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BSI Standards Publication

Energy audits

Part 4: Transport

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National foreword

This British Standard is the UK implementation of EN 16247-4:2014.

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

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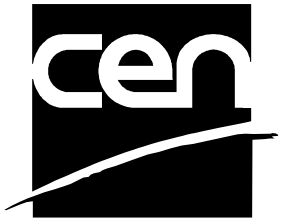

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Foreword

This document (EN 16247-4:2014) 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of an identical text or by endorsement, at the latest by November 2014 and conflicting national standards shall be withdrawn at the latest by November 2014.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 Transport 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 requirements;

— 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.

This European Standard is intended for the energy auditing of mobile assets e.g. vehicles, railways, marine vessels, aircraft, as well as mobile plant.

Due to the mobility of the assets in transport, energy auditing in this area is especially challenging. For example, the meetings are harder to organize, the activities involved are harder to inspect.

The first part of this standard harmonizes the procedures for energy auditing in transport systems. On the other hand, there are certain aspects which are particular to every transport mode. For example, whereas the mobile assets in road transport are numerous, similar and replaced frequently, the assets for marine and air transport are large and long-lived.

In order to state the energy auditing features of every transport mode, there is a specific section for each of them at the end of this document.

Finally, the possibility of planning and selecting the mode of transport (and, sometimes, using different modes for a unique transport service) is also a specific aspect of the transport activity. Therefore, this standard will place special attention to this topic.

NOTE An energy audit is not a fiscal method, the term and the nature of an energy audit are defined in EN 16247–1 Energy Audits.

1 Scope

This European Standard 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.

The procedures described here apply to the different modes of transport (road, rail, marine and aviation), as well as the different ranges (local to long distance) and what is transported (basically, goods and people).

This European Standard specifies the requirements, methodology and deliverables specific to energy audits in the transport sector, every situation in which a displacement is made, no matter who the operator is (a public or private company or whether the operator is exclusively dedicated to transport or not), is also addressed in this document.

This European Standard advises on both the optimization of energy within each mode of transport, as well as selecting the best mode of transport in each situation; the conclusions drawn by the energy audit can influence decisions on infrastructure and investment e.g. in teleconferencing or web meetings.

Energy audits of buildings and processes associated with transport can be conducted respectively with the EN 16247-2 Buildings and EN 16247-3 Processes e.g. pipelines, depots and escalators/travelators. This part of the standard does not include the infrastructure which supplies energy e.g. the electricity generation of energy for railways.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. 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*

UIC/UNIFE TecRec 100 001 — *Specification and verification of energy consumption for railway rolling stock, 2010*

3 Terms and definitions

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

3.1
transport
activity that implies the movement of people or goods from one place to another

3.2
vehicle
object used to perform the transport, may include the container, trailer or carriage where energy is consumed

Note 1 to entry: This document will use this term, instead of the more general one (audited object), from part 1 of this standard.

3.3
energy
includes fuels, inclusive of biofuels, electricity inclusive of regenerated/recovered energy from braking etc. Excludes feedstock energy sources such as Aqueous Urea Solution (‘Adblue™’ ISO 22241-1)

3.4
fleet
group of vehicles

3.5
train set
consist
railway terminology used to describe a “train” varies between countries, very often it means a single scheduled service. In the UK, the interchangeable terms "set" and "unit" are used to refer to a group of permanently or semi-permanently coupled vehicles, such as those of a diesel multiple unit. In the United Kingdom Section 83(1) of the Railways Act 1993 defines “train” as follows:

a) two or more items of rolling stock coupled together, at least one of which is a locomotive;

b) a locomotive not coupled to any other rolling stock.

In the United States, the term ‘consist’ is used to describe the group of rail vehicles which make up a train

3.6
operator
person that governs the vehicle operation with his/her own hands, e.g. driver, pilot, helmsman, etc.(not the organization being audited)

3.7
organization
owner or operator of the fleet of vehicles subject to the audit

3.8
transport service
service provided to a beneficiary for the transport of goods or of a person from a departure point to a destination point

3.9
segment
group of vehicles performing the same type of transport; i.e. subset of a fleet having a certain common feature

Note 1 to entry: The criteria for segment definition depend on the kind of transport the audited organization performs and the kind of vehicles used. An example might be differentiating the vehicles performing local distribution as opposed to long distance shipment in two different segments.

3.10
operators' representative
group of workers in charge of communicating the interest of the operators to the management of the organization

3.11
load factor
ratio of the average load or passenger number to total vehicle capacity in tonnes, volume or seats/standing

4 Quality requirements

4.1 Qualifications

With reference to prEN 16247-5[1], the energy auditor shall have relevant knowledge of the different modes of transport and energy sources used in transport by the organization subject to the audit.

4.2 Energy audit process

4.2.1 General

Due to the complexity, mobility and time critical nature of transport operations, the site visit needs to be done within restrictions for both auditor and operator to allow both parties to complete their duties, thus this clause (4.2) states distinct requirements to those specified in EN 16247-1, 4.2.

4.2.2 Operations department cooperation

Transport operations are a complex, time-critical process and being able to audit it without affecting its final result is imperative.

The organization shall provide the auditor with appropriate access to relevant personnel, records, documentation or equipment.

The auditor shall agree with the operations department on the needs of both parties to complete their duties in a proper manner. Failing to do so upfront will put extra difficulties into the auditing process.

When a sampling method is used, the selected sample of vehicle(s) shall be representative of the fleet or that part of the fleet.

4.2.3 Personnel

In order to perform the audit in a proper manner, the auditor shall have direct access to people within the organization in charge of the following areas:

a) Planning. Personnel responsible for logistics and route management;

b) Operations. This department is in charge of organizing the transport operations and specifically of assigning them to operators and vehicles;

c) Maintenance. These are the people responsible for assuring the availability and good performance of the vehicles, or granting access to service records if maintenance is outsourced;

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

d) Technical and procurement. Those people responsible for vehicle specifications and acquisition, including sub-contractors and suppliers;

e) Human resources. It is important for the auditor to understand the views of the staff and operators as they are critical to the energy consumption reduction process. Moreover, direct contact with operators is advisable;

f) Operator training department and/or training personnel;

g) Operators. They are one of the keys to eliminating energy wastage and encouraging ecodriving;

h) Finance. They usually process financial data associated with energy purchases, particularly important where energy prices vary week by week.

5 Elements of the energy audit process

5.1 Preliminary contact

Due to the dispersed nature of transport, a focus on communication is of paramount importance. The auditor shall issue a summary of the purpose and main needs of the audit and communicate this to the people with responsibility for the organization's transportation. Where possible, these personnel shall be present at the start-up meeting.

As the audit progresses, the organization shall be informed of the results, deviations and any outstanding issues. Likewise, the auditor shall communicate with the organization on issues affecting the conduct of the audit.

The auditor shall require the organization to inform them of any significant changes that would impact on the energy audit.

5.2 Start-up meeting

Within the restrictions of normal transport operations and where practicable, the organization shall enable the personnel agreed at 4.2.3 to attend the start-up meeting.

5.3 Collecting data

The auditor shall gather the following information: the energy consumption for every vehicle during the last year, with intervals that allow for a useful trend analysis (for seasonal analysis or any other significant factor):

a) criteria used for planning transport operations assignments;

b) description of the routes taken and planning policy;

c) fleet composition: list of all available vehicles along with their age and main technical features (e.g. vehicle category, fuel type, engine size, emissions rating, ancillaries);

d) operator training conducted for energy consumption reduction (e.g. ecodriving), including documented records of any resultant reductions;

e) methods of refuelling where appropriate;

f) evidence of the fuel or electricity consumption metering and relevant training given to operators;

g) energy source pricing documents including historical data over an appropriate period;

h) distance travelled for each vehicle or number of hours of operation during the last year;

i) data regarding goods and passengers to enable the calculation of load factor for the last year;

j) data to enable the calculation of percentage of productive distance and time from operators and vehicles;

k) if part of transport is outsourced, the auditor shall make sure the activities are identified and raise questions about whether details on energy figures were requested and made available from the sub-contractor;

l) where applicable, criteria for supplier and sub-contractor procurement e.g. energy policy or performance criteria;

m) maintenance programmes, service and inspection checklists, maintenance records will be asked for when necessary;

n) policies for vehicle specification, operation, purchase, maintenance, refurbishment and replacement;

o) actions for development and testing of new techniques and methods of reducing greenhouse gas emissions by reductions in energy usage or alternative energy sources.

5.4 Field work

The auditor shall conduct an assessment when vehicles are present, the auditor and operations department personnel shall assess vehicles to observe the issues and opportunities for energy reduction. This may take place out of normal operating hours as appropriate.

Where existing historical data is not reliable, a recording device can be used to record the data of a representative amount of vehicles during an expanded time period, or where available the vehicles' on-board computer should be analysed.

Where insufficient data is available, the auditor may ask permission to personally observe at least one trip (or a significant part of it) for each of the main transportation activities by the audited organization in order to assess how the energy efficiency could be optimized. During the trip, the auditor shall either measure (through an instantaneous recording device, where appropriate) or estimate the consumption of every phase in the transport process.

Where applicable and appropriate on each organization site, the operations and maintenance departments shall be visited to assess the organization's activities during normal working hours.

5.5 Analysis

5.5.1 General

With reference to EN 16247-1 Analysis, the report content (below) outlines the potential outputs from the analysis specific to transport.

The auditor shall take into account the following considerations in order to make the final recommendations:

a) efficiency in every period of the year (12 months) in terms of energy efficiency and load factor;

b) factors affecting the energy consumption, being within or beyond the influence of the audited organization;

c) planning, scheduling, road topography choices and routes/timetable issues;

d) factors affecting goods quality (temperature control), customer comfort/satisfaction (e.g. use of air conditioning);

e) improvement capabilities concerning staff (training and recruitment);

f) productivity impact of the different energy influencers (for example, vehicle speed);

g) vehicle operation and maintenance;

h) vehicle refurbishment, replacement and selection;

i) fleet segmentation (according to the type of transport performed);

j) assessment of the recording of energy consumption and their impact on the accuracy of the available data;

k) assessment of the implied energy efficiency of outsourcing part of the transportation activity.

5.5.2 Energy performance indicators

In order to analyse the energy performance, an indicator or group of indicators shall be selected. These indicators shall be measurable for all modes of transport used by the organization.

A point to bear in mind here is the journey time is required; without which there is no way one can apply the conclusions of the audit to the operations department.

Some examples are: consumed energy/distance, consumed energy/(distance × net weight) for freight transport[2], consumed energy / (distance × number of passengers) for passenger transport[3].

In the cases where it is not possible to have accurate data (for example, to evaluate the weight), some estimation shall be applied.

In the case where the mode of transport is not an option or if it has already been selected in a previous stage, the indicators used to further analyse the performance can be specific to that transport mode.

5.5.3 Transport mode and energy sources

The auditor shall:

[2] See Eurostat definitions: "Tonne-kilometre (tkm) A tonne-kilometre, abbreviated as tkm, is a unit of measure of freight transport which represents the transport of one tonne of goods (including packaging and tare weights of intermodal transport units) by a given transport mode (road, rail, air, sea, inland waterways, pipeline etc.) over a distance of one kilometre".

[3] See Eurostat definitions: "A passenger-kilometre, abbreviated as pkm, is the unit of measurement representing the transport of one passenger by a defined mode of transport (road, rail, air, sea, inland waterways etc.) over one kilometre".

a) Take into account the energy source projections for the different alternatives so as to determine what the best choice for fleet renewal or expansion is. In order to do that, a price projection for the different fuel alternatives will be used;

b) Bear in mind other aspects that can also influence the decision. Some examples are maintenance costs, acquisition cost and the possible Greenhouse Gas emissions calculated using the standard EN 16258 for compensation in some countries;

c) Where applicable, include other means of transport in the auditing process, so as to determine if a multimodal operation is adequate. This involves the possibility of using different transport modes for a certain transport service, as well as the possibility of using a completely different transport mode when feasible and energetically worthwhile.

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

Within the recommendations offered to reduce the energy consumption, the following point's specific to transport shall be covered:

a) Planning, Routes/Timetables:

   1) points to be considered within the operations department when organizing and planning the transport;

   2) trip justification and optimisation;

   3) claims for other parties (for example, governmental infrastructure issues) that may also affect the energy efficiency e.g. road tolling impact on route choice, or regulations not allowing pick-up (e.g. taxis);

b) Vehicles:

   1) optimal configuration of the current fleet so as to reduce the energy consumption;

   2) improvements on the maintenance programme definition (checks to be made and their intervals) and tasks execution (methods to execute the checks and quality of their completion from the maintenance personnel;

   3) specifications to be applied on future purchase decisions. This point may imply the use of different energy sources or fleet concepts;

   4) criteria for fleet renewal;

c) Human resources and Operators:

   1) training programme to be carried out e.g. courses in efficient driving techniques (ecodriving);

   2) criteria for personnel recruitment.

For each of the three points mentioned above (routes, vehicles and human resources) some indicators will be presented, so as to evaluate the efficiency of every element of each group (for example, to be able to compare each operator).

In cases where some estimation for energy consumption has been used, the method for the estimation shall be clearly indicated. The document will present an estimate of the optimal energy required to do the transport duties, compared with the actual current use, to enable the client to address the shortcomings.

5.7 Final meeting

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

Annex A
(normative)

Transport sectors

A.1 General

This section expands on the specific requirements of the audits in each type of transport. Transport modes share many common aspects (this is a general list and is not intended to be exhaustive):

Aspect	Road	Rail	Aviation	Marine
Planning, logistics, routing,	✓	✓	✓	✓
Air resistance or parasitic drag,	✓	✓	✓	✓
Rolling resistance	✓	✓		
Combustion / Conversion losses	✓	✓	✓	✓
Weather conditions	✓	✓	✓	✓
Ambient temperature	✓	✓		
Age of vehicle	✓	✓	✓	✓

Specific differences to take into account for each mode follow.

A.2 Road

Road vehicles are characterised by mobility between depots and refuelling i.e. a vehicle may not return to its home depot for considerable periods and may be refuelled in several depots or even countries during its normal work.

a) When assessing the fleet composition, the auditor shall indicate the level of control the audited organization has on each vehicle. For example vehicle ownership, energy source and efficiency, job need and fit for purpose considerations (e.g. passengers, loading, and energy source: diesel, Compressed Natural Gas, Electric Vehicle);

b) Resolving the empty return problem (name) to minimise empty running and maximise load factor;

c) Where applicable and agreed with organization, include vehicles paid for via expense or allowance;

d) Check tyre pressures or records where necessary, as well as the energy rating of tyres supplied;

e) When a vehicle telematics or tracking system is in place:

   1) The auditor shall request access to that information from the audited company;

   2) In the report, the auditor will compare the data collected from the company through the refuelling process and the telematics system when available;

f) Topography, road condition, traffic and congestion are aspects beyond the control of the operator, but can be addressed by the planners or route choice and should be included in the audit report where applicable.

A.3 Rail

Rail vehicles are characterised by strict timetables and safety considerations, electric train sets or consists may receive power from multiple suppliers as they travel across borders whilst completing a journey.

a) When assessing the fleet composition, the auditor shall indicate the level of control the audited organization has on each vehicle. For example vehicle ownership, requirements by/agreements with customers or contracting authorities;

b) Some electric traction units have no metering and consumption is estimated through computer modelling, diesel traction may also need sub-metering. When the energy consumption of tractive units is analysed, the train set or consists shall be recorded (type of vehicles, gross mass, occupancy);

c) When analysing or simulating the energy consumption, the recommendations of UIC/UNIFE, TEC REC 100 001, Specification and verification of energy consumption for railway rolling stock, 2010 (http://www.tecrec-rail.org/100_001) shall be followed;

d) Auditor and client shall agree on the proportion of vehicles subject to inspection. The resulting amount of vehicles should be representative for every segment the audited company owns;

e) Tractive and auxiliary energy should be analysed and reported separately where possible;

f) Analyse billed energy vs. actual energy use where available and applicable;

g) Infrastructure conditions, energy supply system and timetable issues should be analysed.

A.4 Aviation

Fuel load and use is critical to the safe operation of an aircraft and flight data should be readily available.

a) Where possible in addition, analysis should include ground energy use at terminal and differentiate between ground tug, taxi-ing and flight;

b) The auditor shall collect and analyse the information about freight and passengers transported, distances travelled and fuel consumed;

c) The data will be gathered on a flight or leg basis.

A.5 Marine

Marine vessels include ocean going vessels, coastal craft, inland waterways barges, water taxis and water buses.

a) The auditor shall inspect every single vessel of the client; where applicable fleets of vessels are uniform a sample can be inspected;

b) The auditor shall assess the status of the ship and its major machinery, as well as, the ship's utilization and operational management processes. The technical assessments will, at least, include:

   1) ship performance (hull);

   2) main and auxiliary engine performance;

   3) auxiliary loads balance;

   4) differentiate between shore power, energy use in port and under way;

   5) fuel quality and supply systems;

   6) lighting;

   7) rotating machinery;

   8) boiler and steam system.

The same aspects apply to inland waterways vessels, but specific aspects outside the control of the operator may be taken into account e.g. access to or congestion of waterways impacting on performance.

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EN 16247-3, *Energy audits — Part 3: Processes*

prEN 16247-5, *Energy audits — Part 5: Competence of energy auditors*

EN 16258, *Methodology for calculation and declaration of energy consumption and GHG emissions of transport services (freight and passengers)*

EN 50463:2007, *Railway applications - Energy measurement on board trains*

ISO/IEC DIS 13273-1, *Energy efficiency and renewable energy sources — Common international terminology — Part 1: Energy Efficiency*

ISO 22241-1, *Diesel engines — NOx reduction agent AUS 32 — Part 1: Quality requirements*

IMO: *The Energy Efficiency Design Index (EEDI) was made mandatory for new ships and the Ship Energy Efficiency Management Plan (SEEMP) for all ships at MEPC 62 (July 2011) with the adoption of amendments to MARPOL Annex VI (resolution MEPC.203(62)), by Parties to MARPOL Annex VI*

GLOSSARY E.T.
http://epp.eurostat.ec.europa.eu/statistics_explained/index.php/Category:Transport_glossary

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