ADDRESS WHEN PLANNING, IMPLEMENTING, AND REVIEWING PROGRAMME EVALUATIONS

The author address several key practical issues associated with the actual practice of evaluation.

Tracking System Data Quality

Typical problems are inaccurate account numbers (so that linkage to billing records is not possible), records that are missing key data, data entry errors, and omission of measure costs. These problems are caused by failure to collect needed information on programme application forms, poor or non-existent data quality procedures, and inadequate skills or training of staff collecting or entering programme data. The problems result in an inaccurate picture of the programme's success and programme impacts. They can be resolved by having programme data quality assurance plans and reporting on data quality control in evaluation reports.

Estimating Net Programme Impacts

Net programme impacts are the difference between gross impacts (the measured/estimated change in participant energy use) and the programme baseline (what would have happened in the absence of the programme). There are two main methods of estimating programme impacts — comparing the change in energy use of participants with the change in energy use of a "control group" (e.g., consumers not aware of or not offered the programme), or estimating free ridership through surveys. However, finding a group that is similar to participating customers in every respect except for participation in the programme is very difficult, even more so as more and more DSM programmes are implemented. Also, if non-participants are used as the control group, there is a danger in over- or under-estimating savings because those who choose (or select themselves) to participate may be systematically different from those who do not (e.g., their attitudes/beliefs may be more favourable to taking conservation actions, even if no programme existed). This problem is addressed by estimating a discrete choice model of programme participation and a separate multivariate regression model of energy savings.

Impact Evaluation Accuracy

Increasing precision in impact estimates usually increases evaluation costs, due to the need for more surveys and/or more observations in the sample. Two important questions related to accuracy are as follows:

- How does one provide information on accuracy? Typically, one can calculate levels of precision for specified confidence intervals and/or one can illustrate the robustness of impact results by showing how reasonable changes in impact model structure and approach change the impact estimate.

- What is a good target for accuracy? The accuracy target must vary depending on the expected level of savings. The bigger the expected percentage of savings the easier it will be to hit the target precision. However, the targets may not be achieved.[5] The U.S. Environmental Protection Agency guideline for impact evaluation accuracy is a minimum 75% confidence level.. Because decisions about the level of accuracy affect the cost of evaluation, an option is to set the accuracy target for the lower bound estimate of savings. For example, the same results indicating that there is an 80% probability that actual impacts fall between 900 kWh and 1,100 kWh (80% plus or minus 10%) also means that there is a 90% probability that the actual impacts are greater than 900 kWh. "Targeting higher precision for high percentage savings programmes and lower precision for programmes with lower savings may be the most efficient approach."

Persistence of Efficiency Impacts

The author provides sample persistence estimates used by a U.S. utility company for several residential multi-family retrofit programme measures, to illustrate that persistence varies by measure and by sector. Persistence of savings

[5] The author provides the following example: "If impacts are expected to be 1,000 units per consumer, then a targeted precision of 20% means that the allowable tolerance is ± 200 units. If actual programme savings are less than 1,000 units, e.g., are 600 units per consumer, then even if the experimental design achieves the target tolerance of ± 200 units the resulting precision will be ± 33% instead of the expected ± 20%."

can be expensive to measure. Decision must be made with regard to (1) the appropriate methodology to use (verification inspections, billing analysis, , and the frequency of the studies (annually, biannually, etc.). The author recommends that follow-up persistence studies “be carried out for at least 3 years, and probably for no more than 10 years . . . the time horizon . . . can vary by measure-type and programme, depending on such factors as the expected measure lifetimes.”

Separation of Programme Evaluation and Implementation Functions

The author provides advantages and disadvantages of having implementors involved in evaluation. Blending the two functions (1) is likely to provide greater accuracy and lower evaluation costs, (2) suggests the use of an outside audit of the evaluation process, as a check against lack of objectivity, and (3) requires the implementor to identify with, accept responsibility for, and be an active participant in the evaluation.

Evaluation Reporting

The author provides the following guidelines for reporting evaluation results:

- Provide the context for the evaluation — programme description (programme history, goals, significant design features, energy efficiency measures promoted, target markets, performance to date, issues from previous evaluations), and the objectives and scope of the evaluation
- Describe the sources of data and sample strategies/sizes, including the data collection instruments and protocols as appendices.
- Describe methods used and the rationale for selecting them, including:
- assumptions, caveats, and limitations of results
- selection criteria
- major steps in the analysis, including the type of analysis and the calculations
- Indicate programme performance relating to each objective of the evaluation, the accuracy of the estimate (at least subjective, if not a statistical measure of confidence), biases or limitations that should be considered in using the results
- Present conclusions.

The author presents a detailed discussion on accuracy calculations as an appendix.

EVALUATING ENERGY-EFFICIENCY PROGRAMMES IN A RESTRUCTURED INDUSTRY ENVIRONMENT: A HANDBOOK FOR PUC STAFF

Author(s):	J. Schlegel, M. Goldberg, J. Raab, R. Prahl, M. Keneipp, and D. Violette
Time:	Prepared for the National Association of Regulatory Utility Commissioners, April 1997.

Purpose: "To assist state regulators and staff in their oversight and review of energy-efficiency programme evaluation activities and reports" and "to assist regulators in planning for evaluation of energy-efficiency programmes in an environment of ongoing utility industry restructuring."

Scope: Addresses three types of energy efficiency efforts likely to exist in "the new industry environment" which will be regulated to some degree and for at least some period of time:

- Public purpose wires charge (systems benefits) energy efficiency activities;
- Least-cost distribution system investments;
- Least-cost transmission system investments.

"The role of programme evaluation will be determined only when the role of energy efficiency is decided."

The authors provide historical information about the U.S. utility industry and conjectures about the future of DSM. The future, they say, is likely to focus increasingly on "the need to try and intervene in markets only where necessary to reduce market barriers and correct market failures — with the need for a clear goal and strategy to turn those market segments over to the market as soon as possible." This implies information and market transformation programmes, as well as programmes to reach low-income populations. Funding: non-bypassable systems benefits charge, typically a few mils or less (per kWh sold). Three main options exist for who would administer and deliver the programmes: regulated utility (most likely a distribution utility); a non-profit or private, state-wide entity; or allowing distribution companies to bid against energy service companies.

If distribution utilities engage in DSM to defer distribution capacity investments, emphasis could be more on estimating gross rather than net savings. If they offer DSM as a customer service, there is probably no need for regulatory oversight at all.

Long-term effect of restructuring: Evaluations every two to three years, rather than every year; if performance incentives, lost revenues recovery mechanisms or both are abandoned, evaluation standards can be relaxed from the regulators' point of view.

The authors suggest methods for evaluating information and market transformation programmes.

EVALUATION OF INFORMATION PROGRAMMES

Issues:

- What must be documented?
  - Information had the desired effect on knowledge/attitudes
  - The changes led to increased adoption of energy efficiency measures or practices

- The measures/practices resulted in energy savings

The greatest uncertainty surrounds the first two items.

Methodological challenges:

- ➢ Difficult to identify "participants" (recipients of the information, and the intensity/duration of their exposure)

- ➢ Relationship between attitude and behaviour is complex; need to document knowledge/attitudes effects AND effects on behaviour.

- ➢ Information programmes may have very long lag times, making attribution very difficult 6 months to three years is most appropriate time frame).

- ➢ May be very difficult to sort out "other" influences.

Three approaches for evaluating information programmes:

- ➢ Direct analysis of consumption data — useful when participants can be easily identified, when savings are a substantial portion of consumption, and when there is not a long lag time before savings are apparent

- ➢ Self-reports from participants and market actors — useful when participants can be easily identified, survey respondents can reliably indicate whether they saw, heard, or read the information, when survey respondents can remember what action they took, and when respondents can state why they took action the degree to which it was because of the programme.

- ➢ Rigorous analysis of changes in attitudes and behaviours:

  - Major stages of the process:

    - ∗ Identify recipients of information and establish an experimental design. Use a comparison group (e.g., for audit programme). "Note that it is generally not appropriate to construct a comparison group based primarily on self-reports from market actors saying they haven't been exposed to the programme information . . . due to limitations on people's ability to recall their exposure to information, as well as the likelihood of systematic differences in this ability across sub-groups. If it is not possible to identify a non-participant group (e.g., for mass media advertising campaign), conduct repeated measures of the target population to assess the correlation of changes in attitudes/behaviour with changes in the level of programme effort.

    - ∗ Measure changes in attitudes and behaviour. It is important to comprehensively and reliably measure the baseline levels of key variables, "both those attitudes and behaviours that are the explicit focus of programme efforts, and other attitudes and behaviours that are relevant to energy efficiency but are not directly targeted by the programme." It may be advisable, for broad-based programmes targeting a wide range of attitudes/behaviours, to construct and validate indices to characterise the overall baseline.

    - ∗ Control for self-selection effects. " . . . people who are more aware of or more interested in energy efficiency issues (e.g., people who are already intending to install energy-efficiency measures) . . . [will be more likely] to more readily pursue the information being offered than the average recipient. For example, it is probably inappropriate to evaluate the impacts of an energy-efficiency hotline simply by comparing adoption rates and changes in consumption between those customers who called in and those who did not. Many customers who call in may already be planning to install an energy-efficiency measure, and only want either specific guidance or confirmation."

    - ∗ Develop ancillary evidence of energy and demand reductions. Examples of such evidence include the following:

a) "Hard evidence is presented, based on market research, that a programme addresses a specific market barrier to energy efficiency associated with either the knowledge or attitudes of market actors.

b) Market indicators change in the predicted order.

c) A correlation can be demonstrated between the intensity of a recipient's exposure to the offered information and changes in his or her behaviour.

d) Targeted market actors demonstrate behavioural changes of the specific type advocated by the programme, but not of other types."

* Document potential indirect programme effects and market transformation benefits. To address participant spill-over, analysts must take care to control for self-selection effects and may need to deal with spill-over effects that "may occur beyond the time frame covered by the analysis of direct impacts." In estimating non-participant spill-over, it may be difficult to isolate those information recipients who have received programme information from those who have not, and to also isolate market actors who have had significant contact with information recipients from those who have not. Documenting market transformation effects is more difficult for mass information programmes than for direct information programmes, due to difficulty in identifying information recipients and the nature, intensity and duration of their exposure to the information. For each of these types of effects, identifying suitable comparison groups can be very difficult task.

EVALUATION OF MARKET TRANSFORMATION PROGRAMMES

Challenges associated with evaluating market transformation programmes:

- "Markets are interactive.
- Markets are dynamic — e.g., they are constantly changing and evolving.
- For the most part, markets are regional and national in nature, rather than being organised at the level of utility service territories.
- Fundamental changes in the structure and functioning of markets may occur only slowly."

To claim that a market has been transformed, utilities must demonstrate the following:

- "There has been a change in the market that resulted in increases in the adoption and penetration of energy-efficient technologies and/or practices.
- That this change was due at least partially to a utility programme or initiative (based both on data and a logical explanation of the programme's strategic intervention and influence).
- That this change is lasting, or at least that it will last after the utility programme is scaled back or discontinued."

Establishing causality is a major challenge. There are two primary approaches to addressing this issue:

- Give up and focus on measuring the level of gross change in a market (rather than net change).
- Relax evidentiary standards regarding causality somewhat and provide at least qualitative evidence of causality, through quasi-experimental design and tracking of relevant market indicators, and using data collected from several different types of market actors. A causal relationship would be suggested "by the occurrence of predicted differences in market indicators between test and comparison areas, and by the fact that various market indicators showed changes in the order that would be predicted given the stated intent of the programme."

Meeting the challenges of market transformation evaluation:

- Define performance using several different metrics:
  - "Ultimate outcomes (energy and demand savings, product sales as a proxy for energy and demand savings, or market penetration)
  - Indicators of effects (indicators of lasting market effects and/or reductions in market barriers)
  - Effective and efficient performance of planned activities (good-faith implementation)."
- Define evaluation broadly. Evaluation of market transformation can have several purposes:
  - "Supporting the planning and design of the programmes and initiatives, including providing up-front market studies and baseline analyses
  - Providing corrective and constructive guidance regarding the implementation of market transformation initiatives
  - Providing indicators of the effectiveness of specific market transformation strategies and activities (e.g., by evaluating indicators of market effects and reductions in market barriers)
  - Assessing the overall level of performance and success of market transformation initiatives (both mid- and long-term)
  - Informing decisions regarding performance incentives provided to administrators (e.g., state-wide entities or distribution utilities) for market transformation activities."
- Focus on evaluating and assessing indicators of market effects. "Market effects are timely and observable, the utility has the ability to impact and observe them, the information collected can help improve the initiative in a timely manner, and often they can be used to develop or forecast estimates of market penetration and load impacts (for purposes of assessing ultimate outcomes)." For example, indicators that might be relevant to track for a commercial lighting remodelling initiative might include the following:
  - "Increased knowledge or awareness among specifiers, designers, and decision-makers
  - Existence and deployment of decision-making tools and structures which are likely to lead to efficient design and equipment installation, and which are being used on more jobs
  - More frequent recommendation or specification of efficient equipment and design
  - Increased application of efficient equipment or design
  - Attendance at and intent to implement training
  - Changes in the costs of efficient technologies and practices."

  Methods to collect these data might include interviews with vendors, contractors, and managers of targeted large firms, and walk-through surveys or plan reviews of samples of remodelled buildings.[6] This approach "can provide valuable interim directional guidance to initiative efforts between larger impact studies. In some cases, it may be easier to track impacts on specific markets through this type of approach rather than using aggregate sales data tracking."

[6] Based on *Opportunities for Market Transformation for Commercial Lighting Remodeling*, by F. Gordon and L. Tumidaj. Prepared for the Boston Edison DSM Settlement Board. Pacific Energy Associates, Portland, OR.

The authors speculate that "a utility claim of market effects is more likely to receive regulatory approval if it is supported by an assessment of the market, a description of key market barriers on which it focused its efforts, an evaluation of market effects that are likely to result of those barriers are reduced, and other links between observed market effects and reductions in market barriers. In contrast [the authors] believe regulators are less likely to approve a claim that consists solely of observed market effects."

- "Use an iterative process to document and provide support for estimates of market effects . . .
  - Begin with a hypothesis or logical basis for the market effect . . .
  - Assess whether the hypothesis is reasonable by collecting preliminary supporting evidence . . .
  - Design the evaluation to build on the preliminary information and supporting evidence . . .
  - Conduct the evaluation, focusing on the strongest hypotheses of market effects and reductions in market barriers . . .
  - Use the supporting evidence to corroborate the evaluation findings."

Types of data to be collected:

"The best strategy to follow in trying to evaluate market transformation effects is to develop predictions about which specific market indicators will change if the programme is successful, and then to track those indicators, using a quasi-experimental design, if feasible." It is also important to collect data from a variety of sources, including consumers, dealers, contractors, distributors and manufacturers.

The need for up-front market research:

"In order to learn how to transform energy efficiency markets, it is necessary to first develop a detailed understanding of how these markets currently function . . . [including] a specific theory about what market barriers are currently preventing customers from adopting cost-effective energy-efficiency measures on their own, as well as a testable hypothesis about how utility intervention can overcome these barriers. Second, to be able to later document the possible effects of utility intervention, it is necessary to first establish baseline conditions for those market indicators that are expected to be affected by the programme."

Documenting number of induced measures rather than unit savings:

"Regardless of the precision with which [per unit savings] is measured, in order to produce an overall estimate of programme savings, it must be multiplied by a more uncertain estimate of the number of induced measures." Therefore, compared to evaluations of other types of programmes, evaluation of market transformation programmes should allocate significantly more resources to establishing causal effects of the programme, and less to rigorously measure the average gross savings associated with each measure (e.g., through end-use metering or detailed building simulations).

Evaluation Spending:

Regarding evaluation spending, the authors argue that the level of spending, "as a percentage of total DSM spending," may need to increase, compared to evaluations of traditional DSM programmes. They also suggest shifting resources away from evaluation of traditional DSM programmes and toward market evaluations, especially where utility tracking system savings estimates for specific programmes/technologies have been shown to be more reliable. The timing of spending, they argue, should be shifted toward the front of the programme period to (1) develop market intelligence for programme targeting, (2) estimate baseline market conditions, (3) establish tracking systems and procedure for monitoring the conditions, and (4) develop new methods for integrating and analysing the data that is collected.

The authors suggest the use of market influence diagrams, to provide an overall understanding of market transformation initiatives, from planning through evaluation. They show one such tool developed by Eto et al, as shown in **Error! Unknown switch argument.**[7]. Exhibit **Error! Unknown switch argument.** presents a market influence diagram for commercial and industrial lighting incentive and information programme.

[7] *A Scoping Study on Energy Efficiency Market Transformation by California utility DSM Programmes,* by J. Eto, R. Prahl, and J. Schlegel.. Prepared for the California DSM Measurement Advisory Committee (CADMAC), 1996.. LBNL-39058. Lawrence Berkeley National Laboratory. Berkeley, CA.

ADVICE TO REGULATORS

Report authors Schlegel and Prahl make a number of general recommendations to regulators who are reviewing evaluation results and final reports. They discuss shortcomings of billing analysis impact evaluations, which they have reviewed, including problems regarding:

- Criteria for selecting billing analysis instead of other approaches.
- Poor experimental designs, "including treatment of self-selection effects and of both programme-related factors and exogenous effects".
- Degree to which participant and non-participant samples are matched.
- Improper methods for screening out specific data records.
- Failure to justify modelling choices ("including the logical and theoretical basis of the models chosen, the history of the modelling effort, and compliance with basic assumptions underlying regression modelling").
- "Misinterpretation of billing analysis results, including both the inappropriate use of hypothesis-testing approaches and the misapplication of realisation rates" (e.g., extrapolation of billing analysis realisation rates to broader population).
- Poor documentation of the evaluation effort.

They also offer advice to regulators on what to look for in the evaluations they receive, with regard to these issues, and suggest criteria for acceptability related to each issue.

The authors present a list of situations in which end-use metering is most useful:

- "Evaluation of gross savings . . .
- Estimation of coincident peak demand savings . . .
- Focused evaluation of large-impact facilities that are not well suited to statistical analysis
- Providing data for statistical analyses and combination approaches
- Technology evaluation . . .
- Addressing specific research issues, such as determining operating hours (hour loggers) or estimating interactive effects
- Joint utility projects where the relatively high costs can be spread across utilities."

The limitations and disadvantages of end-use metering are then also presented:

- Higher cost
- Smaller sample sizes and increased concern about sample attrition
- Need for customer permission/cooperation
- Possibility that customers will behave (i.e., use energy) differently if they know energy use is being monitored
- Due to long lead times typically needed, increased potential for difficulty in ensuring that sample is representative of population

- Difficulty in collecting pre-participation data
- Insufficient amounts of data
- Difficulty and expense of obtaining similar data for non-participant customers
- Seasonality of energy use relative to short duration metering efforts
- Interactions between measure installations and other energy-using systems they may affect (e.g., lighting and HVAC equipment)
- Adjusting for free-ridership and making other net-to-gross adjustments
- Decreased ability to show that it is the measures that are responsible for changes in energy use, due to lack of data on the behavioural and market impacts of programmes or technologies

SUGGESTIONS FOR EVALUATING CERTAIN TYPES OF TRADITIONAL DSM PROGRAMMES AND MEASURES

The authors offer general guidelines for applying evaluation strategies:

- "In general, billing analysis is most appropriate to programmes where the participant and measure characteristics follow normal statistical distributions (e.g., higher volume programmes with homogenous populations)
- A further general requirement for billing analysis is that the measure effect [be] large enough in relation to overall energy consumption to be discernible and not '‘lost in the noise.’
- Billing analyses typically address only energy impacts.
- Engineering methods can be accurate, but the accuracy of the method is a very strong function of the quality of the data used to produce the inputs to the methods.
- Except in certain case study applications, end-use metering is not an evaluation method; it is a data collection strategy [to supplement econometric or engineering methods]."

Other guidelines refer to the types of measures being evaluated:

- "As measures move from constant efficiency/constant load to variable efficiency/variable load, the analytic approach and data requirements become more challenging.
- For variable efficiency and/or variable load applications the preferred approach may be simulation modelling or pre-/post-installation metering.
- Envelope measures can be deceptively difficult to analyse and simple algorithmic methods are typically inadequate for these measures [due to the impact of these measures on HVAC systems operation].
- Some measures can be difficult to classify or may fall into one of several categories."

The primary strategies for data collection include field inspections, surveys, spot measurements (one-time measurements of instantaneous power draw), metering and monitoring, and billing data.

The primary analytical approaches include simple engineering methods, billing analysis, multivariate billing analysis, enhanced engineering estimates, metering and monitoring, and combination and leveraged data approaches.

Guidelines for Evaluating Common Programme Types

Retrofit and Equipment Replacement Programmes

(Standardised and customised rebates for efficient equipment and systems; financing programmes for efficiency improvement projects)

1. Energy-efficient lighting equipment programmes

Preferred approach is enhanced engineering estimates. Simple engineering algorithms are supplemented by simulation models (that account for the interaction between measures and energy-using systems) and on-site data collection (site-specific operating hours based on run-time hour monitoring). Segmentation by building type accounts for variations in operating schedules. Key evaluation issues:

- Number and type of equipment replaced
- Baseline wattages
- Interactive effects with HVAC systems (especially for commercial programmes)
- Seasonality of lighting energy use

Alternate approaches include simple engineering algorithms (with *assumed* wattages and operating hours) or billing analysis (if lighting is large fraction of total electricity usage and model can address customer variations such as size and business type).

2. Energy-efficient lighting controls programme

Preferred approach is to use simple engineering algorithms, supplemented by simulation models (such as DOE-2 to model daylighting controls) and on-site data collection (metering — e.g., for daylighting controls — and/or site-specific operating hours data by type of space use, to determine load patterns and variations). Load bin methods account for load variations. Segmentation by building type accounts for variations in operating schedules. Key evaluation issues:

- Variation in lighting equipment load (typically based on “engineering judgement”)
- Accurate data on wattage of controlled lights
- Interactive effects with HVAC systems (especially for commercial programmes)
- Seasonality of lighting energy use

Alternate approaches include simple engineering algorithms with estimated “savings factors” (with *assumed* percent savings) for controls or billing analysis (if lighting is large fraction of total electricity usage and model can address customer variations such as size and business type).

3. Energy-efficient motors programmes

Preferred approach is enhanced engineering estimates. Simple engineering algorithms are supplemented as needed by simulation models and on-site data collection (site-specific operating hours, end-use metering, and possibly other). On-site data needs for motors with constant efficiency/constant load include operating houses based on run-time monitoring; for variable efficiency and/or variable load motors, end-use metering is needed. Key evaluation issues:

- Assessing whether motor application is constant versus variable efficiency and load
- Operating hours and profiles

- Rated load factors
- Baseline efficiency
- Large installations may justify expense of on-site inspections and metering/monitoring.

Alternate approach is simple engineering algorithms (with *assumed* efficiencies, load characteristics and operating hours).

4. Energy-efficient motor controls programmes

Preferred approach is enhanced engineering estimates:

Engineering algorithms and load bin calculation supplemented as needed by metering/monitoring (to assess patterns and load variation), simulation modelling (such as DOE-2 to model system changes resulting in variable controls — e.g., conversion of air-handling systems to variable-air volume) and on-site data collection. Key evaluation issues:

- Assessing variation of motor load
- Accounting for efficiency variations among different motor loads

Alternate approach is simple engineering algorithms and estimated "savings factors" for controls.

5. High-efficiency air conditioning and heat pump programmes

Preferred approach is multivariate billing records analysis. Customer surveys are used to develop econometric models, with billing data normalised for weather. Statistically adjusted engineering estimate approaches can be used to leverage prior engineering estimates of impacts. Key evaluation issues:

- Performance characteristics of baseline equipment
- On-site inspections typically required, regardless of method
- Engineering analyses required to estimate demand impacts, when billing analysis approach is used.

Alternate approach is enhanced engineering estimates based on hourly building energy simulation models. This approach requires high-quality site-specific data on construction, operational, occupancy, and equipment characteristics.

6. Building envelope and weatherization programmes

Preferred approach is multivariate billing records analysis. Customer surveys are used to develop econometric models, with billing data normalised for weather. Statistically adjusted engineering estimate approaches can be used to leverage prior engineering estimates of impacts. Key evaluation issues:

- Magnitude of impacts may not be large enough to discern using billing records analysis.
- On-site inspections typically required, regardless of method
- Engineering analyses required to estimate demand impacts, when billing analysis approach is used.

Alternate approach is enhanced engineering estimates based on hourly building energy simulation models. This approach requires high-quality site-specific data on construction, operational, occupancy, and equipment characteristics.

New Construction, Renovation, and Remodelling Programmes (e.g., new home information, information and incentive, C/I information and design assistance, C/I design assistance and incentive,, and C/I design awards programmes)

1. New construction programmes

Preferred approach is combination (hybrid) and leveraged data approaches. Hybrid approaches typically use a mix of statistical methods, engineering, end-use metering supplemented with on-site data collection. Billing records are used to calibrate engineering estimates using post-participation data. Supplemental engineering analyses and metering are leveraged through combination approaches. Key evaluation issues:

- Estimating baseline design characteristics

- Collecting detailed on-site facility and systems data

Alternate approach is enhanced engineering estimates based on hourly building energy simulation models (such as DOE-2). This approach requires high-quality site-specific data on construction, operational, occupancy, and equipment characteristics.

2. Information and Education Programmes (seminars, training sessions, publications, technical assistance programmes)

Preferred approach is simple engineering methods — except where measure adoption is systematic (the same across numerous participants), or where large-scale or high-impact measures are adopted — using simple engineering algorithms and assumptions about key parameters. Key evaluation issues:

- Whether the *programme* is responsible for any measures adopted by the targeted customers

- Identifying the actions taken by programme "participants', including their type, quantity, operating characteristics, timing, etc.

Alternate approach is to use enhanced engineering estimates for systematic, large-scale or high-impact measure adoption. More detailed engineering models and the field data collection may be required and justified.

3. Audit Programmes (may promote a wide range of measures)

Preferred approach is simple engineering methods, based on simple engineering algorithms and assumptions about key parameters. Key evaluation issues:

- Identifying the actions taken by programme participants, including their type, quantity, operating characteristics, timing, etc.

- Some well-designed programmes may include sufficient post-audit follow-up data to justify more detailed analysis

Alternate approach is enhanced engineering estimates, where follow-up data indicate significant or systematic adoption of recommended measures. More detailed engineering models and the field data collection may be required and justified.

The authors end the report by defining and providing a brief discussion on a list of 20 evaluation-related terms and issues. Examples include:

- Accuracy, error, precision, and bias;
- Analysis approaches for estimates of average and totals;
- Collinearity;
- Free riders;
- Realisation rate;

- Sampling;
- Serial correlation;
- Spill-over, free drivers, market effects, and market transformation;
- Value of information.

APPENDIX: BILLING ANALYSIS ISSUES

The appendix to the report contains a discussion of problems the authors have observed in their review of billing analyses, including:

- The decision to perform a billing analysis, rather than select a different evaluation method. This can be the wrong decision if:
  - The expected precision of the resulting impact estimate is low;
  - Key data to be used in the analysis (e.g., billing data) is known to be of poor quality;
  - It is obvious from the start that "characteristics of either the measures installed, the customers participating, or the available data or budget are likely to . . . [produce analysis results that cannot] demonstrate some robustness in the face of minor variations in modelling decisions and in the handling of data."
- Evaluators' experimental designs sometimes suffer from:
  - Lack of clarity as to whether the evaluation is estimating net or gross savings, and which programme-related factors (free-ridership, spill-over, self-selection, etc.) will be controlled/-accounted for;
  - Not determining how exogenous effects such as changes in the economy or facility will be handled;
  - Failure to address self-selection effects.
- Inappropriate selection of non-participant samples (e.g., not matched properly to participant samples, due to average consumption level or distribution of consumption levels)
- Screening out customer records because they either show unusually large consumption changes or because savings initially estimated are unusually large as a proportion of normalised energy consumption. This can result in upwardly biased savings estimates and can be mitigated somewhat by putting more effort into improving data quality prior to analysis.
- Use of statistically adjusted engineering analyses when there are significant errors in tracking system savings estimates (causes downward bias in savings)
- Inappropriate regression modelling practices. For example:
  - Poor logical and theoretical basis of the selected model
  - Failure to report the sequence of models that have been rejected and the reasons for rejection
  - Inappropriate disaggregation of models by building type or size (resulting in lost precision due to smaller sample sizes used for each model)
  - Failure to account for heteroscedasticity or systematic variations in error terms in C/I programme billing analyses)
  - Failure to perform diagnostics to determine how sensitive and stable the model results are

- Inappropriate rejection of billing analysis results (due to differences from previous evaluation results)
- Misapplication of realisation rates (improper extrapolation of sample results due to use of data filters that fundamentally change the sample population or due to use of realisation rates from a previous year's participants)
- Insufficient documentation.

MARKET TRANSFORMATION IN A CHANGING UTILITY ENVIRONMENT

Author(s):	S. Hastie, C. McDonald, M. King, R. Smithers
Time:	Prepared for the National Association of Regulatory Utility Commissioners, March 1996

The purpose of this guidebook is to help regulators, utilities and other stakeholders understand market transformation programmes and assess their value and role for achieving energy efficiency objectives.

Utilities and their regulators have long recognised responsibilities beyond merely providing low-cost electricity. One of these responsibilities is to promote energy efficiency, for reasons of environmental quality, resource conservation, sustainable development, economic development, affordability and competitiveness. Recent experience with energy efficiency programmes indicates that market transformation approaches may achieve lasting and widespread energy efficiency improvements at a reasonable cost.

The remainder of this summary provides answers to key questions regarding market transformation, distilled from the more extensive answers appearing in the rest of the guidebook.

What is market transformation and why should regulators consider the market transformation approach to achieving energy efficiency?

Transforming a market means changing the types of products or services that are offered in the market, the basis on which purchase and behavioural decisions are made, the type or number of actors in the market, or in some other way altering this set of interactions in a self-sustaining way. Market transformation is actually a *result* or a *desired outcome*, more than it is a type of programme.

For our purposes, market transformation refers only to those programmes explicitly designed to cause changes in the *structure* of the market for energy efficiency products or service (e.g., new players, different rules, different prices), or in the *behaviour* of some group of market actors, in such a way that energy efficiency is improved and the changes remain after the programme has ended. Unlike traditional DSM programmes, market transformation programmes explicitly try to *change the market* so that energy efficiency products will be purchased in the future without ongoing programmatic intervention to make the targeted purchase or to act in the desired manner.

There is considerable variation (and evolution) in the types of programmes that can be designed to change markets or behaviour, but most are of four general types:

- Introducing a new technology, service, or behaviour into the market.
- Advancing an existing technology, service, or behaviour so that it becomes more widespread.
- Removing or decreasing the use of an inefficient technology, service, or behaviour.
- Accelerating the rate of technological improvement and/or cost reduction.

The scope of market transformation efforts can also vary. For example, initiatives can focus on technical efficiency, cost, distributor/trade ally actions or consumer behaviour, and most initiatives will involve efforts targeted at several of these areas. The target market can also vary in size. Aside from building code initiatives dealing with efficient technologies, most product-oriented efforts will probably need to be mounted at the regional or national level (e.g., heat pump water heater), while some service or behavioural efforts are feasible on a state or local level.

Most market transformation programmes generally share the following characteristics:

- *Involvement of multiple market actors, with critical roles often being played by entities up and down the product distribution chain, as well as by brokers/facilitators/specialists with knowledge of and breadth of contacts in targeted technologies and markets; entities to promote the targeted product, service or practice; and possibly others*

- *Activities designed to remove or lower specific market barriers to energy efficiency technologies, both on the supply and the demand side*

- *Longer time frames (than other DSM programmes) before the majority of programme impacts are obtained (i.e., before the market has been permanently changed)*

- *Significant activity upstream from the customer or end user.*

The benefits of the market transformation approach include:

- *Use of market forces to overcome barriers to efficiency.*

- *Promise of greater energy savings at lower cost.*

- *Permanent changes in the market, i.e., ones that continue after the programme ends.*

In addition, some market analysts have viewed market transformation programmes as a way to merge two recent trends — innovative DSM programme design and utilities' need to minimise costs of energy efficiency programmes. Some see market transformation initiatives, with their focus on using market forces to achieve efficiency improvements, as more compatible with future restructured (more competitive) markets. Others see these initiatives as a less expensive way for utilities in the current regulatory environment to achieve energy savings.

What should qualify as a market transformation programme worthy of being funded by ratepayers?

Regulators must determine whether the "market transformation" programmes submitted to them for approval (either unsolicited or in response to regulatory prompting) represent prudent use of ratepayer funds. The market transformation programme must include a coherent plan that maximises the chances for success. This has been required for the traditional DSM programmes in the past; i.e., programmes must be well-conceived and comprehensively planned. A checklist of the features regulators should require market transformation programme plans to address is summarised in **Error! Unknown switch argument.**.

Exhibit **Error! Unknown switch argument.**: *Programme design requirements for market transformation programmes.*

- *Documentation on how the target market operates* (the set of complex market interactions appropriate to the targeted technology or market)
- *Baseline information* on efficiency levels and market indicators that will be used to establish that market transformation has occurred
- *Identification of key market barriers* to increased efficiency in the target market, including both the supply side (e.g., products and services available in the market) and the demand side (end-user attitudes and behaviour)
- *Development of an implementation plan for lowering or eliminating specific market barriers*, including identification of a lead implementor (or programme champion) and other members of any consortium or coalition formed to implement the programme; a projected timing of costs and benefits; identification of target efficiency improvements and key market indicators; and a forecast of the type and timing of incremental changes to them expected to occur with and without programme
- *A specific implementation plan and timeline, with a rationale for it that is based on market conditions*, including the presence of existing momentum for change, possible linkage of efficiency to other features valued by the targeted decision makers, and existence of related or supporting efforts in the market and how the programme will interface with them (e.g., market transformation or energy efficiency initiatives being implemented by other organisations)
- *Estimation of programme cost-effectiveness* to the relevant jurisdiction, and of value to each of the market actors crucial to its success.
- *A programme evaluation strategy*, including both impact- and process-oriented efforts, that quantifies programme impacts on: (1) energy use (both directly resulting from programme activities as well as lasting changes in efficiency that the transformed market will maintain without intervention); and (2) the market indicators identified as part of the programme design. It also must monitor programme effectiveness and provide reasons for unexpected programme successes and failures.
- *An exit strategy* for the programme, including projected timing and trigger points/thresholds.

The key features that differentiate the market transformation programme design from traditional DSM programme designs include the following:

- *A focus on removing or lowering market barriers.* Market transformation programmes should be directly targeted at removing or lowering market-specific barriers. Key barriers to the targeted technology, service or behaviour must be identified; the market will not be transformed if the programme removes only barriers existing on the product supply side or only on the customer demand side.
- *Use of market indicators.* These are characteristics of the targeted market that are expected to change if the market is truly being transformed. Examples might include the number or percentage of manufacturers offering a new efficient technology, number or percentage of retail outlets carrying the product, amount of shelf space devoted to a targeted product or the prominence of its display in stores, product price, product technical specifications, percentage of consumers aware of a targeted product or service, or number or percentage of builders installing the technology into new buildings.
- *Permanent change in the market.* The programme must include a logic for a chain of events that will result in permanent change in the market.

- *An exit strategy.* The programme plan should have a clear logic explaining why the programme stimulus to the market will no longer be needed after a specified period of time or after certain market indicators reach pre-specified levels. These exit trigger points/thresholds should be specified.

Regulators may have to approve a programme concept in total, but approve funding for programmes in stages. In this way, planning and market research can inform future decisions on level of effort for, and even the advisability of implementing, the programme. Such market research is likely to be needed in the early stages of programme design, in order to document the operation of the target market, develop a consortium, identify baseline efficiency levels, help refine estimates of energy savings potential, and finalise the most appropriate market change indicators to use in monitoring the programme's success in transforming the market.

What is the policy rationale for implementing market transformation and other energy efficiency programmes in both the current, rapidly evolving regulatory environment and in one characterised by significant customer choice of energy provider (competition)?

The decision to provide a programmatic stimulus to the market must be based on a finding that existing market failures result in an inefficient allocation of resources. Restructuring of the electricity industry is likely to remove certain market failures, but others will remain, including:

- Exclusion of externalities (especially environmental ones) in energy costs
- Lack of information
- Transaction costs
- Disconnected decision making.

The decision to provide a market stimulus must be based on an analysis that a market failure exists, that it is significant enough to warrant action, and that the stimulus will have a reasonable chance of improving the situation. The competitive electricity markets in Norway and the United Kingdom have not fostered significant natural market energy efficiency.

What options do regulators have for encouraging market transformation as an approach to achieving energy efficiency objectives; specifically, what are the implementation and programme options?

Market transformation efforts are likely to require some level of participation by many parties, in order to truly transform targeted markets. However, in terms of the entities that would assume the lead role in such efforts, regulators have three general implementation options:

- Implementation of initiatives within the state by a utility or utilities
- Implementation of in-state initiatives by a third party (perhaps specially created for the purpose)
- Implementation by either a third party or a utility consortium at the regional or national level.

Error! Unknown switch argument. and **Error! Unknown switch argument.** compare the advantages and disadvantages associated with each implementation option. It is likely that regulators will want to consider approving ratepayer funds to be used by a third-party implementor for certain market transformation initiatives, with only a minor if any utility role in the effort, to the extent that this is not precluded by existing statues. This is especially true for regional and national efforts and for initiatives being implemented in a more competitive utility environment. Ideally, regulators will be in a position to pick and choose among all three options, and construct a portfolio of initiatives (perhaps including some traditional DSM efforts) that best meets their individual objectives, including efficiency gains, economic development, resource conservation and equitable distribution of benefits among ratepayers.

Competition among market transformation initiatives seeking funding support would most likely result in increased innovation and cost effectiveness. A number of sources have identified possible technology and market targets for market transformation efforts, including a June 1994 ACEEE study,[8] the Boston Edison Settlement Board, the Consortium for Energy Efficiency, the U.S. DOE, the U.S. EPA, and others. However, the appropriateness of specific programmes to particular states will vary according to the nature of the markets within each state.

Exhibit **Error! Unknown switch argument.**: *Summary of advantages of major market transformation implementation options.*

Utility In-State Implementation	Third-Party In-State Implementation	Utility/Third-Party Regional or National Implementation
• Experience in implementing energy efficiency programmes • Staff experienced with energy efficiency initiatives (some, with market transformation programmes) • Established relationships with trade allies and customers • History of regulator-utility interactions with regard to energy efficiency initiatives • Regulators have significant level of control over implementation • Easier to ensure compatibility with utility traditional DSM programmes	• If special market transformation entity is created for multiple efforts, can develop efficient protocols and procedures • Need for rate treatment mechanisms reduced (with regard to market transformation programmes) • Would project an image of objectivity, facilitating cooperation of utility and non-utility parties • Utility transition to more competitive market likely to have less effect on implementing ongoing initiatives • Greater willingness to share information to advance the state of the art in programme design, implementation and evaluation	• Larger array of programme options, due to ability to address larger (multi-state) markets • Share costs and risks with many others • Only regional or national efforts can transform regional or national markets

[8]Steve Nadel and Howard Geller, *Market Transformation Programmes: Past Results, Future Directions*, June 1994.

Exhibit ***Error! Unknown switch argument.****: Summary of disadvantages of major market transformation implementation options.*

Utility In-State Implementation	**Third-Party In-State Implementation**	**Utility/Third-Party Regional or National Implementation**
• Not all types of programmes are appropriate due to market size (especially for small states) • Costs/unit energy saved may be higher, due to fewer entities over which to distribute programme costs • Advantages in a regulated environment may become disadvantages in a competitive market • May be reluctance to share information with others implementing market transformation initiatives, due to competitive pressures • Possible divergence of the public and commercial interests • Market transformation skills may not be a competency of the utility • Possible conflicts with initiatives in other states	• Largely untried in most states • May be legal issues to address in providing third parties with ratepayer funds • May be more difficult to dovetail efforts with traditional utility DSM programmes • Limited accountability	• Less control over implementation and evaluation • Possibility for greater communications problems and inefficiencies due to size and complexity of efforts being mounted • Limited accountability • May be issues about ability to fund

Error! Unknown switch argument. presents a list of the actions regulators should take to make market transformation programme implementation feasible and efficient in their jurisdictions.

Federal and state governments may develop initiatives that play important roles in encouraging market transformation, including establishing energy policy, supporting research and development, providing technical assistance, encouraging market acceptance of specific technologies, adopting standards and codes, helping to coordinate and taking part in market aggregation efforts to ensure the private sector of substantial markets for efficient products/services, and recognising outstanding examples of private sector efficiency improvements. Regulators should look for synergies between utility-funded efforts and these initiatives.

Exhibit ***Error! Unknown switch argument.****: Summary of actions regulators should take to encourage implementation of market transformation programmes.*

- ♦ Make clear commitments to encouraging market transformation initiatives both in the current environment and in a more competitive one.
- ♦ Fund market transformation programmes through a non-bypassable, non-discriminatory charge (especially in a more competitive environment).
- ♦ Be willing to approve funding for programmes, or participation in programmes, that may result in significant energy savings outside the jurisdiction.
- ♦ Encourage coordination of market transformation efforts so that synergy of efforts is maximised and initiatives do not run at cross purposes.
- ♦ Work to change statutes, where necessary, to permit funds collected for the purpose of energy efficiency improvements to be spent by consortia or other third-party organisations implementing market transformation initiatives.
- ♦ Change regulatory policies, if necessary, so that:

- Shareholder incentives can be tied to *indications* of market transformation

- The system of funding approvals can address multi-year programme efforts that yield few if any impacts in the first year or two

- Evaluation requirements are modified to reflect the relatively greater uncertainty and complexity of evaluation of market transformation programmes and the greater reliance on market indicators.

- ♦ Make sure that market transformation initiatives are consistent with other public policy goals, both in a franchise market and a more competitive one.
- ♦ Be willing to accept: (1) the reduced level of control and oversight over programme implementation; (2) the front-loading of programme costs; and (3) the greater uncertainty associated with programme impacts that may accompany market transformation programmes in exchange for: (a) the possibility of larger impacts; (b) greater use of market forces to achieve energy efficiency goals; and (c) energy efficiency that will persist.

How should market transformation programmes be evaluated?

Regulators will need to take a number of important actions with regard to the evaluation of market transformation programmes, stemming from how these programmes are different from traditional DSM programmes. These actions are summarised in **Error! Unknown switch argument.**. Key issues responsible for the difference in market transformation evaluation include the following:

- ➢ One year snapshots of energy savings will be of minimal value for deciding whether or not to continue the programme.
- ➢ Ability to attribute impacts solely to the programme is likely to be limited.
- ➢ It may be very difficult to establish a viable comparison group for estimating programme impacts.

Issues to be considered when determining how and when to evaluate market transformation programmes include the following:

- *First and foremost, what is the purpose of the evaluation?* Evaluation will be needed to (1) help refine programme implementation throughout the programme, (2) monitor the programme's effect on key (pre-specified) market change indicators, (3) estimate overall energy impacts for the programme, and (4) provide lessons of experience to improve future programmes.

- *Second, both baseline estimation and final estimation of energy impacts are likely to be much less precise than they are for traditional DSM programmes.* Baseline estimates will most likely have to be estimated over an extended period of years, and sometimes with regard to new technologies. Attribution of programme impacts and counts of programme participants are likely to be more approximate, due to significantly greater opportunities for exogenous factors to influence participant behaviour and to possible difficulties in determining the exact number of participants. In response to these uncertainties, regulators who want to take advantage of the substantial and lasting impacts promised by market transformation programmes will probably want to require that pre-implementation agreements be reached (between regulators and utilities, or between utilities and other interested parties) with regard to what will constitute evidence of impacts for specific programmes.

- *Evaluation should reflect the fact that the programme is attempting to change a market.* This typically will require shifting resources away from estimating per-unit impacts and toward providing evidence of attribution of impacts to the programme and measuring market indicators. Because of the longer time frames likely to be required to achieve market transformation programme impacts, evaluation efforts are needed to monitor market efficiency levels and especially key market indicators throughout the programme.

One option in dealing with these evaluation issues is to use simpler methods to estimate energy savings and focus much of the evaluation on collecting data on market change indicators identified prior to programme implementation. Evaluators can then assemble evidence from all or most of these indicators as to whether the programme is having the effect anticipated by programme planners. This information can aid in modifying the programme, demonstrate market transformation, and provide a basis for awarding shareholder incentives. Incorporation of evaluation planning into programme design is thus critical: Data on specific market change indicators must be collected as part of the initial programme design, to establish baseline values against which to compare later market measurements.

Exhibit ***Error! Unknown switch argument.****: Summary of key actions to be taken by regulators to facilitate evaluation of market transformation programmes.*

- *Regulators need to negotiate evaluation requirements and standards prior to programme implementation.* This is to obtain agreement on areas of uncertainty that are key to measuring the effectiveness of the programme, such as:
  - How will gross energy savings be estimated?
  - How will attribution of energy impacts to the programme be demonstrated (i.e., what will constitute a sufficient proof of attribution)?
  - How will the level of participation be estimated or measured (i.e., those who purchase the targeted product/service or perform the targeted behaviour)? For many programmes, these participants need not inform anyone involved with the programme of their participation status.
  - What will be used as the forecast of how the targeted efficient product or practice would have changed over time, in the absence of the programme?
  - What are the market indicators for which specific changes will be considered evidence that the market is being transformed?

(to be continued)

(continued)

- What is the approximate order and timing of the changes that should occur to these market indicators, if the programme is transforming the market? When should measurements occur?
- What types of data will be sufficient in demonstrating that the selected market indicators have changed in the expected manner?
- What is the expected level of effort required to measure changes to all market indicators?
- Which indicators, or combination of indicators, will signal that the programme should end, and how will they be measured or estimated?

♦ *Shareholder incentive mechanisms linked to evaluation results should be altered* to address delayed market transformation impacts, for example, by tying portions of incentives to achieving specified market indicator milestones.

♦ *The rigor of the evaluation requirements needs to be tied to the level of utility participation*. It may make sense to require little if any evaluation research for utilities playing a minor role in a programme (e.g., sending bill stuffers to customers). Utilities or third parties serving as primary programme implementors should face more rigorous requirements, though these requirements should acknowledge the uncertainties involved in market transformation evaluation. It may be advisable to have an independent evaluation team to perform some or all of the key research tasks: Baseline efficiency and market indicator analysis, monitoring of energy savings and market indicators during the programme, and post-programme evaluation of energy savings and market transformation impacts.

This approach holds promise for maintaining a degree of rigor while acknowledging the practical cost and technical limitations of the evaluation of market transformation programmes. The method may be useful in the current utility environment, especially in situations involving shareholder incentive mechanisms, though (as noted earlier) such mechanisms themselves will need to change to reflect the limitations of data collection associated with market transformation evaluation. It is also likely to be effective in assisting decision-makers in a more competitive environment.

The effects of market transformation programmes are not entirely controllable by the implementors. They must take advantage of existing forces in the market for change and stimulate that market so that permanent efficiency change results. They do not try to compensate market actors for acting in a way inconsistent with their own interest; they try to change that self interest. Such a significant change may require substantial, orchestrated activity on the part of a wide range of market actors, any of which can be influenced by factors outside of the programme to act in ways that greatly accelerate programme objectives or hinder them. Further, the programme may succeed in removing the targeted market barriers and still not result in the energy savings projected, due to factors either unknown to the programme implementors or not controllable by them.

Regulators and implementors will have to share this risk in some way. Penalising an implementor for a well-conceived but ultimately unsuccessful market transformation programme — by, for example, denying cost recovery or withholding shareholder incentives altogether — will send a message that market transformation programmes are not worth the risk. Rather than discouraging market transformation programme implementation, a sharing of risk emphasises the substantial, lasting benefits that may result from the programme, as well as the importance of pre-programme market research and ongoing evaluation activities to carefully assess market conditions, market barriers, market indicators, market indicator baseline levels, and overall implementation effectiveness.

Conclusions

Programmes that influence energy efficiency decisions by transforming markets have some obvious advantages over those relying on repeated stimuli to influence each decision. These advantages include potential for increased cost effectiveness and greater use of market forces in attaining efficiency objectives. Market transformation initiatives may replace or complement "traditional" DSM efforts. They are likely to involve multiple market actors working together for an extended period of time, require a longer time frame to achieve their objective (transforming a market), and include significant activity upstream of the targeted decision maker. These differences suggest corresponding differences in the evaluation of such programmes and in regulatory policy.

The promise of market transformation programmes, however, will not be realised unless regulators make clear to utilities and other interested parties their expectations regarding such programmes. This guidebook attempts to provide a basis on which regulators can provide such guidance.

EUROPEAN B/C ANALYSIS METHODOLOGY - A GUIDEBOOK FOR B/C EVALUATION OF DSM AND ENERGY EFFICIENCY SERVICES PROGRAMMES

Author(s):	SRC International ApS for the European Commission DGXVII
Time:	February 1996

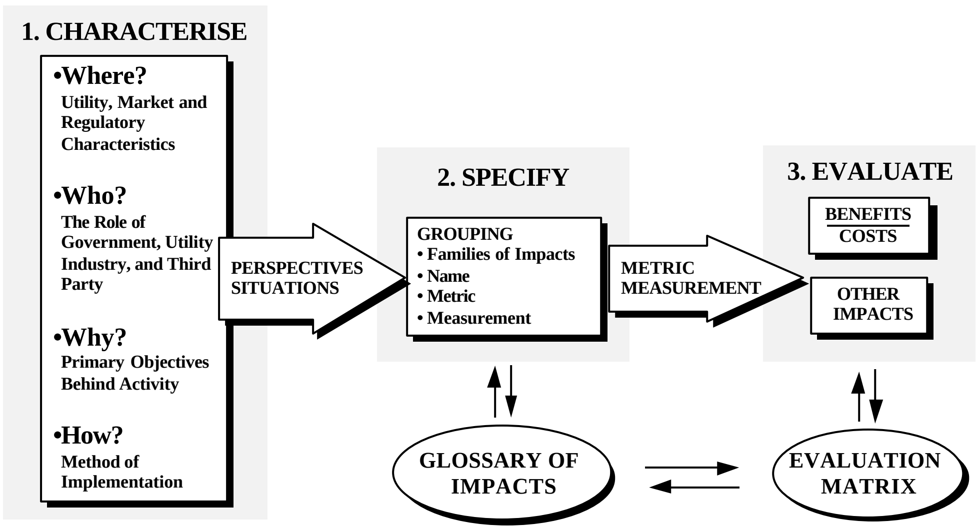
A consistent methodology and a guidebook for how to perform B/C analysis of DSM and energy services programmes in different utility and market situations are provided. The methodology is flexible and robust so as to allow for the B/C analysis to take place in different European countries and types of energy systems.

Structured B/C analysis consists of three steps:

- Characterisation of external environment;
- Specification of impacts;
- Evaluation.

These steps constitute the EUBC methodology and an overview of the methodology is presented in **Error! Unknown switch argument.**.

Exhibit ***Error! Unknown switch argument.****: Overview of B/C methodology.*



STEP 1 — CHARACTERISATION

A robust methodology must be established upon which a discussion of cost-effectiveness of DSM and energy services programmes can be based. Phase one of this study offers such a framework. Without a framework it would be very difficult to perform a meaningful discussion, and results would be of limited value. The main outcome of the characterisation process is an improved understanding of the situation at hand and the perspectives to be included into the analysis.

Four key issues must be addressed to allow assessment and comparison of DSM and energy services programmes:

- Where — Characterisation of the environment in which the DSM and energy service programme is being implemented. This external framework includes describing the energy market type, utility industry structure, and regulation type.
- Who — Identification of the role of government, utility industry, and third party involved in the DSM and energy service programmes.
- Why — Identification of the reasons for performing DSM and energy service programmes? Are programmes, for example, performed as a part of public policy to achieve a public policy goal, or as part of a utility strategic marketing programme to increase market share and profitability?
- How — Determination of the implementation method for the DSM or energy service programme.

STEP 2 — SPECIFICATION OF IMPACTS

The main outcome of this step-by-step process is an improved understanding of which impacts to include in the B/C evaluation. As support for the B/C specification process the report provides a glossary of B/C impacts containing the following for each impact:

- Name and definition of B/C impact;
- Suggested metric unit and measurement;
- Perspectives for which perspectives the impact is relevant;
- How the impact should be included in the B/C equation — as a cost or a benefit;
- Potential for overlap with other benefits;
- Guidance on interpretation of results.

STEP 3 — EVALUATION

Step 3 encompasses compilation of the impacts in a manner that allows a consistent comparison of alternatives. Experience in performing these evaluations has shown that both qualitative and quantitative impacts should be used in the evaluation.

*Exhibit **Error! Unknown switch argument.**: Example of a generic EUBC evaluation matrix.*

Perspective	Costs	Benefits	B/C Ratio	Other Impacts
Customer				
Distribution Utility				
Wholesale Utility				
Government				
Society				
Other				

The guidebook suggest that for each of six different perspectives costs, benefits, benefit/cost ratio and other impacts be analysed (see **Error! Unknown switch argument.**). Monetized costs and benefits are often given the most weight, so they are listed individually. Other impacts are sometimes critical to decision-making, and they are included formally in the matrix so they can be used if desired.

Which impacts are relevant depends on the specific programme, programme context, and the perspective of the valuation. However, as a guideline a generic overview of possible relevant impacts for each perspective is given in **Error! Unknown switch argument.**. The evaluation planner may then decide which impacts are irrelevant to the evaluation in question and eliminate these and maybe add others. Impacts can be added or subtracted from this list, as can be seen in the examples. Some perspectives shown in this table may not be used or may not have any meaning in some analyses. Impacts marked with a (*) indicate that they should be included in the primary equation if they are translated into monetary equivalents.

Exhibit ***Error! Unknown switch argument.****: Overview of likely relevant benefits and costs by perspective.*

Perspective	Included In Primary Equation	Otherwise Accounted
Participating Customer	Consumption of Other Fuels Change in Energy Bill Industrial Productivity Customer Capital Investment Customer O&M Utility Incentives Third Party Incentives Tax Credits Taxes Other Customer Transaction Costs (*) Customer Value (*) Tariff Changes (*)	Proven Performance Ease of Implementation Availability of Capital (Other Customer Transaction Cost (*)) (Customer Value (*)) (Tariff Changes (*))
Non-participating Customer	Tariff Changes (*)	(Tariff Changes (*))
Generation and Transmission Utility	Energy Generation Costs Generation Capacity Cost Transmission Capacity Cost Power Purchase Revenue Wholesale Utility Programme Costs Wholesale Utility Incentive Payments Risk and Reliability (*)	Public Image (Risk and Reliability (*))
Distribution and Supply Utility	Power Purchase Cost Utility Revenue Change Distribution Capacity Cost Distribution Utility Programme Costs Distribution Utility Incentive Payments Tariff Changes (*)	Market Share Public Image Proven Performance Ease of Implementation Ease of Evaluation Availability of Capital Cash Flow (Tariff Changes(*))
Government	Tax Revenues Government Programme Costs Tax Credits Environmental Effects of Supply (*) Environmental Effects of Consumption (*)	Industrial Productivity Regional Employment Public Image Diminishment of Natural Resources Anti-Competitiveness (Environmental Effects of Supply (*)) (Environmental Effects of Consump. (*))
Society	Energy Generation Costs Generation Capacity Cost Transmission Capacity Cost Distribution Capacity Cost Utility Programme Costs Government Programme Costs Third Party Programme Cost Customer Capital Investment Customer O&M Environmental Effects of Supply (*) Environmental Effects of Consumption (*) Tariff Changes (*) Other Customer Transaction Costs (*) Customer Value (*)	Industrial Productivity Regional Employment Diminishment of Natural Resources Anti-Competitiveness (Environmental Effects of Supply (*)) (Environmental Effects of Consump. (*)) (Tariff Changes (*)) (Other Customer Transaction Costs (*)) (Customer Value (*))

THE INTERNATIONAL PERFORMANCE MEASUREMENT AND VERIFICATION PROTOCOL

Author(s):	U.S. Department of Energy
Time:	August 2000

When firms invest in energy efficiency, they naturally want to know how much they have saved and how long their savings will last. If the installation had been made to generate energy, measurements would be trivial — install a meter. But to measure savings is a challenge, and requires both metering and a methodology, known as a measurement and verification protocol.

Until recently energy efficiency financing has been limited because investors and financial institutions lacked a reliable approach to measure and ensure savings from these investments. *The International Performance Measurement and Verification Protocol* (IPMVP) has helped to overcome this barrier. This new version, developed by hundreds of organisations and experts from over 25 countries, is an effective tool for increasing investments in energy efficiency. The IPMVP is revised every year and is maintained under the sponsorship of the US Department of Energy by a broad coalition of facility owners/operators, financiers, contractors or ESCOs and other stakeholders.

The IPMVP has become the industry standard in the United States, is published in ten languages, and is becoming the industry standard in countries around the world to finance energy efficiency projects

It is an updated and improved version of the *North American Energy Measurement and Verification Protocol* (1996). It was the result of a collaborative effort between federal and state agencies and experts in the United States, Canada and Mexico. The effort was sponsored by the U.S. Department of Energy and reflected a broad consensus in the energy and efficiency industries. It addresses measurement and verification needs for performance contracting (contracts to install energy efficiency measures in which payment is in some way based on the performance of the measures installed).

The IPMVP is not intended to prescribe contractual terms between buyers and sellers of efficiency services, although it provides guidance on some of these issues. Once other contractual issues are decided, this document can help in the selection of the measurement & verification (M&V) approach that matches best:

- Project costs and savings magnitude,
- Technology-specific requirements, and
- Risk allocation between buyer and seller, i.e., which party is responsible for installed equipment performance and which party is responsible for achieving long term energy savings.

Purpose of the IPMVP

When firms invest in energy efficiency, their executives naturally want to know how much they have saved and how long their savings will last. The determination of energy savings requires both accurate measurement and replicable methodology, known as a measurement and verification protocol.

The long-term success of energy and water management projects is often hampered by the inability of project partners to agree on an accurate, successful M&V Plan. This M&V Protocol discusses procedures that, when implemented, help buyers, sellers and financiers of energy and water projects to agree on an M&V Plan and quantify savings from Energy Conservation Measure (ECM) and Water Conservation Measure (WCM). Simply put, the purpose of the IPMVP is to increase investment in energy efficiency and renewable energy. The IPMVP does so in at least six ways:

- Increase energy savings.

- Reduce cost of financing of projects.
- Encourage better project engineering.
- Help demonstrate and capture the value of reduced emissions from energy efficiency and renewable energy investments.
- Increase public understanding of energy management as a public policy tool.
- Help national and industry organisations promote and achieve resource efficiency and environmental objectives.

Role of the IPMVP

This Protocol:

- Provides energy efficiency project buyers, sellers and financiers a common set of terms to discuss key M&V project-related issues and establishes methods, which can be used in energy performance contracts.
- Defines broad techniques for determining savings from both a "whole facility" and an individual technology.
- Applies to a variety of facilities including residential, commercial, institutional and industrial buildings, and industrial processes.
- Provides outline procedures, which i) can be applied to similar projects throughout all geographic regions, and ii) are internationally accepted, impartial and reliable. Presents procedures, with varying levels of accuracy and cost, for measuring and/or verifying: i) baseline and project installation conditions, and ii) long-term energy savings.
- Provides a comprehensive approach to ensuring that building indoor environmental quality issues are addressed in all phases of ECM design, implementation and maintenance.
- Creates a living document that includes a set of methodologies and procedures that enable the document to evolve over time.

Audience for the IPMVP

The target audience for this Protocol includes: Facility Energy Managers; Project Developers and/or Implementers; ESCOs (Energy Service Companies); Non-Governmental Organisations (NGOs); Finance Firms; Development Banks; Consultants; Government; Policy Makers; Utility Executives; Environmental Managers; and Researchers

Summary of IPMVP volumes

Volume I defines basic terminology useful in the M&V field. It defines general procedures to achieve reliable and cost-effective determination of savings. Verification of savings is then done relative to the M&V Plan for the project. This volume is written for general application in measuring and verifying the performance of projects improving energy or water efficiency in buildings and industrial plants.

Volume I is largely drawn from the December 1997 edition of IPMVP. Apart from a general refocusing of the document for increased clarity, the definitions of Options A and B have been significantly modified in response to reactions received to earlier editions. These changes now include required field measurement of at least some variables under Option A, and all variables under Option B. Examples of each M&V Option have been added in Appendix A. Former sections on M&V for new buildings, residential and water efficiency have been moved to Volume III. The text has been updated and language tightened to achieve greater technical consistency and ease of use.

Volume II reviews indoor environmental quality issues as they may be influenced by an energy efficiency project. It focuses on measurement issues and project design and implementation practices associated with maintaining acceptable indoor conditions under an energy efficiency project, while advising on key related elements of M&V and energy performance contracts. Volume II is scheduled for publication concurrently with Volume I.

Volume III is planned for publication in early 2001, and reflects guidance and input of over 100 international experts. It will review application specific M&V issues. It is intended to address M&V specifics related to efficiency projects in industrial processes, new buildings, renewable energy, water efficiency, and emission trading. This volume is expected to be an area of continued development as more specific applications are defined.

M&V options

The Protocol defines a range of M&V options so that readers have flexibility in the methods chosen and the cost to implement them. **Error! Unknown switch argument.** below is provided by the document as a summary of the major types of performance contracts.

Exhibit ***Error! Unknown switch argument.****: Major types of performance contracts.*

	On Owner's Balance Sheet	Not On Owner's Balance Sheet
Net Owner Payment Contingent on Performance	• Guaranteed Savings • (Long Term)	• Shared Savings • Pay from Savings • Chauffage
Net Owner Payment Not Contingent On Performance	• Guaranteed Savings Loans • (Short Term) • Capital Leases	• Certain Municipal Leases • Operating Leases

The Protocol discusses various aspects of the measurement and verification process, including:

- Baseline verification;
- Post-installation verification;
- Regular interval post-installation verification;
- M&V techniques (engineering calculations, metering and monitoring, utility meter billing analysis, computer simulations, agreed upon stipulations by the owner and the contractor/ESCO);
- Energy use stipulations.

The document then addresses M&V issues such as metering and monitoring issues and protocols, the role of energy costs in the contracts and M&V protocol, minimum energy standards, and interactive effects.

Determining the level of effort for M&V depends on:

- Value of the energy efficiency measure (called an energy conservation measure, or ECM, throughout the document) in terms of projected savings;
- Complexity of the measure;
- The number of measures at a single facility and the degree to which their savings are interrelated;
- Uncertainty of savings;
- Risk allocation between the contractor/ESCO and the owner;
- Other uses for M&V data and systems.

Error! Unknown switch argument., from the Protocol document, presents the four basic M&V options, how savings are calculated, and typical applications.

*Exhibit **Error! Unknown switch argument.**: Four basic M&V options.*

M & V Option	How Savings are Calculated	Typical Applications
Option A: Partially Measured Retrofit Isolation	Engineering calculations using short term or continuous post-retrofit measurements and stipulations.	Lighting retrofit where power draw is measured periodically. Operating hours of the lights are assumed to be one half hour per day longer than store open hours.
Option B: Retrofit Isolation	Engineering calculations using short term or continuous measurements.	Application of controls to vary the load on a constant speed pump using a variable speed drive. Electricity is measured by a kWh meter installed on the electrical supply to the pump motor. In the base year this meter is in place for a week to verify constant loading. The meter is in place throughout the post-retrofit period to track variations in energy use.
Option C: Whole Facility	Analysis of whole facility utility meter or sub-meter data using techniques from simple comparison to regression analysis.	Multifaceted energy management programme affecting many systems in a building. Energy use is measured by the gas and electric utility meters for a twelve month base year period and throughout the post-retrofit period
Options D: Calibrated Simulation	Energy use simulation, calibrated with hourly or monthly utility billing data and/or end-se metering.	Multifaceted energy management programme affecting many systems in a building but where no base year data are available. Post-retrofit period energy use is measured by the gas and electric utility meters. Base year energy use is determined by simulation using a model calibrated by the post-retrofit period utility data.

The *International Performance Measurement and Verification Protocol* can be obtained at http://www.ipmvp.org

EVALUATING MARKET TRANSFORMATION INITIATIVES: ISSUES, CHALLENGES, AND STATE OF THE ART

Author(s):	Jeff Schlegel, Schlegel and Associates
Time:	Presented at the ACEEE Workshop on Market Transformation, Washington, DC, March 11, 1997

The following summarises Mr. Schlegel's presentation.

- "All evaluations will not look the same – there will be a wide variety of evaluation and research activities."
- Purposes of evaluation for market transformation initiatives:
  - Help determine whether to intervene in market (prior to programme).
  - Support planning/design of programmes, including up-front market analyses and baseline studies.
  - Provide ongoing feedback on programme design and implementation.
  - Document indicators of programme effectiveness (changes in market indicators signalling reductions in market barriers).
  - Assess overall programme success.
  - Provide data on which to base performance incentives offered to programme administrators/implementors.
  - Document need to change nature or level of market intervention.
- Key questions to be addressed:
  - What changes have occurred in market? (Need for up-front market research to gain a detailed understanding of how market operates, identify market barriers, and determine market indicator and efficiency baselines.)
  - What was the role of the market transformation initiative in bringing about these changes?
  - Will the observed changes persist?
- Key evaluation challenges:
  - Difficult to (1) prove that the initiative "caused" any observed market effects and (2) forecast what would have happened in the absence of the programme
  - Difficult to estimate effects of one partner in coordinated or regional market transformation initiatives
  - Important to obtain information at a time when it can affect decision making about the initiative, and to know when to estimate programme impacts (where the product/practice is on the technology diffusion curve)

- In evaluating the success of an initiative:

    - Define success in multiple ways:
        - Ultimate outcomes (e.g., energy savings, products sales)
        - Market effects (e.g., changes in market indicators, reductions in market barriers)
        - Good-faith effort by the administrator/implementor in implementing tasks that are based on a consensus plan of key decision-makers.

    - Focus on market indicators (timely, observable, real-time feedback, close in time to programme activities).

    - Provide a complete logic for whether the initiative has been successful

        - Evidence of market changes caused by initiative
        - Logic of how and why initiative caused the changes
        - Explanation of confounding factors and alternative theories.

    - Use a systematic framework throughout planning-evaluation process (e.g., market influence diagram or flow chart showing expected effects of programme)

    - Consider the option of retrospective analysis (limited usefulness for certain types of decision making)

    - Balance the level of effort with the purposes of the evaluation

- Possible approaches for evaluating market transformation initiatives:

    - Track and analyse indicators of market effects

    - Analyse decision, actions, behaviour and attitudes of affected market actors

    - Analyse and model adoption and penetration of targeted product/practice

    - Track sales and analyse sales data

    - Analyse changes in load data over time

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APPENDIX C:

STANDARD REPORTING FORMAT

CONTENTS

PROCESS DESCRIPTION

In the following a short summary of the work on the standard reporting format is given. It is followed by four examples of formats.

THE INITIAL INTENTION

The initial intention was to prepare a standard reporting format linked to the developed ex-post evaluation methodology, which could facilitate and support comparison of different DSM and EE service programmes and evaluation efforts in a consistent and logical manner (at intra-company, regional, national, and international level).

The format was therefore intended to encompass questions regarding the context in which a programme was born and implemented. The registration of external characteristics, which naturally influence the success of a programme, were to function as information to support strategies for replication of programmes and transfer of programmes to other countries and energy systems.

The standard reporting format was thus to include information on the person/organisation completing the form; programme context; programme overview; programme details; evaluation status; chosen evaluation framework; evaluation details; evaluation results; lessons learned; and application/dissemination strategy.

Other sophisticated databases on DSM and EE service programmes exist both in Europe and elsewhere. An example of an international database is the INDEEP database developed under the IEA DSM Programme (see Exhibit C-1). Also, some nations already collect programme information in a national database. The new standard reporting format would therefore have had to be clearly distinguishable from these and provide new insights for it to be of use. It was anticipated that the standard reporting format would contain information concerning programme context and evaluation approach and experiences in addition to some basic information concerning the programmes to give meaning to the other information.

DILEMMA

The dilemma of the project team was how much information to collect and for what purpose:

- If the objective is to enable comparison and replication of programmes and services, then quite detailed information is required. In this case the programme and evaluation reports might be better suited.
- If the objective is to provide an overview of what has been done where, then a very short format is necessary. Such a format was already developed under the SAVE project "Public Policy Base DSM in the Nordic Power Sector" (see Exhibit C-2).
- If the objective is to function as a kind of checklist, then it is better as a natural part of the methodology presented in the guidebook. Two types of checklists are given in Chapter 3 on planning the evaluation effort.

Important in this discussion is also to identify the users of the information collected in such a standard reporting format.

Alternatives to producing a new standard reporting format were:

- To use the existing databases;
- To expand one or more of the existing databases to include context and evaluation elements;
- To postpone the development of a new standard reporting format until a definite need arises.

FINDINGS

The project team tried out two types of formats. The first was a continuation of the draft standard reporting format developed in Phase I of the project (Exhibit C-3). It was found inadequate to provide new insights. A second format resembling a checklist was also tried out on all project evaluation cases and it appeared to be more user-friendly (Exhibit C-4). However, again the relevance of the format kept coming up in project meeting discussions.

It was therefore decided by the project team to abandon the standard reporting format. Within the scope of this project it was judged impossible to make a useful tool. Also, it did not make sense to create a database for which no user has yet been identified.

RECOMMENDATIONS

In the light of EU's Kyoto commitment and intention to implement an internal CO_2 emission trading scheme in the EU, there is a need for reliable standard formats for documenting that emission reductions have been reached. Furthermore, the Commission is currently exploring ways on how to promote energy services in the EU internal energy markets. A co-ordinated promotion initiative for energy services requires a co-ordinated European standard reporting format for DSM and EE services results and evaluations.

To ensure a valuable and useful reporting format, the effort must be tightly co-ordinated with the activities to establish rules for emission trade and an internal market for energy services. In other words, a tool for the implementation of the Kyoto Protocol is needed.

A Kyoto Protocol tool is most likely best based on an existing database such as INDEEP. The tasks, related to creating a Kyoto Protocol tool, would as minimum include the following:

- Identification of the future **controlling entity** of the database;
- Identification of **who should provide data** for the database;
- Identification of the future **users of the database output**;
- Identification of **relevant output** and **design of output**;
- Identification of **relevant indicators** and **calculation methods**;
- Establishment of a **reporting procedure** (who, when, how).

The present SAVE project has created both methods and a network of evaluators, which would be very valuable in the development of such a tool.

The following exhibits C-2, C-3, and C-4 contain illustrative programme information while Exhibit C-1 is "blank".

EXHIBIT C-1: INDEEP DATA COLLECTION INSTRUMENT

DCI-1

DCI Number	**Country**		
Name of INDEEP Expert			
First Data Submittal [ ]	Date of Submittal		
Data update [ ]	Date of Update		

Primary Programme Implementing Agent	**Contact Information**	
Electric or Gas Utility [ ]	Name	
Central Government [ ]	Programme Implementing Agent	
Regional Government [ ]		
Local Government [ ]	Address	
Local Organisation [ ]	City/Town	
ESCo (Energy Service Company) [ ]		
Other [ ]		
Other (specify)	Zip Code	
	Phone	
	Fax	
	Email	

Programme Name		
Project ID	Programme Implementing Agent	
Programme Summary		

DCI-2

Programme Start Date ______	Ongoing [ ]
End Date	Terminated [ ]

Programme Status Pilot (Demonstration) [ ] Full Scale at National Level [ ] Full Scale at Regional Level [ ] Phase out [ ]	**Evaluation Status** Completed [ ] In-progress [ ] Planned Start Date [ ] Start Date

Energy Objectives	**Programme Goals**	
Energy Efficiency [ ]	Number of participants	
Load Optimisation [ ]	Energy savings	
Fuel Switching [ ]	Demand savings	
	Fuel savings	
	Appliance #1 sales	
	Appliance #2 sales	
	Other (specify)	

Reasons for Selecting this DSM Activity **(Choose 1 - 5 reasons)** Regulatory Incentive [ ] Legislated / Mandated [ ] Political Pressure [ ] Public Image [ ] Result of Screening Process [ ] Result of Other Competitive Analysis [ ] Economic Development [ ] Business Opportunity [ ] Long-term Resource Option [ ] Market Penetration [ ] Quality of Service [ ] Customer Retention [ ] Cost of Services [ ] Reduction of Global Warming [ ] Reduction of Local Emissions [ ] Market Transformation [ ] Other (specify)	**Eligible Markets** New Construction [ ] Replacement/Retrofit [ ] **Energy Source Affected** Electricity [ ] Gas [ ] Fuel Oil [ ] District Heating [ ]

Programme Type General Information (Brochures, etc.) [ ] Site-Specific Information (Audits, etc.) [ ] Installation of Conservation Measures [ ] Operations and Maintenance [ ] Load Control [ ] Hook-up Fees [ ] Education/Training [ ] Research and Development [ ] Building Standards and Labels [ ] Appliance Standards and Labels [ ] Market Transformation [ ] Other (specify)	**Alternative rates** Time-of-Use [ ] Interruptible/Curtailable [ ] Other [ ] Other (specify)

DCI-3

Customers Targeted by Programme Residential	**Non-customers Targeted by Programme**
All [ ] 1-2 Family Houses With Electric Space Heating [ ] 1-2 Family Houses Non Electric Space Heating [ ] Multifamily Houses/Apartments Central Heating [ ] Multifamily Houses/Apartments Indiv. Elec. Space Heating [ ] Multifamily Houses/Apartments Indiv. Non-Electric Heating [ ] Multifamily Houses/Apartments District Heating [ ] Other (specify)	Building Owners [ ] Retailers [ ] Wholesalers [ ] Appliance manufacturers [ ] Builders [ ] Realtors and developers [ ] Architects and engineers [ ] Bldg. mgrs. and administrators [ ] Bldg. and equipment operators [ ] Energy service companies [ ] Leasores &Rentors [ ] Other (specify)

Commercial [ ]	All Others (specify 6-digit NACE code(s))
Industry [ ]	All Others (specify 6-digit NACE code(s))
Agricultural [ ]	All Others (specify 6-digit NACE code(s))

Technologies

Technology Code (see DCI Instructions)	Payback time in years

Marketing instruments	**Marketing methods**
Rebates and Cash Awards [ ] Financing, Loans, and Leasing [ ] Direct Installation [ ] Tarif reduction [ ] Bulk Purchasing [ ] Gifts and Merchandise [ ] Other (specify)	Direct mail [ ] Advertising [ ] Energy Audits [ ] Personal Contact [ ] Other (specify)

Participation Summary

	Most recent year		Cumulative			Units
				to		
Participants						
Eligible Customers						
Participation Rate		%			%	

DCI-4

Programme costs, Energy Savings, and Appliance Sales			
		Most Recent Year	Cumulative
Costs in Euro	Total Utility/Organiser Costs		
Specify years	Total Non-Utility/Organiser Costs		
	Total Programme Costs		
	Incentive Costs (%)		
	Non-Incentive Costs (%)		
Energy Savings	Electricity savings (MWh)		
	System peak demand savings		
	Fuel savings (TeraJoule)		
Appliance Sales (# units)	#1 Specify units		
	#2 Specify units		

<u>Data used to calculate savings</u>	**<u>Life-Cycle Programme Costs</u>**
Engineering data [ ] Utility billing data [ ] Spot metering [ ] Whole-buildings load data [ ] End Use load data [ ] Equipment specifications [ ] Site-specific data [ ] Appliance sales data [ ] Other (specify)	Average measure lifetime [ ] Real societal discount rate [ ] Real utility discount rate [ ]

<u>Lessons Learned</u>

INSTRUCTIONS FOR COMPLETING THE INDEEP DATA COLLECTION INSTRUMENT

This data collection instrument (DCI) is designed to facilitate the collection of information on utility and government DSM programmes. These instructions provide guidelines for completion of the DCI. The person(s) completing the DCI should regard the instructions as a reference that should only be consulted when there is a question regarding the completion of a particular data request.

Four fields have to be filled in by the country experts. These fields are:

- DCI reference number;
- INDEEP expert and country;
- Date submitted;
- Data collection phase.

Two fields will get special attention by the country expert and will be improved, if necessary:

- 6-digit NACE codes for sectors targeted by programmes;
- Cost information, the conversion to Euro;

DCI - 1

Primary Program Implementing Agent

This is the organisation performing the actual program implementation/delivery - e.g., utility company, government agency (central, regional or local), local community organisation, or an energy service company. A municipal government should be coded as "local government." There may be a combined effort in program implementation. **Check all applicable implementing agents.**

Energy Service Company (ESCo)
An Energy Service Company is a firm that specialises in providing DSM conservation services. Typically, this firm enters into contractual agreements with utility companies to assist in planning, implementation/delivery, and monitoring and evaluating DSM programmes.
Other
Please provide a brief explanation.

Contact Information

Enter the name for the person to be contacted for additional information, the organisation that is the programme implementing Agent, address, telephone number, fax number, and electronic mail (email) address

Programme Name

Enter the full name of the DSM programme (in English).

Project ID Number

If you have given the programme an internal code, please complete, so that it is easier to communicate and avoid misunderstanding.

Implementing Agent Name

Enter the full name of the primary programme implementing agent (in English).

Programme Summary

Describe the programme in a few sentences, using the section headings of the DCI. Provide programme highlights that capture the essence of the programme: e.g., its market delivery system, programme impacts, uniqueness of programme, expectations versus results, etc.

DCI - 2

Programme Start and End Dates

Enter the month and year for start and end dates of the **overall programme.** For ongoing programmes, check **ongoing;** for programmes that have ended, check **terminated** and specify the programme end date.

Programme Status

"Programme status" refers to the life-cycle stage of the programme. Programmes may be in one of three stages in their life cycle. These stages are defined below. **Check one only.**

Pilot
Pilot Programmes are designed to test or build the capability to deliver full-scale programmes.
Full-Scale
Full-Scale Programmes are available to all customers in an eligible market at the **national** level or for a particular **region**.
Phase Out
A Phase Out Programme is in its last year of operation; the evaluation of the programme may continue after a programme has ended.

Evaluation Status

Check one only.
Completed
A programme evaluation has ended and that at least one evaluation report is available.
In-progress
A programme evaluation has started and is ongoing.
Planned
A programme evaluation is being planned and is likely to be implemented. Specify the approximate date when the evaluation will start.

Energy Objectives

Check one or more of the three objectives that apply to the DSM programme.

Energy Efficiency
Programmes promoting more efficient use of energy.
Load Optimisation
Load optimisation programmes include *load shifting* (promoting the movement of electricity use from one time period to another, usually from the on-peak to the off- peak period for a single day), *valley filling* (promoting increased off-peak electricity consumption, without necessarily reducing on-peak demands), *peak clipping* (promoting reduced electricity demand (kW) at times of peak daily demand (typically, at system peak)), and *load building* (promoting increased electricity consumption, generally without regard to the timing of this usage).
Fuel Switching
Programmes promoting the conversion (switching) of one source of energy (e.g., gas) to another source of energy (e.g., electricity).

Programme Goals

Most programmes have goals that shape the programme. Where appropriate, describe the goals in terms of number of participants, energy savings, demand savings, fuel savings, appliance sales, or other category. Specify the units.

Reasons for Selecting this DSM Activity

Sixteen potential reasons for implementing this DSM activity are listed on the DCI. **Cheek at least one and no more than 5** key reasons that apply to the DSM activity.

Regulatory Incentive
A regulatory body (e.g., a public utilities commission) has offered incentives to the primary programme implementing agent (see pg. 1) for promoting DSM programmes. The incentives may be financial or non-financial, and the primary programme implementing agent has the option of taking advantage of these incentives.

Legislated/ Mandated
A regulatory/legislative body has required that the primary programme implementing agent implement DSM programmes.

Political Pressure
Pressure by the general public, interest groups, political parties, and others made it necessary for the primary programme implementing agent to implement this DSM activity.

Public Image
Implemented for enhancing the public image of the primary programme implementing agent (i.e., for good public relations).

Result of Screening Process
A formal screening process (e.g., using computer cost-effectiveness tests) was used to select the DSM activity - e.g., a programme may be selected because its benefit-cost ratio was greater than one

Result of Other Competitive Analysis
A bidding process or some other form of competitive analysis was used to select the DSM activity - e.g., a programme may be selected because the winner of a DSM bid included this programme in its menu of programme offerings.

Economic Development
Implemented for developing a stronger economy - e.g., creating more employment in the region.

Business Opportunity
Implemented for developing a new business for the primary programme implementing agent.

Long-term Resource Option
Implemented for providing a resource for the future.

Market Penetration
Implemented for increasing the penetration of one or more energy efficiency measures and practices in the marketplace.

Quality of Service
Implemented for increasing the quality of service offered to the utility's customers or the government's taxpayers.

Customer Retention
Implemented for retaining customers for the utility - e.g., offering low billing rates so customers will stay with the utility.

Cost of Service
Implemented for reducing the cost of service to the utility (e.g., less generating capacity needed to build).

Reduction of Global Warming
Implemented for improving the quality of the global environment as it relates to global warming (e.g., CO_2)

Reduction of Local Emissions
Implemented for improving the quality of the local environment (e.g., air quality and water quality).

Market Transformation
Implemented for influencing the attitudes and behaviour of individuals and organisations, so that investments in energy efficiency persist even after the programme is changed or eliminated.

Other
If another reason is important and is not listed, please specify.

Eligible Markets

The Eligible Market is any set of customers or participating units that qualify for a programme based on the programme's eligibility requirements. **Check all that apply.** Eligible Market definitions can be classified into two main categories:

New Construction
New Construction refers to buildings and facilities (or additions) constructed during the current year; it may also include major renovations of existing facilities and building envelope components (although there is no strict definition, "major renovations" occur when large amounts of floor area are affected).

Replacement/Retrofit
Replacement/retrofit buildings are structures that are in use as of the beginning of the current year. Replacement is the installation of new equipment or building envelope components for worn out equipment at the end of its useful life. Retrofit is the substitution of new equipment for existing equipment prior to its normal retirement age accompanied by the removal and disposal of the old equipment.

Energy Source Affected

Indicate type of energy source that the DSM programme affects: e.g., electricity, gas, fuel oil, and district heating.

Programme Types

Check all applicable types.

General Information
Programmes that inform customers about DSM options through advertising media such as brochures, bill stuffers, television, and radio ads.

Site-Specific Information
Programmes that provide guidance on energy efficiency and load management options tailored to a particular customer's facility. They often involve an on-site inspection of the facility to identify potential cost-effective DSM actions. An energy audit and design assistance are examples of site-specific information programmes.

Installation of Conservation Measures
Programmes where the utility, contractor, or customer installs energy efficiency DSM measures in the facilities of participating customers (with or without incentives).

Operations and Maintenance
Programmes that include regular maintenance of particular measure(s), along with training and education of O&M personnel, maintenance manuals, and periodic re- testing to measure actual performance.

Load Control
Programmes that promote shifts in electricity consumption from one time period to another (usually from on-peak periods to off-peak periods during a single day) or clipping peak usage.

Hook-Up Fees
Programmes that are usually performance-based with a sliding scale; the fees decline as the energy efficiency of the home increases, and increase as it decreases.

Education and Training
Programmes that attempt to educate and train the general population or key target groups (e.g., builders and architects) through workshops, seminars, and special courses.

Research and Development
Development of new technologies as well as the demonstration and technology transfer of these research projects.

Building Standards and Labels
Standards that typically require minimum energy efficiency levels for new construction and, sometimes, when making improvements to existing stocks. Typical actors involved in building standards are local, state, and federal government. In some cases, labels may be provided by utilities or government which show the energy efficiency of the building.

Appliance Standards and Labels
Standards that typically require minimum energy efficiency levels for new appliances . In some cases, labels may be provided by utilities or government, which show the energy efficiency of the appliance.

Market Transformation
Programmes that try to influence the attitudes and behavior of individuals and organisations, so that investments in energy efficiency persist even after the programme is changed or eliminated

Alternative Rates
Programmes that offer special rate designs or structures for customers in return for participation in programmes designed to change load shape, especially peak load.

Time-of-Use
Programmes that feature rates differentiated by time-of-the-day and/or season of the year.

Interruptible/Curtailable
Programmes that provide incentives in the form of bill credits or special (reduced) rate structures. In exchange for the incentive, the customer agrees to reduce electrical loads upon request from the utility. The utility's request is usually made during critical periods when the system demand approaches the utility's generating capacity. For interruptible programmes, the power company is able to remotely switch off the equipment. For curtailable programmes, the customer voluntarily reduces power consumption, as laid down in an agreement.

Other
Please provide a brief explanation.

DCI - 3

Customers Targeted By Programme

Refers to groups (or subgroups) of customers with similar characteristics, such as income, building type, or economic activity which is the focus of the programme. Major sectors include Residential, Commercial, Industrial, and Agricultural. Each DSM programme will target at least one sectors. For commercial, industrial, and agricultural sectors, specify 6- digit NACE codes (consult with country experts on selection of codes). **Check all that apply.**

For the multi-family houses/apartments group, four options are possible: central heating, individuals electric space heating, individual non-electric space heating, and district heating.

Non-customers Targeted By Programme

Refers to key groups that participate in the programme as intermediaries for the customers targeted by the programme: e.g., building owners, retailers, wholesalers, appliance manufacturers, builders, realtors and developers, architects and engineers, building managers and administrators, building and equipment operators, and energy service companies. **Check all that apply.**

Technologies

Specify all Technologies that apply to the DSM programme and **use the codes that are listed at the end of the instructions.** Use the **Other** category only if necessary. For each technology, indicate an estimated simple payback time in years.

Payback Time
The period of time required for the energy savings to equal the cost of the conservation action; e.g., if a compact fluorescent exit light costs $6 and saves $3 per year, the payback is 2 years.

Marketing Instruments

Type of Incentives: Any award used to encourage customer participation in a DSM programme and adoption of recommended measures is an incentive. Below are definitions of incentive types:

Rebates and Cash Awards
Cash payments in the form of a check awarded for participation in a DSM programme.

Financing/Loans/Leasing
Utility DSM programme incentives where the financing cost associated with a financial instrument or loan is paid for, in part or in whole, by the utility. The utility may also provide favourable terms for leasing equipment.

Direct Installation
Programmes that offer equipment and installation at no cost to the customer (i.e., out-of-pocket investment on the part of the customer is not required).

Billing Rate Discounts
Reduced billing rates offered to a customer in order to encourage participation in a DSM programme.

Bulk Purchasing
Bulk Purchasing occurs when a utility purchases a large quantity of merchandise (e.g., refrigerators) and sells them at a wholesale cost plus a slight markup (usually lower than retail cost).

Gifts
Incentives in the form of merchandise are awarded to a customer, utility, or trade ally for participation in a DSM programme.

Other
Please provide a brief explanation.

Marketing Methods

The list identifies methods commonly used to contact, educate, or solicit customer participation in a DSM programme. **Check all applicable methods.**

Direct Mail
Direct Mail is used when the primary programme implementing agent sends mail (including brochures and bill inserts) directly to the target group.

Advertising
Includes radio, television, and newspaper advertising of the programme.

Energy Audits
An inspection of a house, building, or industrial process by an expert who makes recommendations for ways the customer can reduce energy use.

Personal Contact
Personal Contact is used when the primary programme implementing agent directly contacts individuals of a target group, face-to-face or by telephone.

Other
Please provide a brief explanation.

Participation Summary

Most Recent Year and Cumulative Participation

Enter the calendar year for which the most recent year costs apply and enter in the column header. Enter the start and end years in the **column** header for which the cumulative costs apply.

Number of Participants
Enter the number of participants that have participated in the programme, where participants may be customers, households, facilities, or firms. The units chosen should be the same unit type as those used to specify the number of expected participants (see page 2 of DCI) and eligible customers (see below).

Number of Eligible Customers
Enter the number of eligible customers, where eligibility refers to criteria that a customer must meet in order to participate in a DSM programme.

Participation Rate (% of Eligible Customers)
The Participation Rate is defined as the *ratio* (expressed as a percent) of the number *of participants* in a programme to the total number of *eligible customers* for the programme. The following equation specifies the participation rate: Participation Rate = (Participants/Eligible Customers*100)

DCI - 4

Programme Impacts

Cost Information

Report all costs in Euro's and enter the calendar year for which the costs apply (if national currency is calculated to Euro.

Most Recent Year and Cumulative Programme Costs, Savings, and Sales

Enter the calendar year for which the most recent year costs, savings, and sales apply and enter in the column header. Enter the start and end years in the column header for which the cumulative costs, savings, and sales apply.

Total Utility/Organiser Costs
All utility/organiser expenses associated with a DSM programme: e.g., rebates, labour costs (such as the time of utility staff, field representatives, and contractors) as well as programme support costs which are directly associated with individual customers participating in the programme; such costs include advertising and programme promotion.
Total Non-Utility/Organiser Costs
All programme expenses paid by customers, trade allies, and other organisations that are not reimbursed by the utility/organiser.
Total Programme Costs
The sum of the utility/organiser costs and non-utility/organiser costs associated with a DSM programme.
Incentive Costs (%)
Indicate the percentage of total programme costs that are monetary inducements in the form of a rebate or payment. Incentives costs could include reimbursement of installation and/or equipment costs as well as other costs such as cash rebates to customers and incentives to trade allies. Incentive cost % plus non-incentive cost % should equal 100%.
Non-Incentive Costs (%)
Indicate the percentage of total programme costs that are non-incentive (administrative) costs. These include labour costs (such as the time of utility staff, field representatives, and contractors) as well as programme support costs which are directly associated with individual customers participating in the programme. Such costs include advertising and programme promotion. Incentive cost % plus non-incentive cost % should equal 100%.
Electricity Savings
Electricity Savings should be entered in megawatt-hours. A megawatt-hour is equal to 1,000 kilowatt-hours or 1,000,000 watt-hours and is abbreviated MWh.
System Peak Demand Savings
System Peak Demand Savings should be entered in megawatts. A megawatt is equal to 1000 kilowatts or 1,000,000 watts and is abbreviated MW. The changes in the demand for electricity resulting from the programme occur at the same time the utility experiences its system peak demand (often referred to as diversified coincident peak demand).
Fuel Savings
Fuel Savings should be entered in TeraJoules (TJ). A TeraJoule is equal to 10^{12} joules.
Appliance Sales
Appliance Sales should be entered in number of units sold. Specify the appliance in the second column using the codes on page 3 of the DCI.

Data Used to Calculate Savings

This section requests information regarding the types of energy data used for the 12calculations of energy and load impacts. **Check all that apply.**

Engineering Data
Estimates using engineering principles with assumptions about equipment and system performance characteristics and operation profiles of measures installed through the programmes.
Utility Bills
Ideally, utility bills are obtained for a year before and a year after participation, Annual electricity and gas use is typically adjusted for weather and other relevant factors, and the differences between pre- and post-participation use in kWh/year or therms/year are computed.
Spot Metering
Generally, electricity and gas use is monitored before and after participation for short times (e.g., a few days). Other relevant factors (e.g., operating hours for equipment and heating degree days) are measured for a longer time (e.g., up to a year).
Whole-building Load Data
Electrical use of a facility is monitored to record kW demands and kWh before and after participation.
End-Use Load data
Specific circuits or equipment affected by new systems are monitored to record kW demand and kWh before and after participation.

Equipment Specifications
Performance of new equipment is calculated based on information obtained directly from the manufacturer. (In those cases where there is a handbook of equipment specs in the hands of engineers, "engineering data' should be checked instead.)
Site Specific Data
Energy and load effects are calculated based on information obtained by a programme representative during an audit of, or other type of visit to, the facility.
Appliance Sales Data
Data on appliance sales generally come from manufacturers or retailers. Sometimes special surveys are conducted to obtain more precise data.
Other
Indicate other data sources used for estimating or measuring the energy impacts of DSM programmes.

<u>Life-Cycle Programme Costs</u>

Average Measure Lifetime
This is the average lifetime of all of the measures installed in the programme. Where possible, the average should be weighted by energy savings (weighted average).
Discount Rate
The real societal and utility discount rates should be reported; these rates exclude the rate of inflation.

<u>Lessons Learned</u>

Enter any lessons learned in this section. Lessons learned may pertain to the current programme year or to the entire life of the programme. Where available, discuss difficulties encountered in programme design, financing, implementation, and evaluation; recommendations for programme improvement; and key elements for programme success.

EXPERT INSTRUCTIONS FOR COMPLETING

These instructions provide guidelines for country experts for the completion of the DCI.

Also it is explained how “Levelised Total Resource Cost” and “Levelised Utility Resource Cost” are calculated.

Four fields have to be filled in by the country experts. These fields are:

- DCI Reference Number;
- INDEEP Expert and Country;
- Date submitted or Date updated;
- Data Collection Phase.

Two fields will be checked by the country expert and improved, if necessary:

- 6-digit NACE codes for Sectors Targeted By Programmes;
- Cost information; the conversion to Euro;

DCI - 1

<u>DCI Reference Number</u>

The DCI reference numbers will consist of the acronym for the country , followed by a “-“ and a two-digit number (-01, -02, -03, etc.). For example, NL-01 is the first DCI by The Netherlands. Other country codes: Austria = AUS; Commission of the European Union = CEU; Denmark = DK; Korea = K; Spain = ES; Sweden = S; United States = USA.

INDEEP Expert and Country

Enter the name of the INDEEP expert entering the data, and the name of the country for this DCI.

DCI Information

Date Submitted
Enter the month, day, and year when the DCI was completed.
Data Collection Phase
If this is the first submission for the DSM programme, check first data submittal. Otherwise, cheek data update.

DCI - 3

Sectors Targeted By Programme

For commercial, industrial, and agricultural sectors, INDEEP country experts may need to **work** with people completing the DCI for specifying the correct 6-digit NACE codes.

DCI - 4

Cost Information

INDEEP country experts need to convert costs (if it is in their country's monetary units) to Euro's; specify which day the Euro was converted.

Life-Cycle Programme Costs

Levelised Total Resource Costs

The levelised total resource cost is the uniform cost of a programme *over its lifetime,* or the cost of the programme's first year multiplied by the uniform capital recovery factor applied at the utility's discount rate divided by the average annual energy or demand changes (in kWh, kW, therms, or MBtus). The costs are the total programme costs listed in the table at the top of page 4 in the DCI. Indicate the average measure lifetime, discount rate, and the cost units used in determining the levelised total resource cost. The equation used in calculating the levelised total resource cost is:

$$\text{Levelized Total Resource Costs} = \frac{\text{Total Program Costs} \times \frac{d}{(1-(1+d)^{-n})}}{\text{Annual Energy Savings}}$$

Where: d = real societal discount rate

n = average measure lifetime

Total programme costs = utility costs plus participants costs

Levelised Utility Resource Cost

The levelised utility resource is calculated in the same way as the levelised total resource cost; the differences are: (1) the costs are utility-related costs (not total programme costs) listed in the table at the top of page 4 in the DCI; and (2) the real discount rate is the utility's discount rate.

EXHIBIT C-2: SUMMARY FORM – PUBLIC POLICY BASED DSM IN THE NORDIC POWER SECTOR

Name:	**Energy labelling**		30/11/98
Country:	Finland	**Data sheet:**	SF2

Intervention type:	Information	**Time period:**	Nov 1995 - Jan 1997

Programme concept:	Pilot project on energy labelling of white goods combined with marketing of the labelling concept to consumers and training of sales personnel in use of EE as a marketing tool.
Programme goals:	Reduction of residential consumption; market shift towards EE appliances; customer awareness of EE appliances; Train sales personnel in EE appliances and correct use and motivate them to use EE as sales argument.
Targeted actors:	Residential customers, sales personnel

Main barrier:	Lack of information	**Technology stages:**	Application/choice

	Actor	Name	Comment
Funding sources:	Equipment retailer association	Retailers Association	36%
	Government/national agency	Min. of Trade & Industry	29%
	EU-Save	-	15%
	Customers	National Consumer Adm.	14%
	Distribution companies	SLY (Ass. Electric Utilities)	6%
Implement. org.(s):	Government/national agency	MOTIVA	Co-ordinator
	Equipment retailer association	Retailers Association	Training
	Customers	National Consumer Adm.	Market research
	Distribution companies	SLY (Ass. Electric Utilities)	Information
Monitoring agents:	Government/national agency	MOTIVA	-
	Customers	National Consumer Adm.	-

Est. time of impact:	Short-term (1-2 years)
Indicators of success:	EE of available appliances, EE products being sold, trained sales personnel, consumer awareness of the energy label, consumers considering energy when purchasing, visibility of energy labels and EE appliances in shops.
Results/impact:	Class A-C refrigeration appliances increased from 52% to 61% while F-G reduced from 25% to 15%. Realised energy savings were not measured.

Programme cost [MECU]:	840	**Unit costs [ECU/act.]:**	870,000	**Specific costs [ECU/kWh]:**	?

EXHIBIT C-3: FIRST DRAFT STANDARD REPORTING FORMAT

Exhibit C-3

First Draft Standard Reporting Format

Person completing the form

Name: Ulla Vuorio

Company: Finnbarents, University of Lapland

Organisation type(s): (Select from guide) Regional government

If other:

Address: Urho Kekkkosen katu 4-6 A, 00100 Helsinki, Finland

Telephone: +358 9 56570510 **Fax:** +358 9 56570515 **Email:** ulla.vuorio@urova.fi

Programme context

General level of competition: (See guide) Monopoly

Main barrier: Investment costs

Comments: The programme concentrated on residential buildings: block of flats and terraced houses. The target was to balance room temperatures inside apartments and save energy by reducing heating costs.

Programme overview

Programme name: Improving the heating system balancing services of buildings

Programme type: Market transformation, Customer retention

Programme start (month and year): May 1993 **Programme end (month and year):** December 1996

Affected energy resource: District heating

Programme primary objective (e.g. avoid capacity expansion) and derived goals (e.g. number of kW peak load saved):

- ☐ Energy import reduction
- ☐ Emission reduction
- ☐ Diversification of supply
- ☐ Increased/maintained profit
- ☐ Avoid capacity expansion
- ☑ Energy price reduction
- ☐ Increased employment
- ☑ Other ________________

- ☑ End-use energy efficiency ________________
- ☑ Peak load reduction ________________
- ☐ Fuel switch ________________
- ☑ Customer retention ________________
- ☐ Improved public relations ________________
- ☐ New services ________________
- ☑ Technological advance ________________
- ☐ Other ________________

Perceived market barriers which the programme intends to overcome:

Complete heating system balancing demands investments, which are about 0.4-1.4 EUR per cubic meter of building. The programme tried to overcome that cost barrier, and to promote energy savings gained after balancing the heating system.

Supporting regulatory and/or market mechanism:

It's possible have free of charge information about heating system balancing from Motiva. After the program was implemented, no governmental financial support for investments has been available.

Implementing organisation(s):		**Organisation type(s):**
Lead organisation:	Motiva, Information centre for EE	Central government
Other organisations:	Oras Ltd	manufacturer
	Ensel Engineering Ltd	Energy service company

Programme costs and foundings

Main funding source(s) for the programme:		**Percentage:**
Source 1	Government funding	20
Source 2	Others	80
Source 3		

Total programme costs:	
Costs, participating customers	2,080,000 EUR
Subsidies from government	
Costs, third party	

Programme object details

End-use(s) affected by the program: Temperature, Energy consumption

Implemented measure (e.g. type of EE technology): Training; improved equipment design and QA system

Eligible market (number or Joule): 80,000 buildings **Target market (number or Joule):** 3,600 buildings

Perceived target market benefits (motivation for participation):

Improving the heating system balancing reduce heating costs. Saving in energy consumption is approximately 10%. Living conditions improve by adjusting room temperatures by balancing.

Evaluation stages

If your evaluation has consisted of several separate stages, please complete a copy of the following section for each evaluation stage and list the stages below.

____

____

____

____

Evaluation report title: Impact assessment report: Improving the heating balance in buildings"

Purpose of evaluation:

- [x] Demand (kW or kWh) impact assessment
- [x] Market transformation assessment
- [ ] Programme project process assessment
- [ ] Other: ______________________________

Evaluation status

Present evaluation status: (See guide) Complete

Evaluation start (month and year): 01/09/00 **Evaluation end (month and year):** 31/01/01

Chosen evaluation framework

Organisation of the evaluation i.e., entities involved (indicate lead and organisation type):

Project Leader: Finnbarents Unit, University of Lapland; Suomen Talokeskus Ltd.; Espoo-Vantaa Institute of Technology; Oras Ltd

Cost of evaluation (e.g. absolute or relative to total programme costs including evaluation costs):

20,000 EURO

Evaluation details

Analysis of the following was carried out:

- [ ] Free-riders (Change in energy use which would have occurred without the programme)
  Method used: ______________________________
- [ ] Free-drivers (Change in energy use of programme non-participants caused by the programme)
  Method used: ______________________________
- [ ] Rebound effect (The achieved savings are used to consume more energy)
  Method used: ______________________________
- [x] Drop-out (Removal or non-installation of energy efficiency measures after initial participation)
  Method used: Questionnaire
- [x] Persistence (Do customers pursue programme measures after termination of the programme)
  Method used: Questionnaire to customers

Applied method for determining baseline values (no-program case) and used sources of data:

(no answer)

Process analysis

- ☑ Observations
- ☑ Surveys
- ☑ Indepth interviews
- ☐ Group interviews
- ☐ Other:

Market analysis

- ☐ Sales statistics
- ☐ Benchmark changes
- ☑ Focus groups
- ☑ Interviews
- ☑ Surveys
- ☐ Other:

Investigated indicators/parameters and the respective sources of data:

Annual district heating energy numbers (kWh/a) from local energy disributors; utility companies.

Lessons learned

Lessons learned concerning the programme:

Governmental financial support is promovating and useful in energy efficiency projects in the first phases. The balancing methodology used was considered a bit too heavy and could be simplified.

Lessons learned concerning the evaluation process:

Customers, house managers, were quite reluctant to contribute to follow-up and assessment studies (25 % replied to the questionnaire). Inquirys need to be repeated twice in order to gain the most numerous response and beneficial result. Direct contacts give results; parallel inquirys and studies were necessary (utilities).

What decisions will be based on the evaluation results:

Energy saving was not the most important aspect, also the improved living conditions were considered important. The ceased governmental support didn't cause any significant decrease in installations of heating system balancing.

Application strategy

How are the results of the evaluation going to be disseminated and to whom?:

The evaluation results will be disseminated to government, programme partners, house owners, HVAC companies. The impact assessement report and results will be presented to the public in the web page of MOTIVA.

Evaluation results

Environmental benefits (tonnes/year): *Applied conversion factor(s):*

CO_2 reduction: 77,500 tn/y; balanced buildings (25% balanced, 75% unbalanced)
Potential CO_2 reduction: 231,000 tn/y, if the rest of buildings were balanced.
(Factors used: CHP 77%, 211 gCO_2/kWh; Heat production 23%, 217 g/kWh)

Gross primary energy savings (TJ/year): *Applied conversion factor(s):*

Gross primary energy savings 22,400 TJ/y; balanced buildings.
Potential of gross primary energy savings 67200 TJ/y, if the rest of were balanced.
(Factors used: DH/CHP 46,8 TWh/ year 2000; 53 % for buildings in question)

Utility capacity savings (kW): *Applied conversion factor(s):*

Energy saving: 42,200 kW; balanced buildings.
Saving potential: 126,000 kW; if the rest of buildings were balanced.
(Factors: Consumption in residential buildings 14.6 TWh, year 2000; 25/75% balanced/unbalanced)

Utility energy cost savings (EURO/year): *Applied conversion factor(s):*

12,7 MEURO/y balanced buildings;
Saving potential: 37 MEURO/y; if the rest of buildings were balanced.
(Factors: the average price of DH 20.4 p/kWh; 1FIM = 100 p; 1EURO = 6 FIM)

Market change (specify unit):

Adoption in the market has occurred: 100 % of anwerers will continue in balancing the heating system.
Other methods have been developed for balancing the heating system in buildings.

Monitoring & verification results (specify unit): *(Relevant to ESCO projects)*

Buildings incuded in the asessment have been in consumption follow up study of the utility company.

Other results (specify unit): *Applied conversion factor(s):*

The most of the answerers cosidered that the investment has been benefial; information on the subject should be increased.

Registered positive/negative side-effects (e.g. extra heating requirement, less noise)?:

None significant side-effects; only slight noise effects possible.

What is the difference between expected and realised programme impacts and why?:

The programme intended to get residents' adoption of room temperature of 21 degrees, which seemed not realistic, since many residents prefer temperatures of 22-23 degrees.

Did the evaluation provide reliable and useful results?:

The results are reliable because they are based on the realistic consumed figures from utility companies.

Did the chosen indicators prove appropriate?:

(no answer)

Person completing the form

Other
Generator
Transmission company
Distribution company
Retail company (sales only)
Central government
Regional government
Local government
Energy service company
Manufacturer Consumer organisation
Environmental protection organisation
Non-governmental organisation

Programme context

Strongly competitive
Partial captive market (less competitive)
Monopoly

EXHIBIT C-4: SECOND DRAFT STANDARD REPORTING FORMAT (CHECKLIST FORMAT)

Your company name	Novem, the Netherlands
Project name	**Energy Performance Standard in the Dutch Building Decree**
Why did you want an evaluation?	Information to advocate that the legal maximum could be lowered, as energy savings are realised
What was the goal of the evaluation?	Indication of the energy use in houses with an EPC 1.2 or lower
Which questions should be answered by the evaluation?	Are the calculated ex ante savings realised in practice or not
Who was the buyer of the evaluation?	Ministry of Environment, Spatial Planning and the Environment
Who did perform the evaluation?	Novem
Who is going to use the results of the evaluation?	Ministry of Environment, Spatial Planning and the Environment
Did you have an evaluation plan from the start of the project?	No
Was the evaluation divided into part-studies?	Yes (four parts)
What were the key areas of uncertainty in the evaluation?	Influence of behaviour on the energy use in houses with more or less equal energy performance
Did you evaluate development and design of the project?	No
Did you evaluate economy/profitability?	No
Did you do Benefit/Cost analysis and for which perspectives?	No
Did you evaluate the technology?	No
Did you evaluate energy efficiency?	Yes
Did you evaluate implementation?	No
Did you evaluate co-operation?	No
Did you evaluate marketing processing?	No
Did you evaluate participant data collection?	No
Did the project include tracking/monitoring from the start?	No
Did the project include tracking/monitoring later?	Yes
Did the evaluation include non-participant survey/metering?	No
Did the evaluation include use of billing data?	Yes
Did the evaluation include end-use metered data?	No
Did the planning and evaluation use engineering methods?	No
Did the planning and evaluation use statistical methods?	Yes
Did you evaluate free-ridership?	No
Did you evaluate spill-over?	No
Did you evaluate rebound?	No
Did you evaluate the persistence of savings?	Partly
Did you evaluate estimation of market transformation impacts?	No
Did you do market indicator interviews with vendors etc.?	No
Did you evaluate the lifetime of the market transformation?	No
Did you do market studies by direct observation?	No
Did you do personal interviews?	No
Did you do telephone survey?	No
Did you do mail surveys?	Yes
Did you do in-depth and group interviews?	No
Were market studies conducted at the start, medio and/or end?	No