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Information technology — Data centres — Impact of the ISO 52000 series on energy performance of buildings

Technologies de l'information — Centres de données — Impact de la série ISO 52000 sur la performance énergétique des bâtiments

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Foreword

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This document was prepared by Joint Technical Committee ISO/IEC JTC 1, *Information technology*, Subcommittee SC 39, *Sustainability, IT and data centres*.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html and www.iec.ch/national-committees.

Introduction

It is recognized that no “free” energy exists, even if certain processes or technical solutions are implemented in data centres, whose names can potentially suggest that energy is free (e.g. renewable energy, "free" cooling with air or water, geo-cooling, etc.).

In particular:

— even if the cost of certain renewable energy sources is low compared to non-renewable sources, there are still costs associated with the use or implementation of renewable energies such as transport and/or storage;

— some energy-efficient solutions implemented in data centres can also have other capital and operational energy costs;

— the remaining energy going out of a subsystem of a data centre, if not evaluated inside or outside the data centre boundary, is lost; every effort in order to minimize these losses results in improved energy efficiency of the data centre.

Regulatory frameworks exist (for example, in the European Union) which request primary energy assessment and that the energy consumption of computer rooms included in commercial or residential buildings can be assessed within primary energy as part of the overall energy consumption for these types of buildings.

The common objective of the key performance indicators (KPI) specified in the ISO/IEC 30134 series is the efficient or effective use or utilization of energy and other resources.

The ISO 52000 series defines methods and tools to assess the energy performance of buildings (EPB), routing and energy balance, together with greenhouse gas emissions.

These methods and tools are to be used (when mandatory) for mixed use buildings that include a data centre or server room in their premises. They can also be used in the case of stand-alone data centres.

Information technology — Data centres — Impact of the ISO 52000 series on energy performance of buildings

1 Scope

This document proposes elements for the expression of energy production, storage, reuse and consumption in reference to primary energy in data centres, taking into account both the elements needed for energy assessment and the concepts developed in the framework of the ISO 52000 series for energy performance of buildings (EPB).

This document:

— provides the main definitions and concepts from the ISO 52000 series needed to make a primary energy assessment for data centres;

— provides approaches for discriminating true sources of energy used by a given data centre;

— compares, where relevant, the terms used in both the ISO/IEC 30134 series and ISO 52000 series and provides explanations on the use of factors for converting final or delivered energy to primary energy which take a different approach in each series (and how to move from one to the other);

— illustrates the impact of using the EPB approach on data-centre-energy-related key performance indicators (KPIs), both in general and by the provision of examples;

— provides known sources of weighting or conversion factors to be used when there are no recognized or agreed local factors applicable to the studied data centre energy performance assessment.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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.

ISO/IEC 30134 (all parts), *Information technology — Data centres key performance indicators*

ISO/IEC 22237 (all parts), *Information technology — Data centre facilities and infrastructures*

3 Terms, definitions and abbreviated terms

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in the ISO/IEC 30134 series and the ISO/IEC 22237 series and the following apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

3.1.1
assessment boundary
boundary where the delivered and exported energy are measured or calculated

[SOURCE: ISO 52000-1:2017, 3.4.2]

3.1.2
bin
statistical temperature class (sometimes a class interval) for the outdoor air temperature, with the class limits expressed in a temperature unitNote 1 to entry: The bin usually includes non-consecutive interval of times with the same temperature condition.

[SOURCE: ISO 52000-1:2017, 3.6.2]

3.1.3
delivered energy
energy, expressed per energy carrier, supplied to the data centre through the assessment boundary, to satisfy the uses taken into account or to produce the exported energy

Note 1 to entry: Delivered energy can be calculated for defined energy uses or it can be measured.

[SOURCE: ISO 52000-1:2017, 3.4.6, modified — Reference to "technical building systems" replaced by "data centre".]

3.1.4
distant
<to the data centre premises>not on-site nor nearby

[SOURCE: ISO 52000-1:2017, 3.4.7, modified — Domain changed from "<to the building site>" to "<to the data centre premises>".]

3.1.5
electricity grid
public electricity network

[SOURCE: ISO 52000-1:2017, 3.4.8]

3.1.6
energy carrier
substance or phenomenon that can be used to produce mechanical work or heat or to operate chemical or physical processes

[SOURCE: ISO 52000-1:2017, 3.4.9]

3.1.7
energy source
source from which useful energy can be extracted or recovered either directly or by means of a conversion or transformation process

EXAMPLE Oil or gas fields, coal mines, sun, wind, the ground (geothermal energy), the ocean (wave energy, ocean thermal energy), forests etc.

[SOURCE: ISO 52000-1:2017, 3.4.15]

3.1.8
exported energy
energy, expressed per energy carrier, supplied by the technical data centre systems through the assessment boundary

Note 1 to entry: It can be specified by generation types [e.g. combined heat and power (CHP) and photovoltaic (PV)] in order to apply different conversion factors.

Note 2 to entry: Exported energy can be calculated or it can be measured.

[SOURCE: ISO 52000-1:2017, 3.4.20, modified — Reference to "building systems" replaced by "data centre systems"; in Note 1 to entry, reference to "weighting factors" replaced by "conversion factors".]

3.1.9
final energy
energy as delivered to an energy-using system

Note 1 to entry: This concept is sometimes referred to as "delivered energy".

[SOURCE: ISO/IEC 13273-1:2015, 3.1.11, modified — Note 2 to entry deleted.]

3.1.10
nearby
<energy source> usable only at local or district level, connected to the same branch of the distribution network (for electricity: distribution network meaning medium voltage or lower) or having a dedicated connection, requiring specific equipment for the assessed data centre to be connected to it (e.g. district heating or cooling)

Note 1 to entry: This definition is based on that given for the same term in ISO 52000-1:2017, 3.4.24.

Note 2 to entry: The concept of "nearby" is expressed here in relation to the data centre premises. See Annex A and Annex B for further explanation.

3.1.11
non-renewable energy
energy taken from a source which is depleted by extraction (e.g. fossil fuels)

Note 1 to entry: Resource that exists in a finite amount that cannot be replenished on a human time scale.

[SOURCE: ISO 52000-1:2017, 3.4.26]

3.1.12
on-site
building, premises and the parcel of land on which the data centre is located

Note 1 to entry: On-site is defining a strong link between the energy source (localization and interaction) and the data centre

[SOURCE: ISO 52000-1:2017, 3.4.27, modified — References to "the building" replaced by "the data centre" in both the definition and Note 1 to entry; "Building" added to the beginning of the definition.]

3.1.13
perimeter
<boundary classification>origin of delivered energy

Note 1 to entry: This document distinguishes between "on-site", "nearby" and "distant" energy sources.

[SOURCE: ISO 52000-1:2017, 3.4.28]

3.1.14
primary energy
energy that has not been subjected to any conversion or transformation process

Note 1 to entry: Primary energy includes non-renewable energy and renewable energy. If both are taken into account it can be called total primary energy.

[SOURCE: ISO 52000-1:2017, 3.4.29]

3.1.15
technical data centre system
technical equipment for heating, cooling, ventilation, humidification, dehumidification, domestic hot water, lighting, building automation and control and electricity production (other than for IT services)

Note 1 to entry: A technical data centre system can refer to one or to several data centre services.

Note 2 to entry: A technical data centre system is composed of different sub-systems. A technical data centre sub-system is a part of a technical data centre that performs a special function (e.g. air handling, cold generation and distribution, water-based cooling, etc.).

Note 3 to entry: Electricity production can include electrical power supply generation equipment (including fuel storage), cogeneration, wind power and photovoltaic systems, transformers.

3.1.16
uninterruptible power system
UPS
combination of convertors, switches and energy storage devices (such as batteries), constituting a power system for maintaining continuity of load power in case of input power failure

Note 1 to entry: Continuity of load power occurs when voltage and frequency are within rated steady-state and transient tolerance bands, and with distortion and interruptions within the limits specified for the output port. Input power failure occurs when voltage and frequency are outside rated steady-state and transient tolerance bands, or with distortion or interruptions outside the limits specified for the UPS.

[SOURCE: IEC 62040-1:2017, 3.1.01]

3.2 Abbreviated terms

For the purposes of this document, the abbreviated terms given in the ISO/IEC 30134 series, the ISO/IEC 22237 series and the following apply.

CHP	combined heat and power
COP	coefficient of performance
EPB	energy performance of buildings
ERF	energy reuse factor
ITEEsv	IT equipment energy efficiency for servers
PV	photovoltaic
CHP	cogeneration, combined heat and power
PDU	power distribution unit
PUE	power usage effectiveness
REF	renewable energy factor
RER	renewable energy ratio
SLA	service level agreement
UPS	uninterruptible power system
XEEF	excess electrical energy factor

3.3 Symbols (variables)

For the purposes of this document, the following symbols apply. These symbols are used throughout the document in combination with the indices defined in 3.4.

E	energy consumption or loss

f	weighting factor (e.g. primary energy factor)
Q	quantity of heat
R	ratio
t	time
X	conversion factor (ratio of weighting factors)

EXAMPLE 1 $E_{pe;DC;tot}$ = total data centre primary energy

EXAMPLE 2 $E_{pe;IT;tot}$ = total information technology equipment primary energy

EXAMPLE 3 $E_{del;DC;nren}$ = non-renewable energy delivered to the data centre

EXAMPLE 4 $E_{nb;DC;ren}$ = renewable energy produced nearby the data centre

3.4 Symbols (indices)

For the purposes of this document, the following indices apply:

A	other appliances
AB	assessment boundary
an	annually
avl	available
C	temperature and humidity control systems
chp	combined heat and power
cooling	delivered (energy) used by the entire cooling system
cr(1), cr(2).., cr(*n*)	energy carriers
DC	data centre
del	delivered (energy)
dhc	district heating/cooling
dst	distant
el	electricity
EnEPus;el	total energy for non-EPB uses and DC and total energy for non-EPB non-DC uses
EPus	energy performance use
excess	excess (energy)
exp	exported (energy)
gas	gas
gen	produced by the generator
grid	from public electricity grid

in	total delivered (electrical energy) provided to the data centre
IT	information technology equipment
meas	measured
nb	nearby
nDC	non-data-centre
nEPus	non-energy-performance use
nexp	without energy export
nren	non-renewable (energy)
pe	primary (energy)
pr	produced on-site
PSD	power supply and distribution
Q	quantity of heat
rdel	redelivered (energy)
ren	renewable (energy)
reuse	energy reuse
S	service
tmp	temporarily exported (to be reused later) either to the grid or to an energy storage
tot	total
we	weighted (energy)
Z	zone

4 Background, motivation and exclusions

4.1 Background and motivation

The common objective of the key performance indicators (KPIs) of the ISO/IEC 30134 series is the efficient or effective use or utilization of resources including:

— minimization of energy and other resource consumption;

— effectiveness of the IT load (processing, storage and transport) within the data centre, maximizing the IT output with the minimum energy consumption;

— reuse of unconsumed resources (e.g. energy reuse in the form of waste heat);

— utilization of renewable energy, both generated on- and off-site.

The KPIs consider the different data centre services (IT, cooling, lighting, power supply, etc.) in relation to the main form of final energy used in data centres, electricity. Final (or delivered) energy can come from different sources of primary energy, and to do such assessments it is necessary to consider if the energy is the result of investment of effort done by the data centre owner/manager or by energy providers.

In general, the ISO/IEC 30134 series provides essential tools for the resource management of data centres both in terms of operation of facilities and of decision-making. These documents can also be used to support pre-regulatory or regulatory proceedings, or to benchmark facilities projects or realizations.

In many countries approaches of incentives for energy efficiency such as energy saving certificates or certificates of renewable energy production have been implemented. Whether at the level of data centres management or at incentive or regulatory processes, the existing measures can require the energy performance to be expressed in a primary energy reference system.

The ISO 52000 series aims at achieving international harmonization of the methodology for the assessment of the energy performance of buildings (EPB). The documents from the ISO 52000 series can be used for energy assessment of buildings containing a data centre.

4.2 Exclusions

This document does not address design, material or organizational aspects of data centre power supply and energy management, but focuses instead on methods, tools and references to process delivered and exported energy data from various carriers to assess primary energy balances in data centres.

Although the following topics are important and can affect the data centre energy efficiency, they will not be covered in this document.

— Monitoring or metering of energy consumption (developed in the ISO/IEC 30134 series), due to the fact that primary energy is calculated from final energy and losses measurement or assessment.

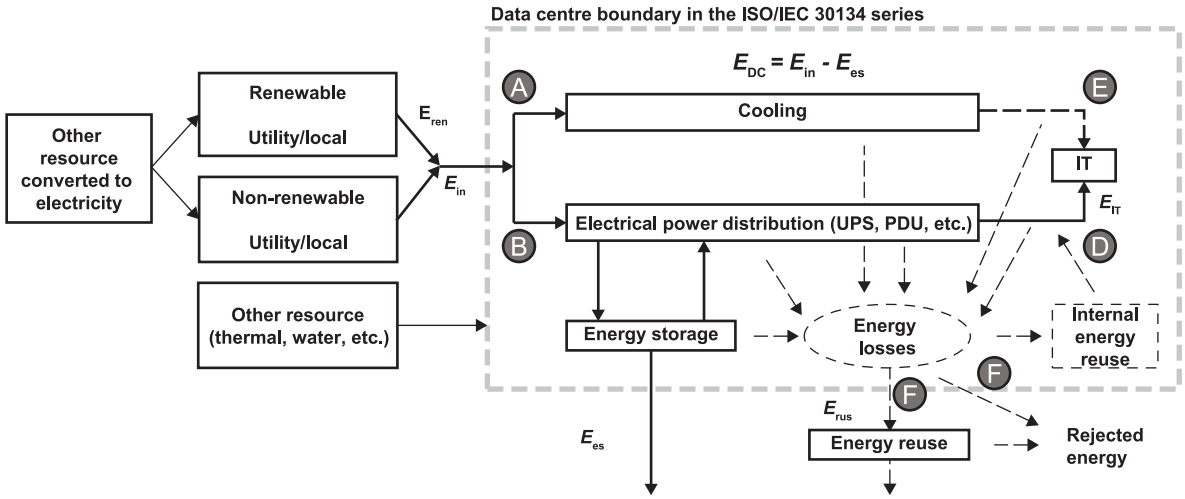
— Power quality relation to energy production, transport and transformation; assessing the primary energy balance of a data centre can lead to challenging energy carriers and it is the role of data centre managers to ensure that the choice of an energy carrier resulting from high primary energy efficiency also meets the power quality criteria such as those for electronic equipment, but these issues are not treated in this document.

NOTE ISO/IEC 30134-1:2016, Clause A.2 insists on the relationship between absolute energy consumption (contribution to KPIs) and availability of service [level of service level agreement (SLA)]. It proposes solutions based on uninterruptable power systems (UPS), stressing that tolerance to faults and ensuring availability to meet SLAs are important factors in the energy consumption of data centre equipment and infrastructures. In terms of energy assessment, the higher the power quality, the greater the potential losses in the data centre power supply to be considered, whether considering final energy (e.g. for KPIs) or primary energy (e.g. in an EPB approach).

5 Data centre assessment boundary

5.1 Data centre boundary in the ISO/IEC 30134 series

The ISO/IEC 30134 series considers the boundary of a data centre being crossed by the relevant energy flows in order to determine energy-related KPIs. Energy flows can be metered at this boundary. Flows and boundaries are illustrated in Figure 1.



Key

——→	electrical energy
- - - -→	thermal energy
– – –→	re-useable energy
——→	other energy

Figure 1 — Schema representing the concept of a data centre boundary and energy flows

For the purpose of this document E_{DC}, E_{excess} and E_{reuse} are detailed in Clause 8.

5.2 Assessment boundary of the system in the ISO 52000 series

In the EPB approach from the ISO 52000 series, the assessment boundary is related to the assessed object (e.g. data centre, data centre spaces, systems or sub-systems).

Inside the assessment boundary the system losses are explicitly taken into account in the energy balance; outside the assessment boundary they are taken into account in the conversion factor applied to the energy carrier.

Energy can be imported or exported through the assessment boundary. The assessment boundary defines the overall energy balance.

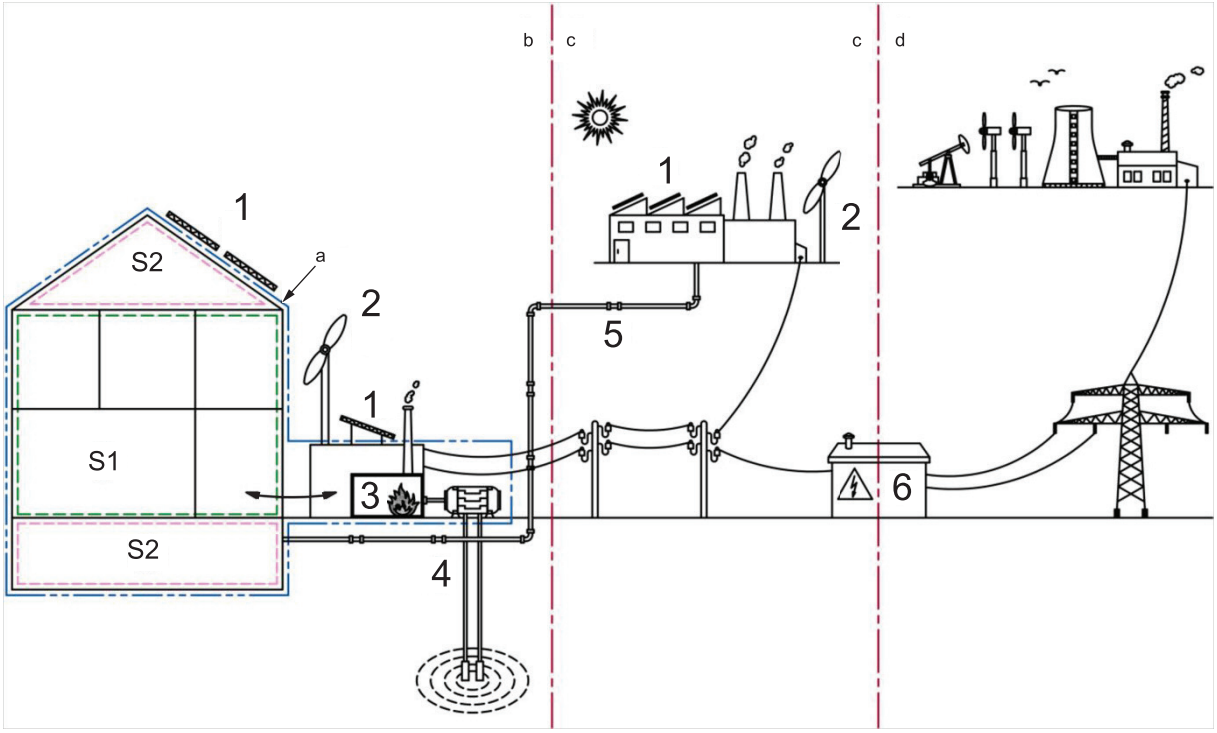
Some of these energy flows can be quantified based on the meters (e.g. gas, electricity, district heating). For active solar, wind or water energy systems the incident solar radiation on solar panels or the kinetic energy of wind or water is not part of the energy balance of the building. Only the energy delivered by the generation devices, the auxiliary energy needed to supply the energy from the source (e.g. solar collector) to the building, and the thermal losses are taken into account in the energy balance.

As shown schematically in Figure 2, the delivered energies are classified as:

— on-site,

— nearby,

— distant.



Key

a	assessment boundary (use energy balance)	S1	thermally conditioned space	1	photovoltaic (PV)
b	on-site	S2	space outside thermal envelope	2	wind
c	nearby			3	boiler room
d	distant			4	heat pump
				5	district heating / cooling
				6	substation (low voltage and possible storage)

Figure 2 — Schema representing the concept of perimeters and assessment boundary

Primary energy factors, or weighting factors, are defined for each energy flow delivered or exported through the assessment boundary taking into account the origin for delivered and destination for exported.

In case of energy produced on-site or nearby and for distant energy, the weighting factors are calculated according to the related EPB standards and regional/local regulations when they exist. Default values of weighting factors are proposed in Clause 9.

Inclusion or exclusion of energy contribution according to the perimeter (origin) depends on the calculation objective: e.g. for defining the renewable energy factor (REF) of ISO/IEC 30134-3 or to determine the energy flows to be taken into account in the exported energy.

6 General principles of the overarching EPB framework and procedures

6.1 Output of the method

The main output of ISO 52000-1 is the overall energy performance of a building or part of a building (e.g. building unit). Secondary outputs include breakdown in partial energy performance such as:

— per energy service (heating, lighting, etc.);