

Energy audits – best practice and decision support

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Abstract

Energy audits are a central feature in the effort to increase energy efficiency. The paper provides an insight into key elements of an Energy Audit Programme and gives guidance in relation to how such programmes should be set-up to produce high quality results in an efficient way. The paper is based on the AUDIT II project, which has been co-financed by the EU's SAVE programme. It mainly focuses on five vital elements of Energy Audit Programmes, i.e. *Implementing Instruments* – which instruments ensure that Energy Audits are implemented on a broader scale?; *Monitoring* – what are the effects/impact of the Energy Audit programmes?; *Energy Audit Models* – what kind of models are used to ensure that the audits are focused, comprehensive and answering the appropriate questions?; *Energy Audit Tools* – what kind of tools can bring additional efficiency to the audit work and lower administrative burden of the operating agent?; and *Auditor Training, Authorisation and Quality Control* – what is the right balance between these three topics to ensure that the audits have good quality, taking into account available resources?

Basic options and recommendations within the above topics will constitute the core of the paper. Administrative issues that need to be addressed by the operating agents of energy audit programmes are also discussed. Finally, the pa-

per addresses the need for a European standard for energy audits.

Introduction

Energy audits are frequently used as an instrument to achieve energy savings – and they are often vital parts of more comprehensive national and regional energy efficiency programmes. By energy audits we mean a “*systematic procedure where the purpose is to obtain adequate knowledge of the existing energy consumption profile of a site/object, to identify the factors that have an effect on the energy consumption, and to identify the energy saving opportunities and group them according to their profitability*” [1]. In this context energy audits are limited to existing sites/objects. The main purpose of an energy audit is to illustrate the energy efficiency measures that are available for an energy end-user and to convince him to accomplish those energy projects, which are technically viable and economically profitable.

In the AUDIT II project (EU SAVE supported), reports have been elaborated regarding the use of energy audits in all EU countries, including Norway, and the majority of the applicant countries to the EU. The country reports are based on interviews with national experts in each country. The country reports have been used for preparing reports on selected topics, such as *Implementing Instruments, Monitoring, Energy Audit Models, Energy Audit Tools and Auditor Training, Authorisation and Quality Control*. The main objective of the project has been to identify the basic options, produce recommendations and give guidance in relation to how an Energy Audit Programme could be set-up in an efficient way. The final product of the project is a tool for

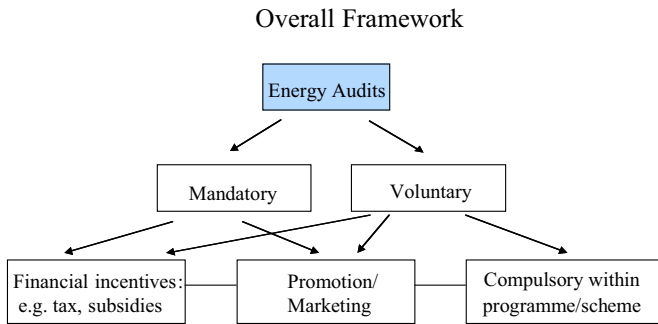


Figure 1. Basic options (paths) on how to implement energy audits.

decision support in the form of a Guidebook [2] aimed at the public administration or operating agent, which has been assigned the task of setting up and manage an energy audit programme or a programme where energy audits have a central place. This paper addresses some of the key findings in the above-mentioned topic reports and shortly presents some key issues addressed in the Guidebook, including a brief discussion on the need for a European standard for energy audits.

Implementing Instruments

An energy audit programme has to include some kind of incentives, which make it interesting for the target group to undertake an audit, i.e. there is a need for an implementing instrument. In principle, audits can be implemented by mandatory or voluntary instruments. Mandatory instruments are instruments, which are legally enforced by laws and regulations. If instruments are not legally enforced they are per definition “voluntary”.

With each of these two types a set of basic options can be applied, to convince a target group to carry out energy audits (see Figure 1). Financial incentives are mainly tax or subsidy schemes, using the money argument as an incentive. Compulsory instruments can be used to make energy audits compulsory within a certain scheme which can be chosen on a voluntary basis, e.g. within agreements between a target group and the authority.

The major findings in the AUDIT II project were that energy audits often are integrated into broader programme structures to take into account the specific conditions of a target group, e.g. agreement and labelling schemes. When energy audits are connected to mandatory instruments no other instruments are in principle required. Mandatory audits are better applicable for large and homogeneous target groups, such as customers in the building sector or small and medium sized enterprises. Labelling schemes and building certificates can serve as programme examples.

If the policy maker opts for voluntary instruments, energy audits can either be integrated as a compulsory element of an overall programme or as a totally voluntary feature. Agreements are an example of how audits can be made compulsory for a target group. To convince the target group to

enter into an agreement, financial incentives are often applied. The less compulsory energy audits are or the weaker the incentives are, the more promotion and marketing is needed. If energy audits should be totally voluntary, financial incentives should be combined with strong promotional activities. Financial support in form of subsidies is often applied, but “free riding”¹ has to be taken into account. Voluntary instruments seem to be better suited for smaller, not so homogeneous target groups. Agreement schemes might be appropriate for large building owners or industry.

Monitoring

Monitoring is an essential element to provide information on the impact of the energy audit programmes and the use of public resources. Monitoring is defined as a continuous or repetitious activity running over the whole lifetime of the project in order to keep control and obtain information on the impact of the audit programme. The monitoring gives an answer to the question: “What did we achieve from the public resources spent on the audit programme?”

There are different levels to choose from when deciding to undertake monitoring. Level 1, “*Expenditure*”, is just a simple monitoring of details concerning the recipient of the subsidy and the actual amount. This is done for accounting purposes. Level 2, “*Energy Audit Volumes*”, only includes simple registration and counting of the audits in total, for example with respect to sector and auditor. This gives a picture of the activity, but does not say anything about the possible energy savings. On level 3, “*Savings potential*”, the energy audits are used to obtain information about the kind of measures that have been identified, the savings in energy and the corresponding costs and economics. The benefit of this monitoring activity is that it provides an overview of the economy – herein lays the attractiveness of the measures. Level 4, “*Theoretical savings of implemented measures*”, entails following up the audits. The aim here is to find out what measures have actually been undertaken. This can be done through questionnaires, site visits or a combination of both. As a minimum, the following information must be collected: energy consumption divided on different carriers, production volumes (industry), accomplished measures and estimates of energy savings. Based on the data obtained, it is possible to calculate a better estimate of the energy savings that have been achieved. To further increase the quality of the monitoring, it is possible to register the energy use at the level of a company or a building. This is done on level 5, “*Measured savings at site level*”. This information will over time show if the implemented measures reduce the overall energy consumption of the factory or the building. Level 6, “*Verified results*”, implies that the implemented measures resulting from an audit are measured and verified by a third party. In practice, verifications at this level are undertaken using sampling methods, in which 5 to 10% of the representative measures are actually controlled. The overall result can be generated through the use of statistical methods.

It is important to note that the information value increases with the monitoring level, but so do the costs. Therefore, it

1. Free riders are clients which would have undertaken the energy audit even without the subsidy.

is necessary to conduct a cost/benefit analysis to determine the appropriate level to apply in each case.

The major findings [3] were that the monitoring system must be designed at the same time as the other characteristics of the programme. To produce the desired effect, the monitoring system must be up and running from day one of the programme. Even if the aim is to run a very limited energy audit programme with a small budget, it is necessary to take into account future developments. Therefore, the operating agent should always establish a simple database, where essential information about the companies and the audit can be saved and used to produce energy statistics. Furthermore, the database should be flexible, i.e. allow for extensions. Such a database allows for monitoring at level 3, which is deemed to be the minimum. If there is a need to produce good quality information on the situation after the audit has been finalised, i.e. what the actual impact is, there is at least a need for a monitoring system at level 4. In this case, it is recommended to control a statistically significant number of samples. Most of the energy audit programmes and relevant schemes used in the countries included in the project used a monitoring system corresponding to level 3 and upwards.

Energy Audit Models

Energy Audit Models (EAM) are agreed features or requirements designed for a specific type of an energy audit application. In a model the actual scope, thoroughness and aim of the audit are defined. The audit model is usually a standardised, commonly known and commonly followed procedure with written guidelines.

The **scope** of an energy audit may vary according to different target sectors or client groups; the audit may cover a building or a site in various ways. An energy audit that is narrow in scope covers typically only a specific system (such as a compressed air system) whereas a wider audit may cover all energy use within the site. The **thoroughness** of audits may also be different – in his work the auditor may use “a fine or a rough comb” when looking for the energy saving potential. The thoroughness of the audit work is directly related to the time and the cost of the audit. Energy audits may also have different **aims** and they are used for different purposes. They can either just point out areas where energy savings can be found or describe in a detailed report specific energy efficiency measures.

The basic options concerning EAMs are the *Scanning* and the *Analysing* models. *Scanning* EAMs are rough, relatively cheap and concern only possible housekeeping/low cost measures for energy savings in the audited site. *Analysing* EAMs are much more thorough and cover either entire factories/premises or specific areas or systems and includes possible capital cost measures for energy savings in the audited site.

In the AUDIT II project the findings are that both basic model options are applied in practice. They include a set of standard audit work features, i.e. audit cost & time, audit phases and audit reporting characteristics. The use of a model is directly connected to the aims and characteristics of a programme.

The EAM usually refers to mandated or recommended supporting tools, e.g. technical codes and guiding documents and software.

Through the use of EAMs, the programme administration gains the benefit of having clear requirements for the audit work input & output parameters, the data and deliverables associated with the specific target group. In addition, the model will lead to increased audit work productivity and replicability because of specified application features and efficient quality control of audit work deliverables.

The selection of models in an energy audit programme depends on various issues:

- the goals of the programme (energy saving, reduction of CO₂, etc.),
- the target sectors of the programme,
- the scope and extent of the programme,
- the auditors' skills.

The models are usually different for different target groups. In heavy industry a multi-phase audit starting with a scanning model is a good option, whereas in the tertiary sector comprehensive audits are often used. The number and type of models are programme- and country-specific, and should be considered parallel with the general formulation and development of the programme elements.

When planning the audit models, the Administrator and Operating Agent should listen to the opinions of the client groups and auditors. Combining the other elements of the programme to the practical audit work needs a thorough analysis. An energy audit programme will not work properly if there are no clearly defined audit models that fit the needs of the client groups and the skills of the auditors.

Energy Audit Tools

The wording “Energy Audit Tools” covers a large family of support documents and applications, which are intended to facilitate the work of energy auditors with a view to minimising the cost of undertaking the audits and maximising the audit quality. They are generally dependant on the energy audit models and address different phases in the energy audit process ranging from marketing to technical and reporting assistance.

Tools may come in different forms, e.g. flyers, guides, booklets, films, web sites or CD-ROMs. The choice of media channel, however important, often becomes a compromise taking into account: cost of production, cost and easiness of dissemination, nature of the content and target group. In the project the findings were that there is no unique “tool box” that would cover all the potential needs in an energy audit programme. Depending on the nature of the programme, the administrator must choose from a mix of various existing tools that would fit their needs, the clients' needs and the consultancy market.

Key determinants for the need for tools are the nature of the target sector and the size of the desired market penetration of this sector (5%, 50%?) as well as the resources on the auditors' side: how many consultants are able to work on the identified market? Do they have the necessary tools to un-

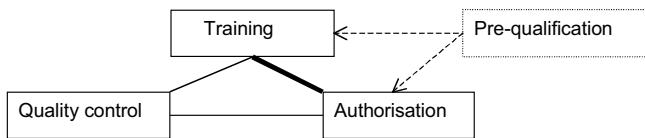


Figure 2. Connections between Training, Authorisation and Quality Control.

undertake marketing and realise the audits in due time and within acceptable economic limits?

The larger the programme and the scarcer the professional resources of the consultant, the more necessary it is to develop tools to assist the market. Consequently, if the target sector consists of a very limited number of specialised entities and the consultants are highly skilled, there is little need for tools (typically an industrial sector with few and large companies). On the other hand, if the target sector consists of a large number of entities, and the number of auditors are many but have little training, there should be a great demand for audit tools (typically the household sector).

Tools for auditors are not the most essential elements of an energy audit programme, but still elements that bring multiple benefits: some tools can also be used as marketing instruments (case studies, fact sheets) or contribute to the training sessions (auditing hand book, software tools). Quality control, monitoring and the application of an energy audit model may also be facilitated through adequate use of tools.

Auditor Training, Authorisation and Quality Control

Auditor Training means education of energy auditors in how to undertake energy audits, and may include only the energy audit procedure, the technical issues connected to it, or a wider range of topics (marketing, financial, environmental, etc.). *Authorisation* of an energy auditor is a “licence” to perform audits within the audit programme. The authorisation may concern a person and/or a company. Usually the authorisation is valid for a specific area and for a limited time. *Quality control* in an energy audit programme means checking the work of the auditors. A neutral body usually performs this control. Quality control is the most effective way to avoid serious quality problems in the energy audit programme. It should guarantee equal treatment and it is also a guarantee for the clients that the quality of auditors’ work is acceptable.

The main aims of training, authorisation and quality control are to keep in touch with the audit business and auditors, to keep the non-professional auditors from the business, to ensure that all auditors address the issues in a similar way and produce work of equal quality and to assure the clients and auditors that the quality and public image of the energy audits is appreciated and controlled.

In the project several different options on how to put into practice these elements have been identified. These three elements support and compensate each other to some degree. Light training and authorisation can be compensated by a strict quality control. However, one of the three “main pillars” must be strong.

Figure 2 illustrates the connection between training, authorisation and quality control. In addition to the main elements, pre-qualification has been added to illustrate a possible requirement for basic education in connection with training and authorisation. Training and authorisation are closely connected and the two elements may not actually be separate from each other. Authorisation is often a normal continuation of training.

The actual effects and also the required resources will vary according to the weight that the administrator would attach to any of these three elements and their combinations. Therefore the choices concerning training, authorisation and quality control should be determined by the aims of the programme and the available human and financial resources. There are several options that could be chosen from each element. Some of the choices between the different options can be made independently, but some have an effect on the other elements or exclude some of the next options. These options vary from simple and low cost to complex and high cost. The quality increases with the complexity.

Administrative issues – Conclusion

When introducing a new energy audit programme it is important to keep in mind that programme administration is important and demanding. The administrative burden is closely linked to quality requirements and the size of the programme. Managing a comprehensive energy audit programme requires considerable professional competence in engineering, economics and marketing on the part of the administrator. Some of the tasks can be outsourced. The size and ambitions of the programme, the capacity of the administrator and the availability of suitable and competent auditors determine whether or not outsourcing would be advisable.

In the AUDIT II project, the need for a European standard for energy audits has been considered. Given the broad range of programme goals, target sectors, fields of energy use and energy audit models, it has been concluded that one single European standard for energy audits has little merit. This standard could never be uniform. It would have to allow for too many adaptations to national and sectoral circumstances. However, it would be useful with European recommendations with regard to sectoral Energy Audits. These could cover several energy audit models in combination with relevant reporting tools adapted to the target of an activity, e.g. from a scanning to a detailed analysis.

In the AUDIT II project, key topics vital for setting-up and running energy audit programmes has been reviewed and analysed. Furthermore, recommendations are made concerning these topics. The most important conclusion from the project is that the success of an energy audit programme depends to a great extent on the clarity of the objective and framework conditions concerning the programme. Furthermore, there are several options to choose from within each key topic, and the efficiency and success of the programme is very much coupled with the ability to choose the right options.

The Topic Reports, the Guidebook and the Country Reports can be found at the following address: www.motiva.fi/english/English/Energy%20Audits/Audit%20II%20Project.

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