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## Introduction

This draft standard is based on international discussions in which the UK has taken an active part. Your comments on this draft are invited and will assist in the preparation of the consequent standard. Comments submitted will be reviewed by the relevant BSI committee before sending the consensus UK vote and comments to the international secretariat, which will then decide appropriate action on the draft and the comments received.

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## Template for comments and secretariat observations

Date: xx/xx/20xx	Document: <b>ISO/DIS xxxx</b>
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1	2	(3)	4	5	(6)	(7)
MB	Clause No./ Subclause No./Annex (e.g. 3.1)	Paragraph/ Figure/ Table/Note	Type of comment	Comment (justification for change) by the MB	Proposed change by the MB	Secretariat observations on each comment submitted
	3.1	Definition 1	ed	Definition is ambiguous and needs clarifying.	Amend to read '...so that the mains connector to which no connection...'	
	6.4	Paragraph 2	te	The use of the UV photometer as an alternative cannot be supported as serious problems have been encountered in its use in the UK.	Delete reference to UV photometer.	



# DRAFT INTERNATIONAL STANDARD ISO/DIS 50002

ISO/TC 242

Secretariat: **ANSI**

Voting begins on  
**2013-06-13**

Voting terminates on  
**2013-09-13**

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## Energy audits

*Audits énergétiques*

ICS 27.010

To expedite distribution, this document is circulated as received from the committee secretariat. ISO Central Secretariat work of editing and text composition will be undertaken at publication stage.

Pour accélérer la distribution, le présent document est distribué tel qu'il est parvenu du secrétariat du comité. Le travail de rédaction et de composition de texte sera effectué au Secrétariat central de l'ISO au stade de publication.

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## Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 50002 was prepared by Technical Committee ISO/TC 242, *Energy Management*.

## Introduction

The purpose of this international standard is to define the processes leading to the identification of opportunities for the improvement of energy performance.

An energy audit or assessment comprises a detailed review of the energy performance of an organization, of a process, or both. It is typically based on appropriate measurement and observation of energy uses and consumption. Audit outputs typically include information on current consumption and performance, and they can be accompanied by a series of ranked recommendations for improvement in terms of energy performance. Energy audits are planned and conducted as part of the identification and prioritization of opportunities to improve energy performance. An energy audit can support an energy review as is described in ISO 50001 or be used independently.

There can be differences in approach and in terms of scope, boundary and audit objective. This International Standard seeks to harmonize common aspects of energy auditing in order to enhance clarity and transparency to the market.

The energy audit process is presented as a simple chronological sequence, but this does not preclude repeated iterations of certain steps.

The main body of this International Standard covers the general requirements common to all energy audits. For auditing of specific economic sectors, processes or equipment, refer to the relevant international, national and local standards and guidelines.

An energy audit allows an organization, whatever its size or type, to improve its energy performance, reduce energy consumption and obtain related environmental benefits.

This International Standard does not address the requirements for auditing an organization's energy management system: these are described in ISO 50003.





# Energy Audits

## 1 Scope

This International Standard applies to an energy audit carried out in relation to energy performance and specifies the requirements, common methodology and deliverables for energy audits. It applies to all forms of establishments and organizations, all forms of energy and uses of energy.

This International Standard covers the general requirements common to all energy audits.

This International Standard does not address the requirements for auditing an organization's energy management system: these are described in ISO 50003.

## 2 Normative References

There are no normative references.

## 3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

### 3.1

#### **audit objective**

deliverables of an energy audit agreed between the organization and the energy auditor

### 3.2

#### **audited objects**

subject of the energy audit

EXAMPLES Site(s), building(s), equipment, system(s), process(es), transport system(s) or service(s)

### 3.3

#### **boundary**

physical or site limits and/or organizational limits as defined by the organization

Note to entry: The boundary of an energy management system could be different to the boundary of an energy audit

### 3.4

#### **energy audit**

systematic analysis of energy use and energy consumption of audited objects, in order to identify, quantify and report on the opportunities for improved energy performance.

Note to entry: "Energy audit" is the normal expression in English. There are other expressions for the same concept for example: analysis, review, study, assessment, "diagnosi" in Italian, "diagnostic" in French.

### 3.5

#### **energy auditor**

individual, group of people or body conducting an energy audit

Note to entry: Energy audits can be conducted by the organization using internal resources or external recourses such as independent energy consultants, and energy service companies.

[SOURCE: EN 16247-1:2012, 3.2]

**3.6**  
**energy balance**  
accounting of inputs and/or generation of energy supply versus energy outputs based on energy consumption (3.7) by energy use (3.12)

Note 1 to entry: Energy storage is considered within energy supply or energy use.

Note 2 to entry: Feedstock variation as well as wasted energy and energy embodied in material flows need to be considered within the energy balance.

**3.7**  
**energy consumption**  
quantity of energy applied

[SOURCE: ISO 50001:2011, 3.7]

**3.8**  
**energy efficiency**  
ratio or other quantitative relationship between an output of performance, service, goods or energy, and the respective input of energy

EXAMPLES Conversion efficiency; energy required/energy used; output/input; theoretical energy used to operate/energy used to operate.

Note to entry: Both input and output need to be clearly specified in quantity and quality and be measurable.

[SOURCE: ISO 50001:2011, 3.8, modified — “the respective” has been added.]

**3.9**  
**energy flow**  
description or mapping of process for transfer of energy or conversion of energy within the audited object(s)

**3.10**  
**energy performance**  
measurable results related to energy efficiency (3.8), energy use (3.12) and energy consumption (3.7)

[SOURCE: ISO 50001:2011, 3.12, modified — NOTE 1 and NOTE 2 have been deleted as the notes were specific to energy management.]

**3.11**  
**energy performance indicator**  
quantitative value or measure of energy performance, as defined by the organization

Note to entry: This could be expressed as a simple metric, ratio or a more complex model.

[SOURCE: ISO 50001:2011, 3.13]

**3.12**  
**energy use**  
manner or kind of application of energy

EXAMPLES Ventilation, lighting, heating, cooling, transportation, processes, production lines.

[SOURCE: ISO 50001:2011, 3.18.]

**3.13****organization**

company, corporation, firm, enterprise, authority or institution, or part or combination thereof, whether incorporated or not, public or private, that has its own functions and administration and that has the authority to control its energy use and consumption

Note to entry: An organization can be a person or a group of people.

[SOURCE: ISO 50001:2011, 3.22]

**3.14****relevant variable**

quantifiable parameter impacting energy consumption

Note to entry: relevant variables could also be known as adjustment factors

EXAMPLES Weather conditions, operating parameters (indoor temperature, light level) working hours, production throughput.

**3.15****scope**

activities the energy auditor and the organization agree are necessary for the energy audit

**4 Energy audit principles****4.1 General**

A good energy audit is characterised by reliance on a number of principles. These principles help to make the energy audit an effective and reliable tool in support of management decisions and controls, by providing information on which an organization can act in order to improve its energy performance.

Adherence to these principles is a prerequisite for providing an effective energy audit and for enabling energy auditor(s), working independently from one another, to reach similar conclusions in similar circumstances.

Application of these principles is fundamental to the evaluation of the energy auditor's competence, confidentiality, and objectivity.

**4.2 Energy auditor principles****4.2.1 Competency**

The energy auditor shall have suitable knowledge for the type of work being undertaken and the agreed scope, boundary and audit objective. Competence can be shown by:

- a) appropriate education and/or training;
- b) relevant technical, managerial and professional experiences and skills;
- c) familiarity with appropriate regulations;
- d) familiarity with the energy uses being audited;
- e) knowledge of the requirements of this International Standard;
- f) for a team member designated as lead energy auditor, having the skills to manage and provide leadership to the energy audit team.

Educational and training qualifications should consider local or national guidelines and recommendations.

#### 4.2.2 Confidentiality

The energy auditor shall exercise discretion in the use and protection of information acquired in the course of their duties. Energy audit information shall not be used inappropriately for personal gain by the energy auditor or the organization, or in a manner detrimental to the legitimate interest of the organization. This concept includes the proper handling of sensitive or confidential information.

#### 4.2.3 Objectivity

The energy auditor shall act independently and in an impartial manner. Conflicts of interest: personal, financial or other shall be identified and disclosed to the organization in a timely manner.

**NOTE** A conflict of interest occurs when an individual or organization is involved in multiple interests, some of which could possibly corrupt the motivation for an act in the other.

If the organization intends to carry out an energy audit using internal personnel, it may not be possible for energy auditor(s) to be fully independent of the audited object(s), but every effort should be made to remove bias and encourage objectivity.

### 4.3 Energy audit principles

The following principles apply to an energy audit:

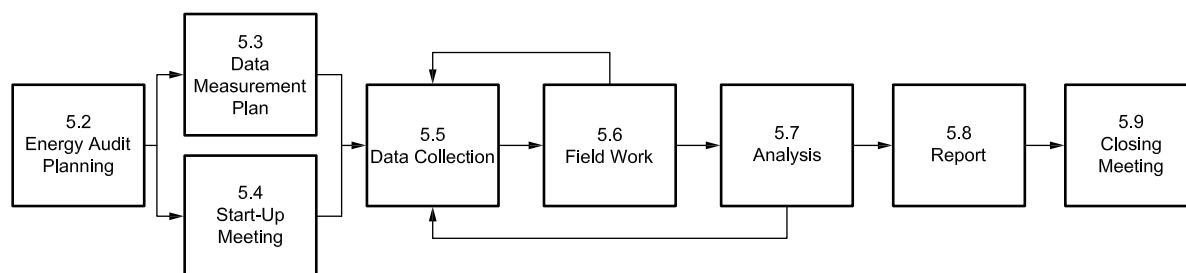
- a) consistent with the agreed scope, boundary and audit objective;
- b) measurement and observation is appropriate to energy uses and consumption;
- c) collected energy performance data is representative;
- d) the process of collecting and analysing data is traceable;
- e) provides energy performance improvement opportunities based on appropriate economic analysis;

## 5 Performing an energy audit

### 5.1 General

The energy audit process consists of the following stages, as illustrated in Figure1:

- a) energy audit planning;
- b) start-up meeting and data measurement plan;
- c) data collection;
- d) field work;
- e) analysis;
- f) report;
- g) final meeting.



**Figure 1 — Energy audit process flow diagram**

## 5.2 Energy audit planning

Energy audit planning activities are essential to define the scope of the works, and to gather preliminary information from the organization.

In order to develop the scope and carry out appropriate and effective energy audits:

a) the energy auditor shall agree with the organization concerning the following aspects of the energy audit:

- 1) audit objective;
- 2) boundary;  
 EXAMPLES the whole site and all energy using systems or the boiler plant or the vehicle fleet.
- 3) aims, needs and expectations;
- 4) level of detail required;  
 EXAMPLES proportion of apartments in a block to be assessed; whether a level of detail sufficient for investment decisions is required.
- 5) time period to complete the energy audit;
- 6) criteria for evaluating opportunities for improving energy performance;  
 EXAMPLES return on investment, potential energy saving over time, life cycle costing
- 7) time commitments and other resources from the organization;
- 8) relevant data to be made available prior to the energy audit commencing;  
 EXAMPLES drawings, historical energy consumption, manuals and other technical documentation relevant to the audited objects; planned measurement and/or inspection to be made during the energy audit.
- 9) expected deliverables and required format of the report;
- 10) whether a draft of the final report to the organization should be presented for comment;
- 11) person responsible for the energy audit process within the organization;

**NOTE 1** It is recommended that organizations nominate a management representative to take responsibility for evaluation and implementation of energy performance improvement measures identified during the audit.

b) where applicable, the energy auditor shall request information concerning:

- 1) the energy audit context;

EXAMPLES          energy audit related to a government or other defined agreement/scheme.

- 2) regulatory or other constraints affecting the scope or other aspects of the proposed energy audit;
- 3) strategic wider programme (planned projects, outsourcing facilities management);
- 4) management system (environmental, quality, energy management system or others);
- 5) changes or special considerations that may have an impact on the energy audit and its conclusions;
- 6) any subjective considerations to include existing opinions, ideas and restrictions relating to potential energy performance improvement measures;

- c) the energy auditor shall inform the organization of any:

- 1) special facilities and equipment required to enable the energy audit to be carried out;
- 2) commercial or other interest which could influence his or her conclusions or recommendations;
- 3) any other conflict of interest issues.

NOTE 2      Annex A provides guidance that may be useful at the planning stage, including indicative levels of audit.

### 5.3 Data measurement plan

For any on-site data measurement and collection, the energy auditor and organization shall come to an agreement on the:

- list of the existing measurement points and their associated processes;
- identification of additional necessary measurement points, suitable measurement equipment, their associated processes and feasibility of installation;
- measurement duration: one-off or electronically logged;
- acquisition frequency for each measurement;
- identified period during which the company's activity is representative;
- people responsible for carrying out the measurements

EXAMPLES          the organization, the energy auditor or any of its subcontractors;

- accuracy and repeatability required for the measurements.

Sampling may be required when it is not practical or cost effective to examine all available information during an audit. Sampling is described in ISO 19011:2011, Clause B.5.

The data measurement plan is developed over three stages:

- a) Stage 1: Use of measurement instrument

The energy auditor should:

- 1) define the measurements' methodology and their level of accuracy;

- 2) be responsible for the measurements taken on site;
- 3) check the proper operation and functioning of the measurement equipment;
- 4) check that measurements taken by the measurement equipment are accurate and repeatable

The type of measuring device to be used is specified in line with the nature of the variable being measured, its magnitude, operating range and the accuracy required, and the conditions of use.

b) Stage 2: Data measurement

During the data measurement stage, the organization may be asked to provide the corresponding relevant variables, e.g. operating parameters, production data.

c) Stage 3: Preliminary data treatment

This stage is to shape the large amount of collected measurements into usable data for analysis. This includes the assessment of the:

- 1) principle of each measurement, the level of uncertainty and the elements which allow its level of accuracy to be assessed;  
  
NOTE Keeping a record of how the measurement was made, manufacturer's stated precision, calibration certificate, etc.
- 2) check and balance of measurements made  
  
EXAMPLES mass balance, energy balance.
- 3) calculations made and their range of applicability;

Results of the measurement could be presented in charts and graphs or summarised in a table.

## 5.4 Start-up meeting

The purpose of the start-up meeting is to brief all interested parties about the audit objectives, scope, boundary, level of detail and to agree on arrangements for the energy audit (e.g. site safety inductions, access, security, etc.)

NOTE 1 The word meeting in this International Standard includes telephone calls, webinars and/or other remote interactive discussions.

a) The energy auditor shall request the organization to:

- 1) identify a person to liaise with the energy auditor, where necessary supported by other appropriate individuals constituted as a team for the purpose;
- 2) inform affected personnel and other interested parties about the energy audit and any requirements placed on them in connection with it;
- 3) ensure the cooperation of the affected parties;
- 4) disclose any unusual conditions, maintenance work or other activities that will occur during the energy audit.

Where the energy auditor is not an individual, a member of the energy auditing team shall be nominated as lead energy auditor.

NOTE 2 Some of these requirements might already have been addressed at an earlier stage.

- b) The energy auditor shall agree with the organization on:
- 1) arrangements for access to the audited objects for the energy auditor;
  - 2) health, safety, security and emergency rules and procedures;
  - 3) resources and data to be provided;
  - 4) non-disclosure agreements (e.g. tenants in a building);
  - 5) proposed visit and other schedules;
  - 6) requirements for special measurements, if needed;
  - 7) procedures to be followed for installation of measuring equipment, if needed.

The energy auditor shall describe the processes, means and schedule of the energy audit and the possible need for additional metering equipment.

## 5.5 Data collection

When determined necessary, the energy auditor shall collate the following information:

- a) list of energy consuming systems, processes and equipment;
- b) detailed characteristics of the audited object(s) including known relevant variables and how the organization believes they influence energy consumption;
- c) current and historical data;
  - 1) energy consumption;
  - 2) relevant variables;
  - 3) relevant related measurements;
- d) monitoring equipment configuration, and analysis information;
 

EXAMPLES local gauges, distributed control systems, instrumentation types.
- e) future plans that affect energy use;
 

EXAMPLES 1 planned expansions, contractions or changes in production volume.

EXAMPLES 2 planned changes in or replacement of equipment or systems that have significant energy implications.
- f) design, operation and maintenance documents;
- g) energy audits or previous studies related to energy and energy performance;
- h) current or a reference tariff to be used for financial analysis;
- i) other relevant economic data;
- j) knowledge on how the organization manages its energy;
- k) relative configuration of the energy distribution system and the management structure



## 5.6 Field work

### 5.6.1 Management of field work

The energy auditor shall:

- a) inspect the audited objects within the boundary;
- b) evaluate the energy use of the audited objects according to the scope, boundary, audit objective and level of details;
- c) understand the impact of operating routines and user behaviour on energy performance;
- d) generate preliminary ideas, opportunities, operational changes or technologies for energy performance improvement;
- e) list areas and processes for which additional quantitative data would provide clarity to the energy audit or support the energy audit conclusions.

### 5.6.2 Conduct

The energy auditor shall:

- a) ensure that measurements and observations are made under circumstances which are representative of normal operation;

**NOTE** It is accepted that it can be beneficial to make observations and measurements outside normal working hours, during shut-down periods or when no climatic load is expected.

- b) ensure that historical data provided is representative of normal operation;
- c) promptly inform the organization of any unexpected difficulties encountered during the work.

### 5.6.3 Site visits

The energy auditor shall ask the organization to:

- a) identify one or more individuals to act as guide and escort for the energy auditor during site visits as required; these individuals shall have necessary competences and authority to request or carry out direct operations on processes and equipment, if required;
- b) where applicable, identify one or more individuals to install data loggers and energy monitoring equipment during site visits; these individuals should have necessary authority to ask the authorized operation or maintenance personnel to carry out direct operations on processes and equipment if required;
- c) give the energy auditor access to relevant documents

**EXAMPLES** Drawings, manuals and other technical documentation.

## 5.7 Analysis

### 5.7.1 General

The energy auditor shall:

- a) evaluate the reliability of data provided and highlight faults or abnormalities and judge whether or not the information provided allows the energy audit process to continue and the agreed audit objectives to be achieved.

NOTE If necessary, the energy auditor may propose a methodology to collect or supplement the data.

- b) use transparent and technically appropriate calculation methods;
- c) document the methods used and any assumption made;
- d) subject the results of the analysis to appropriate quality and validity checks;
- e) consider any regulatory or other constraints of the opportunities for improving energy performance.

EXAMPLES Energy efficiency level, labelling programme.

### 5.7.2 Analysis of existing energy performance

During this phase, the energy auditor shall establish the existing energy performance of the audited object.

The existing energy performance provides the basis for evaluating improvements. It shall include:

- a) a breakdown of the energy consumption by use and source;
- b) energy flows and where appropriate, an energy balance of the audited object;
- c) historical pattern of energy performance;
- d) expected energy performance;
- e) where appropriate, relationships between energy performance and relevant variables;
- f) validation of the existing energy performance indicator(s) and, if necessary, proposals for a new energy performance indicator(s).

NOTE Opportunities for improving energy performance can also be complemented by suggestions for alternative energy sources, fuel switching, cogeneration, renewable energy sources, etc.

### 5.7.3 Identification of improvement opportunities

The energy auditor shall identify energy performance improvement opportunities based on data analysis and:

- a) their own expertise;
- b) evaluation of the design and configuration options to address the system needs;

NOTE System needs is the minimum energy consumption for the audited objects to function.

- c) age, condition, operation and level of maintenance of the audited objects;
- d) the technology of existing audited objects in comparison to the most efficient on the market;
- e) new advanced technical solutions;
- f) best practices.

### 5.7.4 Evaluation of improvement opportunities

The energy auditor shall evaluate the impact of each opportunity on the existing energy performance based on:

- a) energy savings over an agreed time period;

- b) financial savings enabled by the energy performance improvement opportunities;
- c) necessary investments;
- d) agreed economic criteria;
- e) other non-energy gains (such as productivity or maintenance);
- f) noting potential interactions between various opportunities;

NOTE 1 The organization might need to undertake additional work to fully identify and quantify impacts of opportunities

NOTE 2 As far as possible, opportunities are assessed over the planned or expected operating lifetime.

- g) in those cases where it is appropriate to the agreed scope, boundary and audit objective of the energy audit, the energy auditor should complement these results with:
  - 1) requirements for additional data;
  - 2) definition of any further analysis that may be needed.

## 5.8 Report

### 5.8.1 General

When reporting the results of the energy audit, the energy auditor shall:

- a) ensure that the energy audit requirements agreed with the organization have been met;
- b) identify the relevant measurements made during the energy audit, commenting on:
  - 1) frequency, consistency, accuracy and repeatability of data;
  - 2) rationale for the measurements and how they contribute to analysis;
  - 3) difficulties encountered in data collection and field work;
- c) state whether the results of the analysis are on the basis of calculations, simulations or estimates;
- d) summarise the analyses detailing any assumptions;
- e) if applicable, state the limits of accuracy for savings and costs;
- f) report the ranking of the energy performance improvement opportunities;
- g) suggest recommendations and implementation programme.

### 5.8.2 Content of report

The exact content of the report shall be appropriate to the scope, boundary and audit objective of the energy audit.

The report of the energy audit shall cover the following topics:

- a) Executive summary
  - 1) summary of energy use and consumption;

- 2) ranking of opportunities for improving energy performance;
- 3) suggested implementation programme.

b) Background

- 1) general information on the audited organization, energy auditor and energy audit methodology;
- 2) context of the energy audit;
- 3) description of the audited object(s);
- 4) relevant legal and other requirements applicable to the energy audit;
- 5) statement of confidentiality.

c) Energy audit

- 1) energy audit description, scope, boundary, audit objective, timeframe and level of detail;
- 2) information on data collection;
  - i) measurement plan (see 5.3)
  - ii) statement about which data was used (data acquisition frequency, which is measured and which is estimated);
  - iii) copy of key data used, test reports and calibration certificates of measurement equipment where appropriate;
- 3) analysis of energy performance and energy performance indicator(s);
- 4) basis for calculations, estimates and assumptions;
- 5) criteria for ranking opportunities for improving energy performance.

d) Opportunities for improving energy performance

- 1) recommendations and the suggested implementation programme;
 

NOTE Depending on the level of detail for the energy audit, this can include feasibility for implementation, action steps, etc.
- 2) assumptions used in calculating energy savings and the resulting accuracy of calculated energy savings and benefits;
- 3) assumptions used in calculating costs of implementation and the resulting accuracy;
- 4) appropriate economic analysis including known financial incentives and any non- energy gains;
- 5) potential interactions with other proposed recommendations;
- 6) measurement and verification methods suggested/recommended for use in post-implementation assessment of the recommended opportunities.

e) Conclusions.

### 5.9 Closing meeting

Before the closing meeting, the report on the energy audit shall be provided to the organization.

At the closing meeting the energy auditor shall:

- a) present the results of the energy audit in a way that facilitates decision making by the organization;
- b) be able to explain the results and address questions;
- c) if applicable, identify items requiring further analysis or follow-up by the energy auditor.

## **Annex A**

### **(informative)**

## **Guidance on the use of this International Standard**

### **A.1 Applicability of this International Standard**

This International Standard is based on good practice from energy management and energy auditing. It includes a minimum set of requirements to improve the specification, execution, acceptance and closure of an energy audit. Since innovation and differentiation are important contributors to energy auditing value added, this International Standard focuses only on the generic processes and outcomes to be expected from an energy audit. Organizations and external energy auditors are encouraged to use additional methods, approaches, technologies or software.

The applicability and use of this International Standard and individual requirements will be dependent upon a number of factors, such as the energy consumption of the organization and the audited object, the type of auditor, and the purpose of the audit. In some circumstances, not all of the standard requirements will necessarily be applicable. Some of the requirements may be too costly and not relevant for the purpose of the audit. When the energy cost and reduction opportunities for the audited object are proportionally small, the energy audit cost should be appropriate for the application.

### **A.2 Applicability of an ISO 50002 energy audit to an ISO 50001 energy review**

ISO 50001 requires that an energy review be conducted and energy performance be improved over time. An energy review carried out in accordance with ISO 50001 shall consist of analysis of past and present energy use and consumption based on measurement and other data, identify areas of significant energy use, identify, prioritize and record opportunities for improving energy performance, and estimate future energy use and consumption.

The use of an energy audit is not a requirement for ISO 50001 and other procedures may be utilized to complete the energy review or demonstrate energy performance improvement e.g. internal energy review procedures by energy managers of the organization utilizing methods in ISO 50004 Guidance for the Implementation, Maintenance and Improvement of an EnMS, energy flow analysis for the organization followed by improvement potential analysis, or other tools. However, an organization may wish to conduct an energy audit to provide information for an ISO 50001 energy review or demonstrate energy performance improvement at particular points in time, for the audited objects.

If an organization decides to complete an energy audit to facilitate an ISO 50001 energy review or demonstrate energy performance improvement, the energy audit is not required to be in accordance with ISO 50002 unless specifically designated by the organization. While ISO 50001 does not require energy audits to be carried out in accordance with ISO 50002, if an organization does so, this can help it to undertake comparable audits between different sites, fleets or activities and therefore to prioritise energy performance improvement actions. Additionally, an energy audit may be conducted without the intention of providing information for an ISO 50001 energy review.

## A.3 Assessment of levels

### A.3.1 General

Depending on the needs of the organization, one or more of the following levels of assessment (as summarized in Table A.1) may be selected as a guide to the determination of the scope and level of detail of the audit.

The levels of audit outlined below are not absolute requirements. Organizations may adjust the level of detail of the energy audit between levels 1-3 to suit the needs of the organization. Level 1 represents the minimum level of detail that might be appropriately referred to as an energy audit.

The appropriate level of detail required for an audit depends on the object of the audit, the energy uses and energy consumption and the resources available for the audit. As a preliminary audit activity the organization and the energy auditor should establish the availability of data for the energy audit and determine whether or not the data is sufficient to enable a higher level of audit. If additional measurement is required then the organization and the auditor should typically agree on the extent of required measurements before undertaking the audit. For audits at or above level 2 it is advisable for the organization and the auditor to agree on a current or a reference tariff to be used for financial analysis.

There may be some parts of this International Standard that are not applicable for internal auditors based on the level of detail required for the audit and the familiarity of the auditor with the area (e.g. start-up meeting). Based on the level of detail, an organization may choose an external audit to meet the requirements of this International Standard.

There may be some cases where the organization chooses to undertake an audit using a combination of internal and external auditors.

High level energy surveys such as a brief site walk-through or a simple analysis of monthly energy bills are preliminary activities that might be undertaken in advance of an audit, but should not be referred to as energy audits. In such cases, organizations may refer to the standard requirements as best practice but not necessarily comply with the standard requirements.

### A.3.2 Level 1

Level 1 defines a minimum level of detail for an audit, with the following features:

- provides a quantitative overview of energy performance based on overview data;
- intended to determine the potential for energy performance improvement based on further assessment to identify specific systems that merit a greater level of attention;
- aimed at small to medium sized organizations, for whom a detailed audit is not normally cost-effective;
- can also be used as a preliminary audit for larger organizations;
- involves a tour of the site to visually inspect energy using systems;
- includes an evaluation of overall energy consumption data to analyse energy uses and patterns;
- identifies no-cost and low-cost opportunities for improvement of energy performance;
- aimed at moving towards best practice operation of equipment, staff training and building basic capacity to manage energy consumption and use;
- the accuracy of costs and benefits would generally be sufficient for low cost operational expenditures.

### A.3.3 Level 2

Level 2 defines a more detailed level of audit, with the following features:

- detailed audit to enable quantified energy savings recommendations as opposed to numerous recommendations to undertake further investigation;
- some major projects or opportunities may require additional data to quantify the energy performance improvements, costs and benefits, and may still require further investigation;
- quantifies energy consumption through a more detailed review and analysis of equipment, systems, and operational characteristics;
- includes on-site measurements and testing where this is in the scope of the audit;
- establishes operational profile and a detailed energy balance, including analysis of significant mass flows, with energy consumption disaggregated for different end-uses, such as process heating, cooling, or compressed air;
- auditors should have appropriate technical, managerial and professional experience and skills and familiarity with the energy uses being audited in order to analyse detailed energy and process data to identify and evaluate opportunities;
- may involve representatives from the organization in the process of screening the list of opportunities identified, to select the opportunities that will be analysed in detail;
- includes an economic analysis of recommended energy performance improvement actions based on agreed economic criteria to rank opportunities;
- accuracy of costs and savings should generally be sufficient for operational expenditures or medium-scale capital investment.

### A.3.4 Level 3

Level 3 defines a comprehensive audit to quantify capital expenditures, with the following features:

- typically performed after a level 1 or level 2 audit;
- often a process or subsystem level assessment, such as for a pumping system;
- detailed audit to quantify energy consumption through a more detailed review and analysis of equipment, systems, operational characteristics, and on-site measurements, taking varying system demands into account;
- Level 3 audits provide a detailed analysis of energy consumption, involving a detailed energy balance, including analysis of significant mass flows, with energy consumption disaggregated for different end-uses, such as process heating, cooling, or compressed air;
- monitoring of energy data over a period long enough to capture the various operating conditions and relevant variables which require their own set of measurements;
- in addition to competency requirements at Level 2, may require more specific process knowledge, and metering;
- involves representatives from the organization in the process of selecting the opportunities that will be analysed in detail, and in the development of cost estimates, including non-energy gains;



- report from a Level 3 audit provides investment grade levels of accuracy to provide input into the organization's capital expenditure process;
- identifies any energy performance improvement opportunities where additional data or investigation is required to provide sufficient accuracy for capital investment decisions;
- provides recommendations for improvements in site or fleet data collection and accuracy if required;
- accuracy of costs and savings to the level of accuracy required by the company's existing capital expenditure process.

**Table A.1 — Detailed summary of audit levels**

Level	Typical application	Business need addressed	Data collection	Analysis	Opportunities identification	Opportunities evaluation
1	<p>Facilities / processes or fleets</p> <p>Suitable as:</p> <ul style="list-style-type: none"> <li>• energy audit of smaller facilities or</li> <li>• Preliminary audit for larger facilities</li> </ul>	<p>Indication of potential savings and benefits from undertaking more detailed investigations such as a comprehensive energy audit.</p> <p><b>Outputs:</b></p> <ul style="list-style-type: none"> <li>• Identification and basic evaluation of low cost opportunities that can be easily implemented.</li> <li>• Understanding of energy consumption at a site or fleet level</li> <li>• Improved awareness of energy costs and the potential benefits of managing energy</li> <li>• Understanding of the extent of more capital intensive opportunities</li> </ul>	<p>Overall energy data including daily load profiles (where available).</p> <p>Appropriate production data to establish overall EnPIs.</p>	<p>Energy data analysis from energy baseline review.</p> <p>Approximate end-use breakdown based on limited analysis or reference to typical/expected values for the site/process type.</p> <p>High-level review of daily profiles to identify anomalies</p> <p>Comparison with available benchmarks</p>	<p>Walk through to visually inspect energy uses.</p> <p>Identify and quantify low-cost and easily quantifiable savings.</p> <p>Identification of more capital intensive measures at a generic or specific level but not required to be taken through to technical resolution.</p>	<p>Indicative or typical savings calculated using rules of thumb, reconciled to the energy baseline.</p> <p>Nomination of typical payback periods</p> <p>Outline of steps required to generate specific actions that can be implemented.</p>
2	<p>Single site / process or fleet</p> <p>Detailed energy audit</p> <p>Generally not cost effective for organizations with smaller energy budgets.</p>	<p>Identification and evaluation of a range of coherent and specific opportunities with specific costs and benefits</p> <p>Identification of opportunities for further or more detailed investigation</p> <p>Auditors should have appropriate technical, managerial and professional experience and skills - and</p>	<p>Overall available energy data including daily load profiles.</p> <p>Appropriate data to establish EnPIs for significant energy uses.</p> <p>Sub-meter data, evaluated down to load profile level for significant meters.</p> <p>Full use to be made of available site</p>	<p>Energy data analysis from energy baseline review.</p> <p>EnPIs at plant area or fleet level, or at process level for analysis of specific opportunities where applicable</p> <p>Detailed energy balance reconciled with sub-metering data at annual and profile level including seasonal or production variations as applicable.</p>	<p>One or more site energy survey(s) can satisfy audit requirements.</p> <p>Identification of a suite of specific and implementable measures including short term, medium term and long term measures with energy savings reconciled against the detailed energy balance.</p> <p>All, or the majority of, measures provided with costs and benefits, including indications of 'non-energy' gains (eg.</p>	<p>Savings calculated using technology specific measures reconciled to detailed energy balance</p> <p>Costs based on build up of Capital and labour items based on rules of thumb. Quotes from suppliers are not required.</p> <p>Presentation of</p>

Level	Typical application	Business need addressed	Data collection	Analysis	Opportunities identification	Opportunities evaluation
		<p>familiarity with the energy uses being audited - to analyse detailed energy and process data to identify and evaluate opportunities.</p> <p>Auditors with appropriate professional skills and expertise analyse energy and process data to identify and evaluate opportunities.</p> <p><b>Outputs:</b></p> <ul style="list-style-type: none"> <li>• Detailed understanding of energy consumption and use</li> <li>• Data for energy review/monitoring purposes</li> </ul>	<p>data; It is not necessary for the auditor to take additional measurements as part of the audit unless the need for additional data has been identified as part of the audit scope;</p> <p>Energy data and information to be analyzed in the audit could include:</p> <ul style="list-style-type: none"> <li>• detailed data on energy consuming systems, processes and equipment, including known relevant variables</li> <li>• monitoring equipment configuration, and analysis information;</li> <li>• design, operation and maintenance documents;</li> <li>• energy audits or previous studies related to energy and energy performance;</li> <li>• future plans that affect energy use.</li> </ul>	<p>Mass balance for processes that include significant product flows influencing energy consumption, or equivalent analysis of energy and material flows.</p> <p>Evaluation of the design and configuration options to address the system needs</p>	<p>maintenance savings).</p> <p>NOTE: non-energy gains may not always be quantifiable within the scope of the audit</p> <p>Identification of measures where additional data/investigation would be required to improve or clarify measures.</p> <p>The organization may review a draft list of opportunities, to confirm the feasibility of opportunities prior to detailed analysis/investigation.</p>	<p>agreed economic analysis, typically including measures such as IRR or NPV, with simple pay backs as a minimum .</p>
3	<p>Whole site, process, system or fleet</p> <p>Comprehensive energy audit with significant input from the organization</p> <p>Generally only cost effective for organizations with high energy spends.</p> <p>Also applicable at the system level (eg. For compressed air)</p>	<p>Identification and evaluation of a range of coherent and specific measures with specific costs and benefits, , including indications of 'non-energy' gains</p> <p>Auditors should have appropriate technical, managerial and professional experience and skills - and familiarity with the specific energy uses being audited - to analyse detailed energy and</p>	<p>Operating/load profile of the site or fleet</p> <p>Production data to establish EnPIs for significant energy uses.</p> <p>Sub-meter data, evaluated down to load profile level for significant meters.</p> <p>Energy consumption data for the key site processes, systems and</p>	<p>Energy data analysis from energy baseline review</p> <p>EnPIs at plant area or fleet level, and for significant energy uses</p> <p>Detailed energy balance reconciled with sub-metering data, using data of a sufficient frequency to capture variation in performance.</p> <p>Mass balance for processes that include significant product flows influencing energy</p>	<p>One or more site energy survey(s) can satisfy audit requirements.</p> <p>Quantification of a range of specific and implementable measures including short term, medium term and long term measures (if requested) with energy savings reconciled against the detailed energy balance.</p> <p>Identification of any energy performance improvement opportunities where additional</p>	<p>Savings calculated using technology specific measures reconciled to detailed energy balance and considering system interactions</p> <p>Costs calculated using detailed analysis based on build up of capital and labour items, to the level of accuracy</p>

Level	Typical application	Business need addressed	Data collection	Analysis	Opportunities identification	Opportunities evaluation
		<p>process data to identify and evaluate opportunities.</p> <p>More detailed investigation of opportunities</p> <p>Consideration of business strategies in the audit</p> <p><b>Outputs:</b></p> <ul style="list-style-type: none"> <li>• Detailed understanding of energy consumption</li> <li>• Data for energy review purposes</li> <li>• Examination of metering systems and recommendations to address data gaps</li> </ul>	<p>activities.</p> <p>Full use to be made of available site data; installation of additional monitoring or conducting of specific logging exercises should be considered;</p> <p>Data should be collected for a sufficient period to account for the expected range of values for the relevant variables.</p> <p>Energy data and information to be analyzed in the audit could include:</p> <ul style="list-style-type: none"> <li>• detailed data on energy consuming systems, processes and equipment, including known relevant variables</li> <li>• monitoring equipment configuration, and analysis information;</li> <li>• design, operation and maintenance documents;</li> <li>• energy audits or previous studies related to energy and energy performance;</li> <li>• future plans affecting energy use;</li> <li>• information on how the organization manages its energy</li> </ul>	<p>consumption (or equivalent analysis of energy and mass flows)</p> <p>Evaluation of the design and configuration of options to address the system needs</p> <p>Application of a range of analysis methods to explore relationships between energy consumption and relevant variables.</p> <p>Recommendations for additional data/investigation to improve data accuracy</p>	<p>data/investigation is required to improve data or evaluation accuracy.</p> <p>Presentation of draft list of opportunities to the organization for discussion, to confirm the feasibility of opportunities prior to detailed analysis/investigation.</p> <p>Other analysis, techniques or experimental approaches (e.g. engineering, vehicle trials, pilot studies, logistical approaches or thermographic imaging) may be used to fully understand energy consumption.</p>	<p>required by the company's existing capital expenditure process.</p> <p>NOTE: The organization may need to assist the auditor with cost data</p> <p>All measures provided with costs and benefits, including 'non-energy' gains.</p> <p>Presentation of agreed economic analysis, with simple pay backs as a minimum, to provide input to the organization's capital expenditure process.</p>

NOTE Table A.1 presents a detailed summary of requirements at three defined levels of audit. Each of the nominated requirements is a minimum for each level. In some cases it might be appropriate to go beyond the level of detail outlined in the table, as agreed between the organization and the auditor.

## **A.4 Energy auditor principles**

### **A.4.1 Competency**

The energy auditor should have suitable knowledge for the type of work being undertaken and the agreed scope, boundary and objective. Appropriate education and training may involve professional qualifications in relevant technical or quantitative fields.

The degree of technical and managerial experience and skills required will increase for higher audit levels due to the need for process-specific knowledge and the need to identify energy performance improvements that can be implemented within the organization being audited.

**EXAMPLE** A mechanical engineer with experience in auditing and optimisation of boilers in commercial buildings might not have the knowledge necessary to audit the boiler in a large thermal power station.

### **A.4.2 Data measurement plan**

Energy performance data may be considered representative where it accounts for the typical range of variation for the relevant variables. The required time period for data acquisition will vary according to the energy uses and the nature of the processes involved.

## **A.5 Applicability of energy audit report headings**

The energy audit report should cover the following topics listed in 5.7.2 and may use 5.7.2 (a) – (e) as headings. Numbered items under 5.7.2 (a) – (e) may also be used as appropriate subheadings for the report.

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