BS EN 16247-3:2014

BSI Standards Publication

Energy audits

Part 3: Processes

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National foreword

This British Standard is the UK implementation of EN 16247-3:2014.

The UK participation in its preparation was entrusted to Technical Committee SEM/1/1, Energy Management Systems and Energy Audits.

A list of organizations represented on this committee can be obtained on request to its secretary.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

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CEN-CENELEC Management Centre:
Avenue Marnix 17, B-1000 Brussels

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Foreword

This document (EN 16247-3:2014) has been prepared by Technical Committee CEN/CLC/JWG 1 “Energy audits”, the secretariat of which is held by BSI.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by November 2014 and conflicting national standards shall be withdrawn at the latest by November 2014.

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

This Part provides additional material to Part 1 for the Process sector and should be used in conjunction with Part 1.

This European Standard is part of the series EN 16247 “*Energy audits*” which comprises the following:

— Part 1 General requirement;

— Part 2 Buildings;

— Part 3 Processes;

— Part 4 Transport;

— Part 5 Competence of energy auditors.

According to the CEN-CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

0 Introduction

An energy audit can help an organization to identify opportunities to improve energy efficiency. It can be part of a site wide energy management system.

There are various sectors with important differences in processes and utilities. It should be emphasized that there are many types of processes in industry and commerce. In general, energy is used:

— directly by a process, e.g. furnaces, direct fired dryers, etc;

— indirectly by a process (e.g. heat exchange, distillation, extrusion, etc.) including the specific conditions of production (e.g. start-up, shut-down, product change over, cleaning, maintenance, laboratory and product transfer);

— utility processes (e.g. motor driven systems (fans, pumps, motors, compressors, etc.), steam, hot water), including on site power plants;

— other processes (e.g. sterilization in hospitals, fume cupboards, laboratories etc.).

This standard defines the attributes of a good quality energy audit on a site in addition to EN 16247-1, which gives the general requirements for energy audits.

1 Scope

This European standard specifies the requirements, methodology and deliverables of an energy audit within a process. These consist of:

a) organizing and conducting an energy audit;

b) analysing the data from the energy audit;

c) reporting and documenting the energy audit findings.

This part of the standard applies to sites where the energy use is due to process. It shall be used in conjunction with and is supplementary to EN 16247-1, Energy audits — Part 1: General requirements. It provides additional requirements to EN 16247-1 and shall be applied simultaneously.

A process could include one or more production lines, offices, laboratories, research centers, packaging and warehouse sections with specific operational conditions and site transportation. An energy audit could include the whole site or part of a site.

If buildings are included in the scope of the energy audit, the energy auditor may choose to apply EN 16247-2, *Energy Audits — Part 2: Buildings*. If on-site transport on a site is included in the scope of the energy audit, the energy auditor may choose to apply EN 16247-4, Energy audits — Part 4: Transport.

NOTE The decision to apply Parts 2 and 4 could be made during the preliminary contact, see 5.1.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 16247-1, *Energy audits - Part 1: General requirements*

3 Terms and definitions

For the purposes of this document, the terms and definitions in EN 16247-1 and the following apply.

3.1
production process
all the steps necessary to manufacture a product or delivery of a service

Note 1 to entry: Production process could include specific facilities for health, safety and environment pollution control.

3.2
utility
energy carrier necessary for the process and auxiliary

Note 1 to entry: A utility could be generated on-site, off-site, or purchased from a third party.

EXAMPLE Steam, hot water, compressed air, etc.

3.3
utility process
set of utility equipment and distribution

Note 1 to entry: If the utility is purchased from a third party, utility process is only the utility distribution.

3.4
site
processes within the boundary of the organization

Note 1 to entry: This may include pollution treatment processes and energy recovery, and waste product.

3.5
building
construction as a whole, including its envelope and all technical building systems, for which energy may be used to condition the indoor climate, to provide domestic hot water and illumination and other services related to the use of the building and the activities performed within the building

Note 1 to entry: The term can refer to the building as a whole or to parts thereof that have been designed or altered to be used separately.

Note 2 to entry: The building could include its site location and related external environment.

[SOURCE: EN 16247-2, 3.1]

3.6
energy
electricity, fuels, steam, heat, compressed air, and other like media

Note 1 to entry: For the purposes of this standard, energy refers to the various forms of energy, including renewable, which can be purchased, stored, treated, used in equipment or in a process, or recovered.

Note 2 to entry: Energy can be defined as the capacity of a system to produce external activity or perform work.

[SOURCE: EN ISO 50001, 2011, 3.5]

4 Quality requirements

4.1 Energy auditor

The qualification of an energy auditor is defined in prEN 16247-5[1].

[1] prEN 16247-5 is currently not yet published and under development.

4.2 Energy audit process

The quality of the energy audit depends on the knowledge of the processes, the site and available data and information. Close collaboration between the energy auditor and the organization is essential.

NOTE An example energy audit process is shown in Annex A.

5 Elements of the energy audit process

5.1 Preliminary contact

The energy auditor shall obtain a preliminary description of the site and the process from the organization or from a site visit.

NOTE The preliminary contact can be by telephone, webinar, meeting or other remote interactive discussions.

The energy auditor shall agree with the organization on the scope and boundary of the energy audit:

a) processes included in the energy audit;

   NOTE A process can be defined as the whole process, part of a process, part of a system or a component.

b) whether or not outsourced utilities are included in the energy audit;

c) depending of the thoroughness of the energy audit, it is recommended to check if a detailed energy audit needs to be carried out for specific processes. In this case, reference shall be made to the relevant standard (see bibliography).

For energy use not directly related to process (e.g. storing, packaging, logistics, offices, research centre, laboratory and transport), the energy auditor shall agree with the organization the applicability of EN 16247-2 and EN 16247-4. This choice and the agreed scope shall be clearly stated in the final energy audit report (5.6).

For each audited process, the energy auditor and organization shall agree, the relevant personnel, their roles which have an impact on energy consumption, and propose a preliminary list of data to be collected.

5.2 Start-up meeting

The energy auditor and organization shall agree energy performance indicators which can be used in the energy audit.

5.3 Collecting data

5.3.1 General

The data collection could be carried out over several stages during an energy audit.

During data collection, the energy auditor shall:

a) verify the data and information provided by the organization (e.g. the power or the number of pieces of equipment);

b) obtain any missing data;

c) check the accuracy of the measuring device.

5.3.2 Information request

The energy auditor shall request from the organization the following:

a) site information;

b) utility processes information;

c) production processes information;

1) product specification and quality;

2) current operational conditions (set points) of utilities and production process;

3) specific condition and constraint for process and environment (security, pollution, health, etc.);

d) building, boundary and other relevant information;

e) energy sources information.

NOTE 1 The collected data can be based on invoices, contracts, measurements, calculations from given operating hours and installed capacity (technical characteristics), operation and maintenance documents, meeting with operations and maintenance personnel, etc.

NOTE 2 See Annex B for examples of data to be collected.

5.3.3 Review of the available data

The energy auditor shall review the information collected for consistency and suitability.

The energy auditor shall assess whether the information provided is sufficient to achieve the agreed objective.

If data requested is not available, the energy auditor shall define the method to obtain the necessary information (e.g. measurements, estimates, modelling, etc.).

5.3.4 Preliminary data analysis

The energy auditor shall carry out an analysis of the data collected to:

a) undertake a preliminary analysis of the site's energy balance on the basis of energy bills and output;

b) establish the relevant adjustment factors;

c) establish the relevant energy performance indicator;

d) evaluate the distribution of energy consumption on the basis of sub-meter reading, installed capacity and operating time;

e) if there is sufficient information, establish an initial energy baseline;

f) plan further data collection and measurement to be carried out during field works (5.4).

The energy auditor should develop preliminary energy efficiency improvement opportunities.

The energy auditor shall agree with the organization about any data measurement plan on:

1) objectives and parameters;

2) content;

3) required measurement conditions.

NOTE See Annex C for quality data measurement plans.

5.4 Field work

5.4.1 Aim of field work

If necessary, the energy auditor shall carry out additional measurement to:

a) collect any missing data needed for analysis;

b) confirm the suitability of the baseline;

c) confirm the energy consumption, energy balance and adjustment factors;

d) confirm the current operational conditions (set points) of utilities and production processes and the impact with energy use and consumption;

e) relevant information from identification plates, runtime information, interviews with operators, etc.

5.4.2 Conduct

The conduct of energy auditor during field work is defined in EN 16247-1, 5.4.2.

5.4.3 Site visits

The energy auditor shall visit the site and audited processes.

NOTE The schedule for site visits is planned during the start up meeting (5.2).

5.5 Analysis

5.5.1 General

The energy auditor shall:

a) investigate the maximum achievable energy performance of the process and benchmark it with the actual energy performance;

b) calculate the actual energy performance of the process;

c) compare the actual sizing of process and the energy needs;

d) evaluate the optimal quantity of energy and utilities for the process.

5.5.2 Energy balance and breakdown

The energy auditor provides:

a) breakdown the energy consumption by sources;

b) breakdown the energy consumption by processes in absolute number and in consistent energy unit;

NOTE If the activity is time varying, it is recommended to establish the energy consumption at different time periods in relation to the processes.

c) demonstrate an energy balance between energy consumption and energy losses based on appropriate method.

EXAMPLE Material and energy balance, Sankey diagram, steady-state computer simulation.

If feasible, the energy auditor shall determine the energy consumption without production or activity.

The energy balance and breakdown shall be representative of the energy input and energy use. It shall be clear which is based on measurement, estimation or calculation.

5.5.3 Energy performance indicators

The energy auditor and the organization shall discuss and agree on the relevant energy performance indicators. The analysis shall utilize the agreed energy performance indicators.

NOTE If an energy management system exists, the energy auditor could use the relevant energy performance indicators detailed in the energy management system.

5.5.4 Identify and evaluate energy efficiency improvement opportunities

The energy auditor shall propose energy efficiency improvement opportunities including one or more of the following:

a) measures in order to reduce or to recover the energy losses;

EXAMPLE Improve insulation, reduction of leakage of compressed air, waste heat recovery, etc.

b) replacement, modification or addition of equipment;

EXAMPLE High efficiency boiler, variable speed motor, energy efficient lighting, etc.

c) more efficient operation and continual optimization;

EXAMPLE Operating procedure, process and utility automation, logistic and layout optimization, set point adjustment, maintaining the installed equipment to its best performance, etc.

d) improved maintenance;

EXAMPLE Maintenance planning, instruction of the operation and maintenance staff, etc.

e) deployment of behavioural change programme;

EXAMPLE Training, energy awareness campaigns, etc.

f) improvement of energy management.

EXAMPLE Improvement in metering and monitoring plan, implement energy management system, etc.

The energy auditor shall identify energy efficiency improvement opportunities on the basis of:

1) the equipment's age, condition, how it is operated and managed;

2) the technology of actual equipment in comparison to the most efficient equipment on the market;

NOTE The energy auditor may use the EN 16231:2012 energy efficiency benchmarking methodology.

3) the planned life time of the processes.

The energy auditor should consider the use of renewable energy sources and combined heat and power plant.

The energy auditor should propose to categorize the energy efficiency improvement opportunities to:

a) people based opportunities (e.g. training, awareness, etc.);

b) technical based opportunities (e.g. operations, maintenance and replacement of machines);

c) organizational based opportunities (e.g. structure of organization, responsibilities).

For each of the proposed energy efficiency improvement opportunity, the energy auditor shall calculate the expected energy saving (before and after implementing the energy efficiency improvement), taking into consideration the appropriate adjustment factors.

Whenever possible, the energy auditor should consider the applicability of life-cycle cost analysis.

The energy auditor shall consider the possible tariff change for lower energy cost.

5.6 Report

5.6.1 General

The general requirements for the energy audit report are defined in EN 16247-1, 5.6.1.

5.6.2 Content of report

The auditor shall give the following information for each of the recommended energy efficiency improvement opportunities:

a) description of the existing system or equipment that is affected, its current energy consumption, energy performance and the reason for the proposal for improvement;

b) description of the proposed energy efficiency improvement opportunities, the predicted energy consumption, energy performance, and cost savings;

c) non-energy efficiency related benefits.

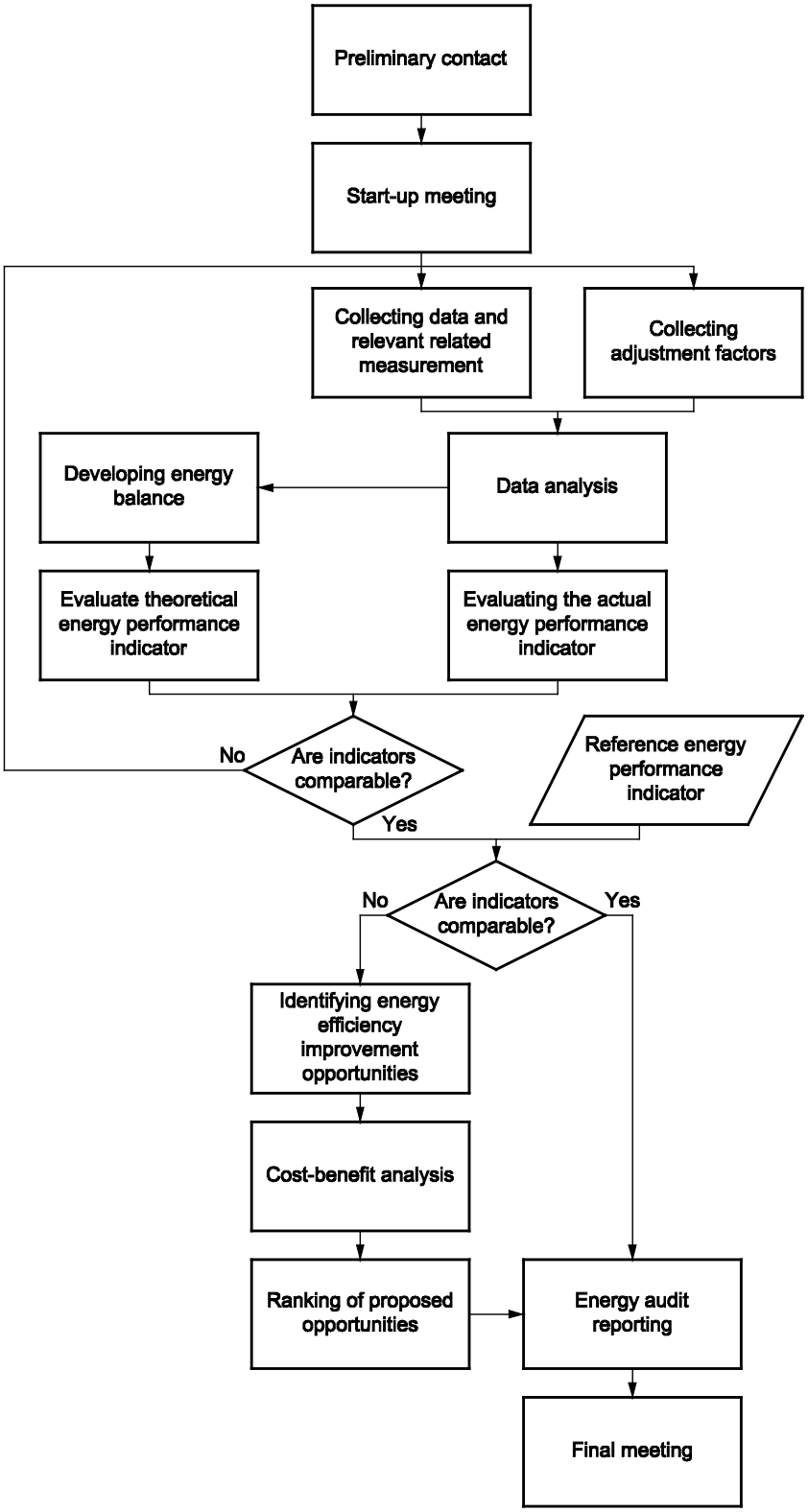
EXAMPLE Non-energy efficiency improvement related benefit may range from quality improvement, manufacturing flexibility, reduced maintenance, reduce water consumption, reduce waste, lower carbon dioxide emissions and improved working condition.

5.7 Final meeting

The requirements for final meeting are defined in EN 16247-1, 5.7.

Annex A
(informative)

Example of energy audit process



Annex B
(informative)

Example list of data to be collected

a) General information on the running of the company

   1) products processed/manufactured;

   2) daily/annual production;

   3) name of the energy official;

   4) name of the transport official;

   5) operating times;

   6) start up and shut downs;

   7) shift patterns;

b) Energy sources;

   1) inventory of energy sources used on site;

   2) daily/monthly/annual consumption;

c) Energy management;

   1) structure of energy consumption;

   2) metering, maintenance of meters;

   3) tariff;

   4) invoice amounts (fuels, electricity, water);

   5) peak demands management;

   6) energy management and monitoring level: which indicators, who monitors them?;

   7) operating board;

   8) training of staff in the rational use of energy;

d) Transportation, handling of materials and products in the plant;

   1) description of fleet;

   2) upkeep planning and record book;

   3) energy consumption;

   4) handling lines, overhead cranes, helpers, etc.;

5) personnel transportation on the industrial site (excluding the company's circulation plan);

e) Production process;

1) description, brand of equipment;

2) nature of operation;

i) drying;

ii) heating, cooking, sterilization, polymerization, melting, etc.;

iii) concentration;

iv) thermal separation (distilling column, evaporator, etc.);

v) incineration;

vi) assembly of parts (brazing, welding, etc.);

3) types of machines;

i) crucible furnace, vacuum furnace, removable-cover furnace, open-hearth furnace, etc.;

ii) tunnel, stack, drying tower, cylinder dryer, etc.;

iii) incinerator, etc.;

4) installed thermal power;

5) nature of the fluid (hot air, steam, hot water, etc.);

6) recoverable condensate;

7) waste heat recovery (flow rates, temperatures, suspended particles, corrosiveness, critical dew point, etc.) of the exhaust gases/discharged fluids, to evaluate the heat recovery opportunities;

8) production capacities and output rates (number of parts, m2, kg produced, kg of evaporated water, etc. according to unit of time);

9) processing method: static, dynamic, batch;

10) products processed: input water content, composition;

11) processing parameters: input fluid temperatures, thermal cycle, application speeds and temperatures of the fluid, power densities applied, etc. regulation;

12) control;

13) metering;

14) number of operating hours;

15) annual consumption;

16) consumption specific to processing;

f) Boiler house;

1) description of the facility, installed capacity and its matching data to operational needs;

2) number of boiler;

3) description of operating regime (cascade, backup, shutdown, supplementary, etc.);

4) operating mode;

5) generator: commissioning date, power, brand, type, fluid (hot water, steam, super heated water, thermal oil, air, etc.), pressure, outgoing temperatures, nominal flow rate, thermal insulation;

6) control and measurement equipment (fuel, heat carrier, fumes), number of operating hours, recovery of condensates, steam traps;

7) burner: nature of fuels, age, type, power;

8) presence of and the performance of recuperators, superheaters, economizers, air heaters;

9) boiler feed water tank volume and temperature;

10) discharge of combustion products;

11) power supply circuits and complementary accessories (circulation pumps, fans, etc.);

12) general condition of the equipment: last settings, maintenance, recent repairs and modifications;

13) water treatment (nature and characteristics of water types, model and flow rates, treatment);

14) atmospheric discharge measurement and performance readings on the basis of the boiler house record book or the regular inspection report;

15) readings (including accuracy class);

16) annual consumption and production levels;

g) Heat exchange;

1) description of the system, installed capacity and its matching data to operational needs;

2) buildings and premises serviced, volume heated;

3) exchangers, blenders;

4) function (heating, domestic hot water (DHW), heating + DHW);

5) primary fluid/secondary fluid;

6) number of operating hours;

7) annual consumption;

h) Fluid distribution networks;

1) nature of fluid;

2) type of network (above-ground, channels, tunnel);

3) distribution method and layout diagram;

4) characteristics (lengths, diameters, flow rates, pressure [LP, MP, HP], temperatures, return systems, etc.);

5) recovery of condensates and steam traps;

6) thermal insulation, thermal bridges;

7) number of operating hours;

8) losses;

9) networks condition and upkeep;

i) Generators of mechanical, thermal or electrical energy;

1) description of the system, installed capacity and its matching data to operational needs;

2) types and number of machines: turbines, diesel engines, CHP, compressors;

3) brand, type, commissioning year;

4) energy source (steam, oil, distillates, gas, renewable energy, etc.);

5) generator's characteristics (nominal power, rotating speed, cycle, exhaust temperatures or steam's pressure and temperature, etc.);

6) nature of the machine powered: characteristics (pressure, flow or power, voltage), operating mode (compressor, alternator);

7) control systems;

8) metering;

9) number of operating hours;

10) general condition of equipment;

11) annual thermal consumption and mechanical and electric production levels;

j) Electric distribution and equipment;

1) list of the main pieces of equipment and characteristics: transformers, low voltage panel, capacitor bank, power plant (turbines, electricity generating sets), inverters, networks, engines, pumps, fans, compressors;

2) variable speed drives, etc.;

3) operation (for each of the main pieces of equipment);

4) annual consumption by station and sector;

5) regulation (for each of the main pieces of equipment);

k) Cooling towers;

1) description of the system, installed capacity and its matching data to operational needs;

2) types and number of machines (air cooled, water cooled, evaporative);

3) thermal capacity;

4) temperatures;

5) control;

6) metering;

7) general condition of the material and the distribution network (system, pump);

8) number of operating hours;

9) annual energy and water consumption;

l) Chillers;

1) description of the system, installed capacity and its matching data to operational needs;

2) types and number of machines (compression- or absorption-based refrigerating unit, compressor, condenser, air cooler, heat pump);

3) capacity (refrigerating, electric);

4) nature of the refrigerant;

5) temperatures of the input/output secondary refrigerant;

6) control;

7) metering;

8) general condition of the material and the distribution network (system, pump);

9) number of operating hours;

10) annual consumption;

m) Pumps;

1) description of the system, installed capacity and its matching data to operational needs;

2) pump description;

3) pump type;

4) pump application;

5) physical location of pump - installed motor data (rated nameplate power, voltage, full load amperage, and frequency);

6) annual operational hours (or % operation);

7) control method (e.g. control valve, VSD, bypass);

8) flow rate;

9) pressure;

10) pumped media (liquid);

11) input/output temperature;

12) general condition of pumps;

n) Fans;

1) description of the system, installed capacity and its matching data to operational needs;

2) fan description;

3) fan type;

4) fan application;

5) physical location of fan - Installed motor data (rated nameplate power, voltage, full load amperage, and frequency);

6) annual operational hours (or % operation);

7) control method;

8) input/output temperature;

9) general condition of fans;

o) Compressed air;

1) description of the system, installed capacity and its matching data to operational needs;

2) type and number of compressor;

3) pressure;

4) power;

5) input/output temperature;

6) flow rate;

7) air production and quality;

8) operation;

9) annual consumption;

10) control;

11) general condition of the equipment and network (insulation, leaks, traps, etc.);

p) Vacuum system;

1) description of the system, installed capacity and its matching data to operational needs;

2) type and number of vacuum system;

3) suction;

4) power;

5) flow rate;

6) operation;

7) annual consumption;

8) control;

9) general condition of the material and the system (insulation, leaks, traps, etc.);

q) Heating ventilation air conditioned (HVAC);

1) description of the system, installed capacity and its matching data to operational needs;

2) analysis of the HVAC systems;

3) nature of the heat source (fluid distribution, fuel, electric);

4) types of devices and distribution of energy carrier;

5) installed capacity (global and by system);

6) heat recovery;

7) control and setting method (zone, sectioning, modulation), controlled variables and correcting variables;

8) monitoring equipment (thermometers, hygrometers, etc.);

9) rate of use;

10) general condition of the devices and the distribution pipes systems;

11) annual consumption levels by system;

r) Domestic hot water (DHW);

1) description of the system, installed capacity and its matching data to operational needs;

2) production principle (centralized, independent, mixed, etc.);

3) characteristics of the material (power, temperature, fluids' pressure, etc.);

4) storage (temperature, insulating material, etc.);

5) description and characteristics of distribution: storage tanks (capacity, coupling), circulation pumps (flow rate, pressure), regulation, network (diameter, number of outgoing lines), insulating material;

6) DHW needs, number of points serviced;

7) condition of the equipment and of the distribution network;

8) metering;

9) annual consumption;

s) Lighting;

1) description of the system, installed capacity and its matching data to operational needs;

2) measurement of lighting levels;

3) installed devices: lamps, instruments, lighting quality, etc.;

4) age of the lighting system (renewal period of light sources);

5) lighting duration (estimation of usual/emergency consumption levels);

6) control systems;

7) access to daylight;

8) occupancy rate by staff;

9) premises' dimensions;

10) dust accumulation;

11) type of activity pursued.

Annex C
(informative)

Quality of data measurement plan

C.1 General

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

a) list of the measurement points and their location;

b) preparation of measurement points/location and its access;

c) measurement duration: one-off or logged;

d) acquisition frequency for each measurement;

e) intervention period during which the company's activity is representative;

f) people responsible for carrying out the measurements, for example: the organization, the energy auditor or any of its subcontractors;

g) operating constraints linked to the processes;

h) implementation constraints of the measurement equipment.

Information on creating a list of data measurement, frequency and duration can be a result of sampling. Sampling is described in Annex B.5 of ISO 19011:2011.

C.2 The data measurement plan

The data measurement plan is developed over three stages:

a) Stage 1: Use of measurement instrument;

The energy auditor should:

1) define the measurements to be taken and their level of accuracy;

2) be responsible for the measurements taken on site;

3) check the proper operations and functioning of the measurement equipment;

4) check that measurement taken by the measurement equipment is accurate and repeatable (e.g. calibration certificate is valid).

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

b) Stage 2: Data measurement

During the data measurement, the organization may be asked to provide the corresponding adjustment factors, e.g. operating parameters, production data.

c) Stage 3: Preliminary data treatment

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

1) principle of each measurement, the level of uncertainty and the elements which allow its level of accuracy to be assessed;

2) calculations made and range of applicability;

3) derived charts and graphs;

4) summary of data measurement results shown in a table.

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