

Review of standardisation activities

# Energy Management and Environmental Viability of Data Centres

Based on the  
Edition 11 Report of the CEN/CENELEC/ETSI  
Coordination Group on Green Data Centres

Status: The 11th Edition of the Report was approved by the CEN/CENELEC/ETSI  
Coordination Group on Green Data Centres on 05.11.2024;  
this brochure is an Executive Summary of the Report

# Table of contents

Foreword .....	4
Executive Summary .....	5
Data Centres .....	6
Standards for Data Centres .....	7
Data Centre Assessment – Its value lies in the eye of the beholder .....	8
Data Centre Energy Management: Infrastructure Design - Requirements .....	9
Overview .....	9
Construction .....	9
Power distribution .....	9
Environmental control .....	10
Telecommunications cabling .....	10
Building automation .....	10
Measurement, monitoring and metering .....	10
Guidance to the application of the EN 50600 series of standards .....	<b>Fehler! Textmarke nicht definiert.</b>
International activity .....	10
Data Centre Energy Management: Infrastructure Design - Best Practice .....	11
Overview .....	11
CLC/TR 50600-99-1 and CLC/TR 50600-99-2 .....	11
ETSI TS 105 174-2 and ETSI EN 305 174-2 .....	11
EU Code of Conduct for Data Centre Energy Efficiency .....	11
International activity .....	11
Data Centre Energy Management: ITE Design - Requirements and Best Practice .....	12
Requirements .....	12
Recommendations (best practice) .....	12
International activity .....	12
Data Centre Environmental Viability: Infrastructure and ITE Design .....	12
Infrastructure design requirements .....	12
Infrastructure design recommendations (best practice) .....	12
International activity .....	12
ITE and software design requirements and recommendations (best practice) .....	12
Data Centre Operating Procedures .....	13
Infrastructure and ITE recommendations (best practice) .....	13
Overview .....	13
CLC/TR 50600-99 and EN 50600 series standards .....	13
ETSI EN 305 174-2 and ETSI TS 105 174-2 .....	13
EU Code of Conduct for Data Centre Energy Efficiency .....	13
International activity .....	13
Data Centre Energy Management: Key Performance Indicators - Introduction .....	14
Overview .....	14
Technical KPIs .....	14
Objective KPIs .....	15
Global KPIs .....	15
Data Centre Energy Management: KPI Standards .....	16
Overview .....	16
Energy management KPIs .....	16
Technical KPIs .....	16
International activity .....	16
Objective KPIs .....	16
International activity .....	16
Global KPIs .....	17
International activity .....	17
Data Centre Environmental Viability: KPI Standards .....	17
Global KPIs .....	17
Objective KPIs .....	17
International activity .....	17

# Foreword

---



The development of the digital economy has led to an increasing demand for data supported by the continuing construction, across Europe, of data centres of all sizes serving a large variety of business applications. This has resulted in increased energy demand. It is necessary to manage this demand and to consider the related environmental, economic and energy supply security impacts.

A data centre encompasses a great variety of products and systems. Many different industries are involved in the design and the operation of a data centre. Within the framework of the complicated and challenging objective to manage energy consumption there is a need to give guidance to stakeholders in the industry for energy management and environmental viability by providing a foundation of standards on data centres.

Over the last few years, all European Standards Organizations (ESOs) have been involved in developing standards related to data centres. In 2010 CENELEC BT/WG 132-3 made the recommendation to establish a joint European coordination group with the task to manage and coordinate European activities and standardization works related to Data Centres Energy Efficiency.

**The CEN/CENELEC/ETSI Coordination Group on Green Data Centres (CEN/CLC/ETSI CG-GDC)** is a joint activity of the three ESOs which comprises representatives of the ESOs together with stakeholders of industry and EU projects. Its main mission is to ensure consistency of the various ESOs initiatives in order to provide European data centre industry with the necessary, useful documents to face their eco-responsibilities in a timely and practical manner.

The CG GDC leads discussions to build a European position, taking into account relevant activity at the wider international level, while scanning the needs of industry in terms of best practice. The CG GDC promotes the definition and deployment of such practices and, as part of this function, maintains a “standardization landscape” report which records existing standards addressing energy management of data centres and identifies any gaps that require further work. The report enables the Coordination Group to recommend future actions by relevant ESOs in order to fill these gaps.

This brochure is a short version of the “standardization landscape” report developed by the CG GDC. It summarises the current standardisation landscape and references the relevant standards, both published and in preparation, in relation to data centres energy management within three ESOs.

Acknowledging the recommendations and guidance contained in this brochure as the close co-operation of all stakeholders jointly with the European Standards Organizations, I am also confident that future works will continue in the same collaborative and inclusive spirit.

I would like to thank all the participants involved in the execution of this task for their commitment with the hope that this will contribute to a greener European economy.

Nicolas Samman

Chair

**CEN/CENELEC/ETSI Coordination Group on Green Data Centres**

# Executive Summary

It is widely recognised that demand for data will increase and that this demand is founded upon data centres of all sizes and serving a variety of business objectives i.e. whether they serve subscribers' demands for broadband delivery or employees demands within enterprises. It is also recognised that this increasing demand for data will, unless pressure is applied to improve energy efficiency, result in an unsupportable demand for power. This is already the situation in certain areas of our large cities.

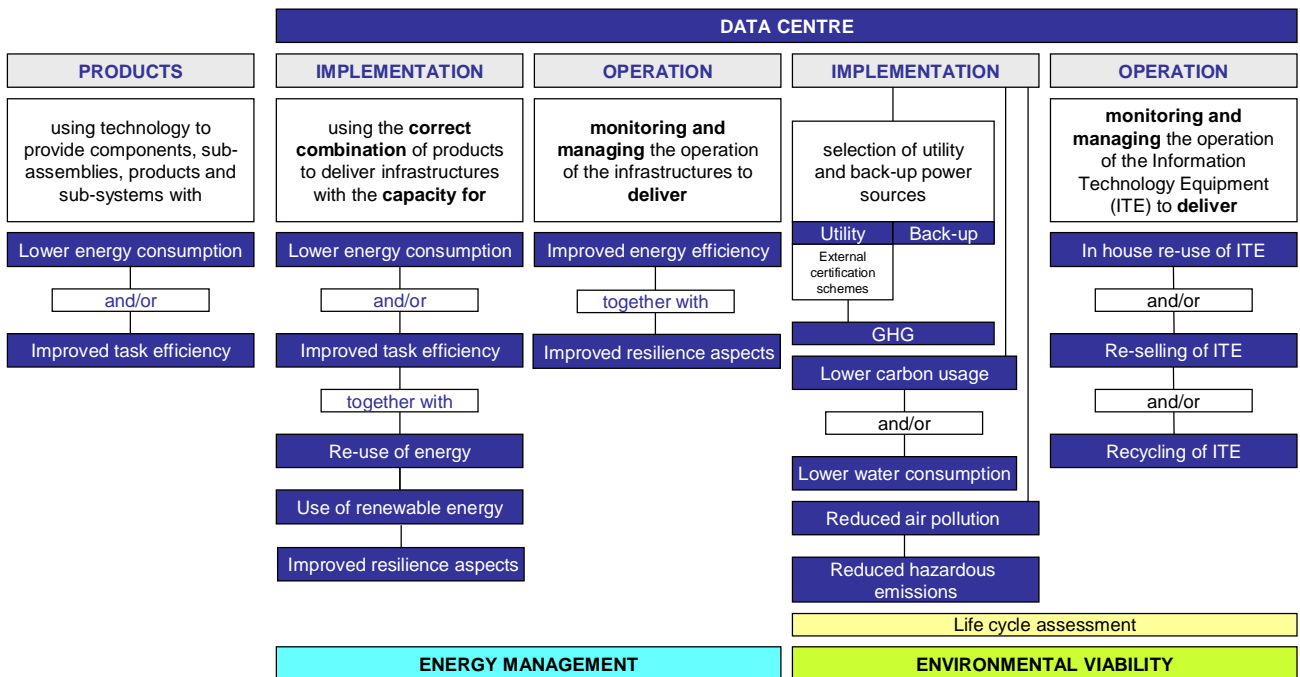
For the purposes of this report, an improvement in energy management comprises five separate elements:

- a reduction of the total energy consumption of a data centre;
- an increase of task efficiency or effectiveness (i.e. doing more work for a given energy input);
- the use, or increased use, of locally provided energy generated from renewable sources;
- the re-use of any waste heat from the data centre;
- optimization with respect to the aspects of data centre resilience.

In addition, it is clear from the schematic below that, in the longer term, there are other environmental viability issues to consider including the use of natural resources such as water to provide cooling to the data centre and the impact of the data centre on greenhouse gas (GHG) emissions, air pollution and other hazardous by-products.

It is therefore imperative to underpin these wider objectives for energy management and environmental viability, which may be met by encouragement (voluntary engagement) or by regulation, by providing a foundation of standards which represent the "tools" to support the application of these "levers".

This document sets out the current standardisation landscape and details actions that are underway in relation to data centre energy management and environmental viability within European Standards Organizations (ESOs) – and those being undertaken by other standards bodies that will be encompassed by European standards in due course.



NOTE: The term "environmental viability" is used recognising that well established treatments of "sustainability" feature three separate viability objectives (environmental, economic and social). For the purposes of this report, only operational aspects of environmental viability are considered. A wider approach to environmental viability takes other factors into account including the use of raw materials and avoidance of hazardous substances in the construction or de-commissioning of the data centre spaces or the equipment within it - these factors are not considered in this report.

# Data Centres

Data centres contain a mixture of equipment providing data storage, processing and transport within the data centre and other equipment connecting the data centre to the “outside world”. This information technology equipment (ITE) has, in most cases, to be supported by power distribution, environmental control and building automation systems (such as lighting and access control). A schematic showing the relationship of these functional elements is shown below.

However, data centres come in all shapes and sizes ranging from one or more cabinets in an existing building to dedicated “stand alone” structures which may comprise multiple buildings. As a result the need for power supply infrastructures, environmental control systems and building automation and access control systems varies greatly as does the implementation (reliability and resilience) of those systems.

For the purposes of this report, an improvement in energy management comprises five separate elements:

- a reduction of the total energy consumption of a data centre;
- an increase of task efficiency or effectiveness (i.e. doing more work for a given energy input);
- the use, or increased use, of locally provided energy generated from renewable sources;
- the re-use of any waste heat from the data centre;
- optimization with respect to the aspects of data centre resilience.

In addition, it is clear that in the longer term there are other environmental viability issues to consider including the use of natural resources such as water to provide cooling to the data centre and the impact of the data centre on greenhouse gas (GHG) emissions, air pollution and other hazardous by-products.

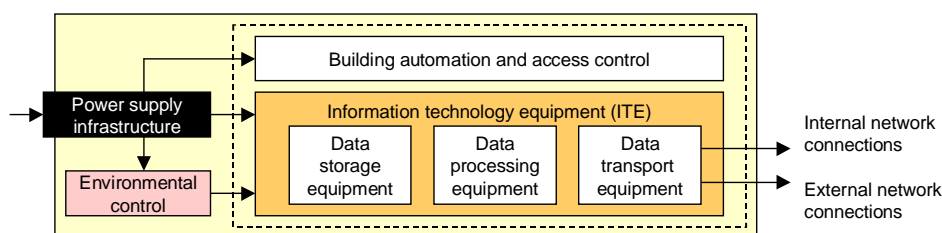
The most basic data centres will have limited “dedicated” content with respect to such facilities and infrastructures and these will generally have a “design” availability defined by that of the building in which they are housed. However, dedicated “stand alone” data centres would be expected to feature facilities and infrastructures meeting specified “design” availability criteria as well as other aspect of resilience.

The purpose of the data centres and the business models served by them can also vary dramatically. The business models are generally differentiated by the nature of separate ownership of the facility, the information technology equipment and the software systems operated on that equipment. These models are commonly described as:

- enterprise: where ownership of the facility, the information technology equipment and the software systems is common: i.e. the “operator” as defined in the European Code of Conduct for Data Centre Energy Efficiency Best Practices (EU CoC BP);
- co-location: where ownership of the facility is separate from that of the information technology equipment, the software systems and their immediate accommodation (“colo” as defined in EU CoC BP);
- hosting: where ownership of the facility and the information technology equipment is common but the software systems are dictated by others (“MSP” as defined in EU CoC BP).

The type of organisations operating the different types of data centre model is not restricted e.g. network operators may operate all three types.

The ability of owners of the data centre facilities and infrastructures to influence the energy performance and environmental viability of their data centres varies substantially across the three models. The same is true of actual availability of the service from the data centre which ultimately relies on the type and configuration of the ITE - independent of the “design availability” of the facility and infrastructures. Nevertheless, facilities and infrastructures with higher levels of “design availability” will tend to exhibit lower levels of task efficiency.



The functional elements of the data centre

# Standards for Data Centres

**data centre**

structure, or group of structures, dedicated to the centralized accommodation, interconnection and operation of information technology and network telecommunications equipment providing data storage, processing and transport services together with all the facilities and infrastructures for power distribution and environmental control together with the necessary levels of resilience and security required to provide the desired service availability

Note 1: A structure can consist of multiple buildings and/or spaces with specific functions to support the primary function.

Note 2: The boundaries of the structure or space considered the data centre which includes the information and communication technology equipment and supporting environmental controls can be defined within a larger structure or building.

The standardisation landscape has the form shown below. It is important to differentiate between standards that support data centre design and those that may be used to improve their operation.

In design terms it is realistic to develop European standards (or Technical Specifications or Technical Reports) that:

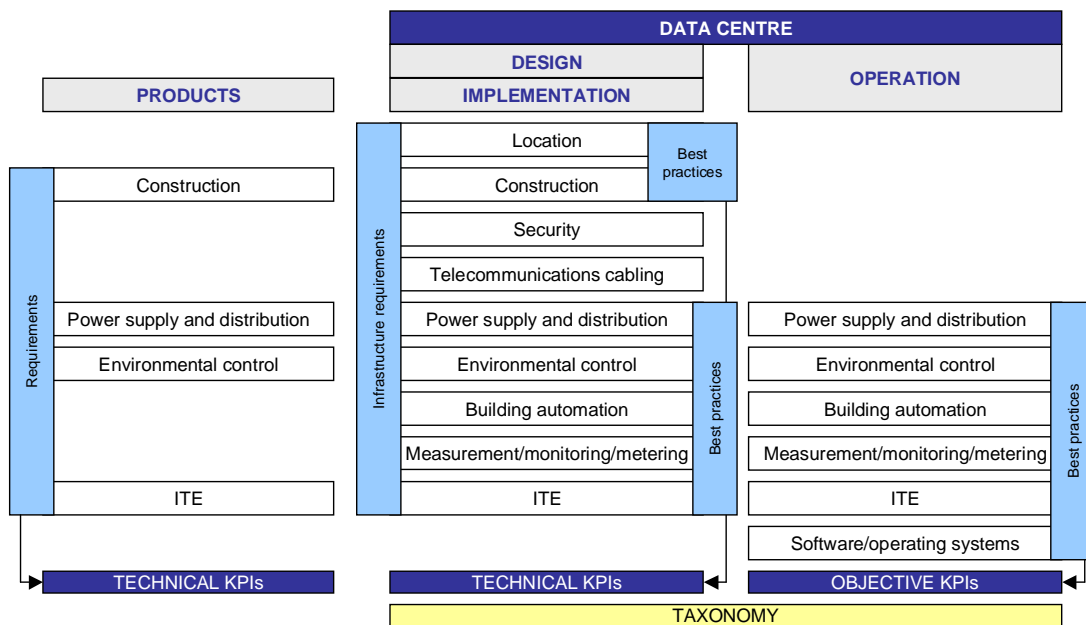
- a) define energy performance and environmental viability requirements for products and infrastructures;
- b) define requirements and recommendations (best practices) which dictate how those products, and others, are used within the implementation of data centre facilities and infrastructures to improve energy management and environmental viability;
- c) specify the various infrastructures of monitoring/metering/measurement devices of defined accuracy necessary to calculate/present the operational Key Performance Indicators (KPIs).

In operational terms it is realistic to develop European standards (or Technical Specifications or Technical Reports) that:

- a) describe best practices, or perhaps sets of best practices, that indicate how management of an existing, operational, data centre may be applied to improve its energy performance and environmental viability;

NOTE: It is important to consider "design" best practices as separate from operational best practices since the latter have to be applicable to legacy data centres within which the design best practices have not been followed. This separation will greatly enhance the value of the documents related to these subjects.

- b) define a range of KPIs for energy management and environmental viability that may be applied to an operational data centre;
- c) specify the various infrastructures of monitoring/metering/measurement devices of defined accuracy necessary to calculate/present the KPIs of b).



Taxonomy is a useful exercise and is included as potential standardisation work. However, there are dangers of trying to define terms with a single meaning that may have to be used differently in the various types of standards to be produced. There are multiple examples of this in other technologies. Despite the apparent universality of taxonomy, it is actually of little importance since individual standards should contain the required definitions - at least in the initial stages.

# Data Centre Assessment – Its value lies in the eye of the beholder

---

## *Introduction*

EN 50600 standards enable certain critical infrastructures of a data centre to be designated as being of a given level with respect to “availability”. EN 50600-1 combines those designations to define an overall “availability” level. Other standards in the series simply require conformance to a set of requirements without an “availability” level designation.

Questions are repeatedly asked about “certification” to these standards and how such “certifications” compare with other 3<sup>rd</sup> Party approaches on the market - and such questions require a formal answer from the CEN/CLC/ETSI Coordination Group on Green Data Centres.

## *Assessment or declaration may be - but not “certification”*

Standards bodies cannot prevent misuse of their standards, but they are able to make transparent to those desiring “certification”, what options they have and what those standards offer regarding “certification” - and importantly what they do not.

However, standards bodies are not in a position to judge whether or not an organization offering certification meets the underlying requirements - that is the role of accreditation specialists.

One of the objectives of standardisation is to enable the determination of whether or not a product, process or system meets a set of minimum requirements. The demonstration of that compliance (conformity assessment) may be ascertained by one of three procedures described as 1<sup>st</sup> Party (carried out by the manufacturer or supplier), 2<sup>nd</sup> Party (carried out by the user or operator) and 3<sup>rd</sup> Party (carried out by a neutral and independent body).

Standards such as those of the EN 50600 series do not define the appropriate procedure, leaving this to bilateral contracts or even national or regional legislation.

In order for 3<sup>rd</sup> Party body to offer their services they have to prove that they fulfil the conditions of the EN ISO/IEC 17000 series (especially EN ISO/IEC 17025 for testing laboratories and/or EN ISO/IEC 17065 for certification bodies) - which requires those bodies to undergo an assessment carried out by an accreditation body. This assessment includes inter alia the proof of neutrality, competence, impartiality etc.

## *EN 50600*

It is probable that, in coming years, an increasing number of organisations will wish assessment of data centres against the conformance requirements of EN 50600 series standards while others will continue to consider alternative solutions.

As a summary of that document the following information provides an outline of the framework offered by the EN 50600 series:

- EN 50600-2-2 defines four levels (1 to 4) for the design availability of the power supply and distribution system of the data centre;
- EN 50600-2-3 defines four levels (1 to 4) for the design availability of the environmental control system of the data centre;
- EN 50600-2-4 defines four levels (1 to 4) for the design availability of the telecommunications cabling systems of the data centre;
- EN 50600-1 defines the overall availability level of a data centre based on the lowest level of three infrastructures detailed above.
- EN 50600-2-5 defines requirements for the maintenance of physical security of data centre spaces independent of the infrastructure level.

In this way EN 50600-1, -2-2, -2-3, -2-4, -2-5 and CLC/TS 50600-4-31 provide a comprehensive framework for assessment of the design availability of a data centre. They are supported by EN 50600-2-1 and EN 50600-3-1 for building construction and operation respectively but these are currently treated as subsidiary to availability objectives.

## *Self-declaration versus 3rd Party assessment - a “value judgement”*

There is nothing to stop a 3<sup>rd</sup> Party from assessing aspects of a data centre against conformance to EN 50600. The same is true for the owner or operator of a data centre. The lack of any true certification system for data centre renders both approaches, and any assessment against alternative 3<sup>rd</sup> party schemes, as being of equal technical status.

EN 50600 was developed to support the wide variety of business models associated with data centres. Self-assessment or self-declaration of conformance against the requirements outlined above is comparatively simple and may be attractive to enterprise owners - whereas a 3<sup>rd</sup> Party assessment against those same requirements may be more appropriate for owner-operators of data centres that market their services to others.

Self-declaration, rather than formal “certification”, is all that is available. The application of a EuroNorm as the basis for that assessment is clearly a step forward but the choice of self- or 3<sup>rd</sup> Party assessment has to be based on the apparent and perceived value and application of the resulting assessment versus the cost of the process to be employed.



# Data Centre Energy Management: Infrastructure Design - Requirements

## Overview

A number of regional “standards” have been published in the last twenty years which address design issues for data centre infrastructures. For example, ANSI/TIA-942-A focuses on the telecommunication infrastructure while BICSI 002 considers itself a standard covering the full range of infrastructures but is, in reality, a comprehensive set of design and implementation best practices. However, neither of these documents can be considered to define requirements that can be wholly employed (or “conformed to”) because of their inherent linkages to other US standards which are incompatible with European or wider international practices.

Within Europe, CENELEC has the objective of producing a set of standards that define minimum requirements for the necessary infrastructures for all shapes and sizes of data centres ranging from one or more cabinets in an existing building to dedicated “stand alone” structures which may comprise multiple buildings. These standards also recognize the very diverse nature of data centre business models and the complexities of configuration and ownership of the information technology and network telecommunications equipment that may be accommodated. For this reason, the standard only addresses the availability of the infrastructures rather than that of the service provided by the data centre itself.

EN 50600-1 and the EN 50600-2 series classify the design of power distribution, environmental control and telecommunications cabling infrastructures in terms of “Availability Class” and “Protection Class” against unauthorised access, internal and external environmental events within the pathways and spaces containing the infrastructure elements.

Infrastructure	Availability of overall set of facilities and infrastructures			
	Low	Medium	High	Very high
	AVAILABILITY CLASS			
	1	2	3	4
<b>Power supply</b> EN 50600-2-2	Single path to primary distribution equipment - Single source	Single path to primary distribution equipment - Redundant sources	Multiple paths to primary distribution equipment - Redundant sources	Multiple paths to primary distribution equipment - Multiple sources
<b>Power distribution</b> EN 50600-2-2 and environmental control EN 50600-2-3	Single path	Single path with redundancy	Multiple paths - Concurrent repair/operate solution	Multiple paths - Fault tolerant except during maintenance
<b>Telecommunications cabling</b> EN 50600-2-4	Single path - direct connections or fixed infrastructure with single access network connection	Single path - fixed infrastructure with multiple access network connections	Multiple paths - fixed infrastructure with diverse pathways with multiple access network connections	Multiple paths - fixed infrastructure with diverse pathways and redundant distribution zones and multiple access network connections

EN 50600-1 defines the general concepts of the series of documents, linking the requirements for the design of an infrastructure and the security of its pathways and spaces to the availability objective for the total set of infrastructures.

This general concept of Availability Classes of specific infrastructures in EN 50600-1 is shown in Figure 1.

Security is a combination of constructional aspects together with the monitoring systems addressing access control, fire etc. In addition, the power supply/distribution and environmental control infrastructures are specified to enable monitoring the efficiency of energy consumption.

Figure 1 - The Availability Class concept of EN 50600-1:2019 and EN 50600-2 series

## Construction

EN 50600-2-1 defines the requirements and recommendations for building construction, independent of the size and function of the data centre. It addresses a wide range of situations including the choice of location and site selection for a new data centre to the assessment of existing buildings and structures. It then defines requirements for the applicable constructional aspects and is directly linked to EN 50600-2-5 in relation to physical security aspects.

## Power distribution

EN 50600-2-2 defines the Availability Class requirements and recommendations for the design of power supply and distribution systems and the “quality” of the supply provided. It adopts the four Availability Classes of EN 50600-1 shown in Figure 1. with the simplest implementation being a basic utility supply with uninterruptible power supply (UPS) support. It defines example implementations of the distribution systems delivering power to the protected, locally protected, short-break and unprotected sockets. It also defines locations of monitoring of energy consumption which can be used to determine energy management Key Performance Indicators.

In addition, EN 50600-2-2 defines the Protection Classes applicable to the pathways and spaces containing the elements of the power distribution infrastructure which are amplified in EN 50600-2-5.

EN 50174-1 and EN 50174-2 contain requirements for the specification, planning and assessment of telecommunications cabling to support the delivery of power using telecommunications cabling.

## *Environmental control*

EN 50600-2-3 defines the environmental requirements for the various data centre spaces and also provides requirements and recommendations for the design of environmental control systems in relation to Availability Class. It adopts the four Availability Classes of EN 50600-1 shown in Figure 1.

In addition, EN 50600-2-3 defines the Protection Classes applicable to the pathways and spaces containing the elements of the environmental control infrastructure which are amplified in EN 50600-2-5.

## *Telecommunications cabling*

Telecommunications cabling is a critical part of the data centre infrastructure – not only connecting the information technology devices of the “computer room” but also providing connectivity for the general telecommunications and building automation systems within all the data centre spaces, together with the measurement, monitoring and metering of the other data centre infrastructures. EN 50600-2-4 defines requirements and recommendations for this cabling infrastructure by reference to existing design standards for generic cabling (such as EN 50173-2, EN 50173-5 and EN 50173-6) with appropriate planning and installation practices in support of EN 50174 series standards. The standard also addresses the installation of cabling in order to maximise the efficiency of environmental control systems - which affects the energy management of the data centre overall.

## *Building automation*

Requirements and recommendations for automated control of the physical security of data centre spaces (including access controls, fire detection and suppression) are addressed in EN 50600-2-5. Other building automation aspects such as general heating, lighting etc are covered in a large range of non-“data centre” specific standards. However, the rapid growth of power delivered over telecommunications cabling in its various forms, suggests that generic cabling in accordance with EN 50173-6 (referenced by EN 50600-2-4) may increasingly support the distributed building services that comprise the total building automation solution.

## *Measurement, monitoring and metering*

In addition, EN 50600-2-2, -2-3 and -2-5 define measurement and/or monitoring locations in support of their specific objectives and, where appropriate, specify the accuracy levels for the measurement and/or metering of the energy consumption at those locations. EN 50600-3-1 addresses the management of this operational information which may be used to assess the performance of the data centre using applicable Key Performance Indicators.

## **International activity**

ISO/IEC JTC 1/SC 39 has published the first editions of EN 50600-1, the EN 50600-2 series and EN 50600-3-1 as sequential parts of the ISO/IEC TS 22237 series and is now developing the TS documents into full international standards (first results are ISO/IEC 22237-1, ISO/IEC 22237-2, ISO/IEC 22237-3, ISO/IEC 22237-4 and ISO/IEC 22237-6).

EN 50173-2:2018	<i>Information technology - Generic cabling systems - Part 2: Office premises</i>
EN 50173-5:2018	<i>Information technology - Generic cabling systems - Part 5: Data centres</i>
EN 50173-6:2018	<i>Information technology - Generic cabling systems - Part 6: Distributed building services</i>
EN 50174-1:2018	<i>Information technology - Cabling installation - Part 1: Installation specification and quality assurance</i>
EN 50174-2:2018	<i>Information technology - Cabling installation - Part 2: Planning and Installation practices inside buildings</i>
EN 50600-1:2019	<i>Information technology - Data centre facilities and infrastructures - Part 1: General concepts</i>
EN 50600-2-1:2021	<i>Information technology - Data centre facilities and infrastructures -Part 2-1: Building construction</i>
EN 50600-2-2:2019	<i>Information technology - Data centre facilities and infrastructures - Part 2-2: Power supply and distribution</i>
EN 50600-2-3:2019	<i>Information technology - Data centre facilities and infrastructures - Part 2-3: Environmental control</i>
EN 50600-2-4:2023	<i>Information technology - Data centre facilities and infrastructures - Part 2-4: Telecommunications cabling infrastructure</i>
EN 50600-2-5:2021	<i>Information technology - Data centre facilities and infrastructures - Part 2-5: Physical security</i>
EN 50600-3-1:2016	<i>Information technology - Data centre facilities and infrastructures - Part 3-1: Management and operational information</i>

# Data Centre Energy Management: Maturity Model for Energy Management and Environmental Sustainability

---

## Overview

Across the international community there are a large number of independent documents that claim to provide information on best practice for the design for data centre infrastructures. Most of this information has coalesced into a variety of reports produced by industry associations and other fora.

## CLC/TS 50600-5-1

In order to substantiate best practices, CENELEC has developed CLC/TS 50600-5-1, the Data Centre Maturity Model for Energy Management and Environmental Sustainability. The 2<sup>nd</sup> edition of the document encompasses the practices previously contained in CLC/TR 50600-99-1:2021 (which is aligned with the contents of EU CoC BP V.14.1.0) and CLC/TR 50600-99-2:2021.

## ETSI TS 105 174-2 and ETSI EN 305 174-2

ETSI EN 305 174-2 specifies universally applicable practices and provides further linkages to EN 50600 series standards for design, operation and energy management. ETSI TS 105 174-2:2020-01 (V1.3.1) maps the practices of CLC/TR 50600-99-1 and provide example outcomes for certain of the practices. Both documents were prepared under Phase 2 of Mandate M/462.

## EU Code of Conduct for Data Centre Energy Efficiency

In a separate activity, the European Union Directorate General Joint Research Council introduced a Code of Conduct (CoC) for Data Centre Energy Efficiency which comprises a monitoring scheme for participating organisations and a separate “Best Practices” document which is updated annually. Currently in its Version 15.1.0 and available free of charge, it contains sections on location, construction, power supply and distribution infrastructures and environmental control systems (or “cooling”). To support the EU Taxonomy, an assessment framework has been developed based on the CoC Best Practices, as the language of the Best Practices is not fit for that purpose.

## International activity

ITU-T Study Group 5 has published ITU-T L.1300 (revised in 2014) with the majority, many without change, of the EU CoC Best Practices for ITE selection and includes a small number of practices introduced by the members of ITU-T including the use of environmental ranges of ETSI EN 300 019 series standards.

ISO/IEC JTC 1/SC 39 has developed ISO/IEC TR 30133 which contains a number of more long-term practices. ISO/IEC JTC 1/SC 39 has also developed ISO/IEC TS 22237-30 which addresses design mitigation in response to identified earthquake risk (adopted as CLC/TS 50600-2-10).

CLC/TS 50600-2-10	<i>Information technology - Data centre facilities and infrastructures- Part 2-10: Earthquake risk and impact analysis</i>
CLC/TS 50600-5-1	<i>Information technology - Data centre facilities and infrastructures- Part 5-1: Maturity Model for Energy Management and Environmental Sustainability</i>
EN 50600-3-1:2016	<i>Information technology: Data centre facilities and infrastructures- Part 3-1: Management and operational information</i>
ETSI EN 300 019 series	<i>Environmental conditions and environmental tests for telecommunications equipment</i>
ETSI EN 305 174-2	<i>Broadband Deployment and Lifecycle Resource Management; Part 2: ICT Sites</i>
ETSI TS 105 174-2:2020	<i>Broadband Deployment and Lifecycle Resource Management; Part 2: ICT sites: Implementation of energy and lifecycle management practices</i>
EU CoC BP v14.1.0	<i>Best Practices for the European Code of Conduct on Data Centre Energy Efficiency</i>
ITU-T L.1300	<i>Series L: Construction, Installation and Protection of cables and other elements of outside plant: Best practices for data centers</i>
ISO/IEC TS 22237-30	<i>Information technology – Data centre facilities and infrastructures – Part 30: Earthquake risk and impact analysis</i>
ISO/IEC TR 30133	<i>Information technology – Data centres – Guidelines for resource efficient data centres</i>

# Data Centre Energy Management: ITE Design - Requirements and Best Practice

---

## Requirements

Currently there are no ESO standards for the design and/or selection of ITE (computing, storage and networking) in relation to energy management or the measurement and/or monitoring of the performance of that equipment in terms of energy efficiency.

## Recommendations (best practice)

CLC/TS 50600-5-1, ETSI EN 305 174-2, ETSI TS 105 174-2 and the “Best Practices” document of the EU CoC for Data Centre Energy Efficiency (see page 11) contain requirements and best practice recommendations in relation to the selection of ITE (computing, storage and networking).

### International activity

ITU-T Study Group 5 has published ITU-T L.1300 (revised in 2014) and ISO/IEC JTC 1/SC 39 has developed ISO/IEC TR 30133 which contain best practices for ITE selection of the European activities (see page 10).

# Data Centre Environmental Viability: Infrastructure and ITE Design

---

## Infrastructure design requirements

Currently there are no ESO standards containing requirements for the environmental viability of data centre infrastructure design.

## Infrastructure design recommendations (best practice)

CLC/TS 50600-5-1 also provides recommendations (which were previously contained in CLC/TR 50600-99-2) in relation to the environmental sustainability of data centres – some of which are aligned with the “Best Practices” document of the EU CoC for Data Centre Energy Efficiency. These include some information in relation to consumption of other resources (e.g. water). In addition, ETSI EN 305 174-8 and ETSI TS 105 174-8 address end-of-life aspects of ITE.

The combination of the former CLC/TR 50600-99-1, the former CLC/TR 50600-99-2 and end-of life aspects are presented in ETSI TS 105 174-2 which also refers to constructional assessments using national guidelines.

### International activity

ITU-T Study Group 5 has published ITU-T L.1300 (revised in 2014) and ISO/IEC JTC 1/SC 39 has developed ISO/IEC TR 30133 which contain some water resource recommendations of the European activities (see page 10).

## ITE and software design requirements and recommendations (best practice)

Currently there are no ESO standards containing requirements or recommendations for the environmental viability of data centre ITE and software design.

CLC/TS 50600-5-1:2023	<i>Information technology - Data centre facilities and infrastructures - Part 5-1: Maturity Model for Energy Management and Environmental Sustainability</i>
ETSI EN 300 019 series	<i>Environmental conditions and environmental tests for telecommunications equipment</i>
ETSI EN 305 174-2	<i>Broadband Deployment and Lifecycle Resource Management; ICT Sites</i>
ETSI TS 105 174-2:2020	<i>Broadband Deployment and Lifecycle Resource Management; Part 2: ICT sites: Implementation of energy and lifecycle management practices</i>
ETSI EN 305 174-8	<i>Broadband Deployment and Lifecycle Resource Management; Part 8: Management of end of life of ICT equipment (ICT waste/end of life)</i>
ETSI TS 105 174-8	<i>Broadband Deployment and Lifecycle Resource Management; Part 8: ICT sites: Implementation of WEEE practices for ICT equipment during maintenance and at end-of-life</i>
EU CoC BP v13.1.1	<i>Best Practices for the European Code of Conduct on Data Centre Energy Efficiency</i>
ITU-T L.13005	<i>Series L: Construction, Installation and Protection of cables and other elements of outside plant: Best practices for data centers</i>
ISO/IEC TR 30133	<i>Information technology – Data centres – Guidelines for resource efficient data centres</i>

## *Infrastructure and ITE recommendations (best practice)*

### **Overview**

Across the international community there are a large number of independent documents that claim to provide information on best practice for the operation of data centre infrastructures and ITE. Most of this information has coalesced into a variety of reports produced by industry associations and other fora.

### **CLC/TS 50600-5-1 and EN 50600 series standards**

A CENELEC Technical Specification, CLC/TS 50600-5-1 provides a “standard-based” set of practices for energy management and environmental sustainability; it is aligned with the contents of EU CoC BP V. 14.1.0. (see below).

EN 50600-3-1 contains the requirements for the recording of data as part of the management and operational information as required by Key Performance Indicators that are chosen to be applied.

### **ETSI EN 305 174-2 and ETSI TS 105 174-2**

ETSI EN 305 174-2 specifies universally applicable practices and provides further linkages to EN 50600 series standards for design, operation and energy management. Both documents were prepared under Phase 2 of Mandate M/462.

A 2019 revision of ETSI TS 105 174-2 maps the practices of CLC/TR 50600-99-1 and provides example outcomes for certain of the practices.

### **EU Code of Conduct for Data Centre Energy Efficiency**

The “Best Practices” document of the Code of Conduct for Data Centre Energy Efficiency contains recommendations for operation of power distribution infrastructures, environmental control systems and ITE, together with recommendations on monitoring of component performance and energy consumption.

### **International activity**

ITU-T Study Group 5 has published ITU-T L.1300 (revised in 2014) with the majority, many without change, of the EU CoC Best Practices for data centre operation and monitoring and includes additional practices introduced by the members of the ITU-T.

ISO/IEC JTC 1/SC 39 has developed ISO/IEC TR 30133 which contains a number of more long-term operational practices.

EN 50600-3-1:2016	<i>Information technology: Data centre facilities and infrastructures - Part 3-1: Management and operational information</i>
EU CoC BP	<i>Best Practices for the European Code of Conduct on Data Centre Energy Efficiency</i>
ETSI EN 305 174-2	<i>Broadband Deployment and Lifecycle Resource Management; Part 2: ICT Sites</i>
ETSI TS 105 174-2:2019	<i>Broadband Deployment and Lifecycle Resource Management; Part 2: ICT sites: Implementation of energy and lifecycle management practices</i>
ITU-T L.1300	<i>Series L: Construction, Installation and Protection of cables and other elements of outside plant: Best practices for data centers</i>
ISO/IEC TR 30133	<i>Information technology – Data centres – Guidelines for resource efficient data centres</i>

# Data Centre Energy Management: Key Performance Indicators - Introduction

**Key Performance Indicator (KPI)**

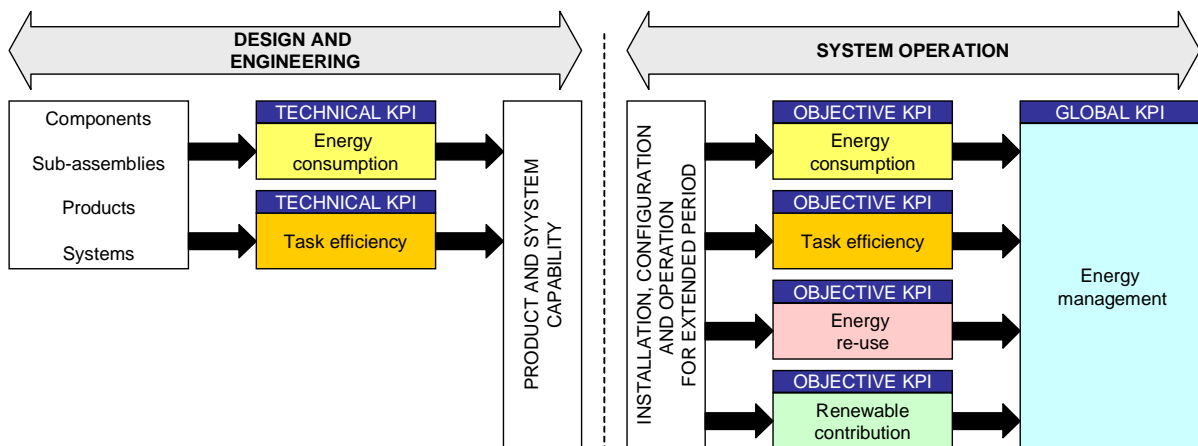
**global KPI**  
a KPI of an operational infrastructure which presents information from a number of separate objective KPIs

**objective KPI**  
a KPI assessing one of the objectives of energy management or environmental viability of an operational infrastructure which may be subsequently used to define a global KPI

**technical KPI**  
a KPI assessing the energy management or environmental viability of a component, sub-assembly, product or sub-system under a specified set of conditions

## Overview

Standards are being developed to specify how Key Performance Indicators (KPIs) are measured, monitored and applied but it is important to distinguish between the roles of the various KPIs as shown below and to support, but differentiate, the separate roles of Technical, Objective and Global KPIs.



Technical KPIs relate to the design and engineering phase for the components, sub-assemblies, products and systems to be employed in data centres. They are measured under specific operating conditions and provide indications of potential performance in an operational data centre.

Objective KPIs apply to the data centre infrastructures in the operational phase and may be used to monitor and drive user behaviour within the data centre.

Global KPIs provide a different view of a user's commitment to strategic energy management practices than the Objective KPIs. For example a user is not supporting overall energy goals by achieving class-leading provision of local renewable energy if their overall energy consumption is based upon equipment with very poor task efficiency.

It is highlighted that it is not the intention to characterise an operational data centre by a single global KPI – different global KPIs may combine different combinations of objective KPIs with the intention of focussing on specific resource efficiency objectives.

**It is also important to:**

- consider operational KPIs (objective or global) as trend indicators and not comparators between different data centres
- ensure that the use of global KPIs does not serve to hide the trends demonstrated by the underpinning objective KPIs.

## Technical KPIs

Individual components or sub-assemblies can be designed to have improved task efficiency i.e. less energy is consumed for a given output or task. Such components or sub-assemblies may be inherently more efficient in the way in which they

use energy under specific operating conditions but are essentially unable to manage that consumption. An example of such a product would be a power supply unit which may be more efficient under higher load conditions. More complex products may contain hardware and/or software which automatically reduce energy consumption under specific operating conditions by putting certain functions into "idle" states if not required. This is distinctly different than that of a single task component or sub-assembly detailed above.

Technical KPIs can be applied to both of the above by assessing energy consumption for a number of specific operating conditions and also across a combination of such operating conditions. Assuming those operating conditions reflect the probable operating environment for the component, sub-assembly or product, a customer may make valued judgements in relation to the appropriateness of the Technical KPI. For example, two products that have equal "combined" Technical KPIs, may be more efficient under very specific conditions. For example, a design of power supply that is more task efficient under high load conditions may be inappropriate for users who plan to predominantly operate under low load conditions (and vice versa).

A higher level of task efficiency management is also possible where groups of products are managed to reduce energy consumption by either allocating loads in such a way that the group is operating at maximum task efficiency and/or by putting individual products within the group into an "idle" mode. Once again, the value of such approaches can be validated by the establishment of Technical KPIs which can be applied to both of the above by assessing energy consumption of a defined group of products for a number of specific operating conditions and also across a combination of such operating conditions.

## *Objective KPIs*

The performance of products and systems, of proven Technical KPIs performance, may exhibit different energy consumption and task efficiency characteristics when subjected to actual operating conditions which lie outside those of the Technical KPIs applied to those products and systems at the design and engineering stages and, equally importantly, when subjected to user configuration and controls which may undermine the sophisticated systems available.

The Objective KPIs relate to specific elements of energy management for operational infrastructures including:

- energy consumption: the total consumption of energy by an operational infrastructure;
- task efficiency: a measure of the work done (as a result of design and/or operational procedures) for a given amount of energy consumed - a number of different indicators are under consideration and the most appropriate solution may depend upon the business model of, processes undertaken within, the data centre;
- energy re-use: transfer or conversion of energy (typically in the form of heat) produced by the operational infrastructure to do other work - however, caution is required since - one needs to consider how the reusable heat is obtained (e.g. is it preconditioned to a higher temperature) and where would the heat have come from otherwise;
- renewable energy: energy produced from dedicated generation systems using resources that are naturally replenished.

The procurement of products and systems based upon their Technical KPIs for energy consumption and/or task efficiency underpins the relevant Objective KPIs. However, Objective KPIs define requirements for the measurement of operational infrastructures i.e. taking into account the real operating conditions over a defined period of time.

Objective KPIs are applicable to aspects of environmental viability. These KPIs may include the use of other resources than energy but the relevance of a specific KPI will depend upon the availability of the resource in question.

## *Global KPIs*

The Objective KPIs, of which task efficiency is only one, may be combined using a formula appropriate to the specific operational infrastructure to produce one or more Global operational KPIs which reflects the overall performance of the operational infrastructures against wider energy management targets which may be self-imposed by the operators or externally applied by legislators.

# Data Centre Energy Management: KPI Standards

---

## Overview

There are a large number of standards which define Key Performance Indicators (KPIs) by which different aspects of the energy performance of data centres may be assessed. Some of these KPIs apply to design performance (termed Technical KPIs in this document) whereas other relate to the operational performance of the data centre (termed Objective KPIs).

## Energy management KPIs

### Technical KPIs

ETSI EN 303 470, under Phase 2 of Mandate M/462, specifies KPIs and associated measurement methods for the energy efficiency of server equipment.

### International activity

ISO/IEC JTC 1/SC 39 has published ISO/IEC 30134-4 and ISO/IEC 21836 (similar to ETSI EN 303 470). Both standards specify Technical KPIs for energy efficiency of server equipment.

### Objective KPIs

EN 50600-4-1 (based on ISO/IEC 30134-1) contains the requirements to which all subsequent KPIs shall conform. EN 50600-4-2, EN 50600-4-3 and EN 50600-4-6 contain the detailed specification of Objective KPIs, namely PUE, REF and ERF, respectively (EN implementations of ISO/IEC 30134-2, 30134-3 and 30134-6 respectively). EN 50600-4-7 addresses cooling efficiency.

ETSI EN 305 200-2-1 and ETSI EN 305 200-3-1 use Objective KPIs of energy management to support Global KPIs as discussed on the following page. These are similar to those specified by CENELEC for PUE, REF and ERF described above.

### International activity

ISO/IEC JTC 1/SC 39 has published standards for Objective KPIs for data centres including ISO/IEC 30134-2, ISO/IEC 30134-3 ISO/IEC 30134-5 and ISO/IEC 30134-6 and has adopted EN 50600-4-7 as ISO/IEC 30134-7. ISO/IEC JTC 1/SC 39 is also developing Technical Reports addressing KPIs including ISO/IEC TR 21897 and ISO/IEC TR 23050. Furthermore, ISO/IEC JTC 1 has published ISO/IEC 24091 on Power efficiency measurement specification for data center storage.

EN 50600-4-1	<i>Information technology - Data centre facilities and infrastructures - Part 4-1: Overview of and general requirements for key performance indicators</i>
EN 50600-4-2	<i>Information technology - Data centre facilities and infrastructures - Part 4-2: Power Usage Effectiveness</i>
EN 50600-4-3	<i>Information technology - Data centre facilities and infrastructures - Part 4-3: Renewable Energy Factor</i>
EN 50600-4-6	<i>Information technology - Data centre facilities and infrastructures - Part 4-6: Energy Reuse Factor</i>
EN 50600-4-7	<i>Information technology - Data centre facilities and infrastructures - Part 4-7: Cooling Efficiency Ratio</i>
ETSI EN 303 470	<i>Energy Efficiency measurement methodology and metrics for servers</i>
ETSI EN 305 200-2-1	<i>Energy management; Operational infrastructures; Global KPIs; Part 2: Specific requirements Sub-part 1: ICT sites</i>
ETSI EN 305 200-3-1	<i>Energy management; Operational infrastructures; Global KPIs; Part 3: ICT sites Sub-part 1: DCEM</i>
ISO/IEC 21836	<i>Information Technology - Data Centres - Server Energy Efficiency Metric</i>
ISO/IEC 24091	<i>Information technology - Power efficiency measurement specification for data center storage</i>
ISO/IEC 30134-2	<i>Information Technology - Data Centres - Key Performance Indicators - Part 2: Power Usage Effectiveness (PUE)</i>
ISO/IEC 30134-3	<i>Information Technology - Data Centres - Key Performance Indicators - Part 3: Renewable Energy Factor (REF)</i>
ISO/IEC 30134-4	<i>Information Technology - Data Centres - Key Performance Indicators - Part 4: IT Equipment Energy Efficiency for Servers</i>
ISO/IEC 30134-5	<i>Information Technology - Data Centres - Key Performance Indicators - Part 5: IT Equipment Energy Utilisation for Servers</i>
ISO/IEC 30134-6	<i>Information Technology - Data Centres Key Performance Indicators - Part 6: Energy Reuse Factor (ERF)</i>
ISO/IEC 30134-7	<i>Information Technology - Data Centres Key Performance Indicators - Part 7: Cooling Efficiency Ratio (CER)</i>
ISO/IEC TR 21897	<i>Information Technology - Data centres – Impact of the ISO 52000 series on energy performance of buildings</i>
ISO/IEC TR 23050	<i>Information Technology - Data Centres - Excess Electrical Energy</i>



## Global KPIs

ETSI EN 305 200-2-1 and ETSI EN 305 200-3-1 each specify Objective KPIs of energy management which are used to support Global KPIs.

ETSI EN 305 200-2-1, specifies a formula which combines its Objective KPIs into a single Global KPI ( $KPI_{EM}$ ).

ETSI EN 305 200-3-1, specifies a formula which combines its Objective KPIs into an alternative formulation of a Global KPI ( $KPI_{DCEM}$ ) which is based on the same Objective KPIs. ETSI TS 105 200-3-1 provides greater detail to support the implementation of EN 305 200-3-1.

## International activity

ISO/IEC JTC 1/SC 39 have published a Technical Report, ISO/IEC TR 20913, which explains the risks of, and provides guidelines for, employing combinations of Objective KPIs.

# Data Centre Environmental Viability: KPI Standards

---

## Global KPIs

CENELEC has published a Technical Specification CLC/TS 50600-5-1 which defines a data centre Maturity Model for Energy Management and Environmental Sustainability based on environmental sustainability practices taken from former CLC/TR 50600-99-1 and former CLC/TR 50600-99-2. The Maturity Model is, in effect, a Global KPI since it assesses the implementation of a broad spectrum of established practices which are recognised as featuring improvements of environmental sustainability.

ETSI has published ETSI Standard ES 205 200-3-2, which specifies the requirements for a Global KPI for carbon management in operation ( $KPI_{DCCM}$ ) and their underpinning Objective KPIs addressing greenhouse gas emissions, effectiveness of energy generation over greenhouse gas emissions, avoided greenhouse gas emission and reused greenhouse gas emission.

## Objective KPIs

Within the EN 50600 series, EN 50600-4-8 and EN 50600-4-9 mirror the publication by ISO/IEC of Objective KPIs for carbon and water usage effectiveness.

## International activity

ISO/IEC JTC 1/SC 39 has published ISO/IEC 30134-8 and ISO/IEC 30134-9 for Objective KPIs of carbon and water usage effectiveness.

CLC/TS 50600-5-1:2023	<i>Information technology - Data centre facilities and infrastructures - Part 5-1: Maturity Model for Energy Management and Environmental Sustainability</i>
EN 50600-4-8	<i>Information technology - Data centre facilities and infrastructures - Part 4-8: Carbon Usage Effectiveness</i>
EN 50600-4-9	<i>Information technology - Data centre facilities and infrastructures - Part 4-9: Water Usage Effectiveness</i>
ETSI EN 305 200-2-1	<i>Energy management; Operational infrastructures; Global KPIs; Part 2: Specific requirements Sub-part 1: ICT sites</i>
ETSI EN 305 200-3-1	<i>Energy management; Operational infrastructures; Global KPIs; Part 3: ICT sites Sub-part 1: DCEM</i>
ETSI ES 203 200-3-2	<i>Carbon Intensity Management; Operational infrastructures; Implementation of Global KPIs; Part 3: ICT Sites; Sub-part 2: DCCM</i>
ETSI TS 105 200-3-1	<i>Energy management; Operational infrastructures; Implementation of Global KPIs; Part 3: ICT Sites; Sub-part 1: DCEM</i>
ISO/IEC TR 20913	<i>Information Technology - Data Centres - Key Performance Indicators - Guidelines on holistic investigation methodology for data centre key performance indicators</i>
ISO/IEC 30134-8	<i>Information Technology - Data Centres Key Performance Indicators - Part 8: Carbon Usage Effectiveness (CUE)</i>
ISO/IEC 30134-9	<i>Information Technology - Data Centres Key Performance Indicators - Part 9: Water Usage Effectiveness (WUE)</i>

# Definitions

---

## **data centre**

### **co-hosting data centre**

data centre in which multiple customers are provided with access to network(s), servers and storage equipment on which they operate their own services/applications

Note: Both the information technology equipment and the support infrastructure of the building are provided as a service by the data centre operator.

### **co-location data centre**

data centre in which multiple customers locate their own network(s), servers and storage equipment

Note: The support infrastructure of the building (such as power distribution and environmental control) is provided as a service by the data centre operator.

### **enterprise data centre**

data centre that is operated by an enterprise which has the sole purpose of the delivery and management of services to its employees and customers

### **hosting data centre**

a data centre within which ownership of the facility and the information technology equipment is common but the software systems are dictated by others

## **energy consumption**

total consumption of energy by an operational infrastructure

## **energy management**

combination of reduced energy consumption and increased task efficiency, re-use of energy and use of renewable energy

## **energy re-use**

transfer or conversion of energy (typically in the form of heat) produced by the operational infrastructure to do other work

## **environmental control system**

facilities and infrastructures necessary to maintain the equipment of a data centre within its required environmental performance range

## **Information Technology Equipment (ITE)**

equipment providing data storage, processing and transport services together with the network telecommunications equipment dedicated to providing direct connection to core and/or access networks

## **ITE load**

total requirement for power by a set of information technology equipment (ITE)

## **operational infrastructure**

the combination of information technology equipment (ITE) together with the power supply and environmental control systems necessary to ensure provision of service

## **power supply and distribution system**

facilities and infrastructures necessary to provide power to the equipment of a data centre to meet desired operational objectives

## **renewable energy**

energy produced from dedicated generation systems using resources that are naturally replenished

## **resilience**

ability to withstand and reduce the magnitude and/or duration of disruptive events, including the capability to anticipate, absorb, adapt to, and/or rapidly recover from such an event

## **task efficiency**

measure of the work done (as a result of design and/or operational procedures) for a given amount of energy consumed

# Abbreviations and Acronyms

<b>ANSI/TIA</b>	American National Standards Institute/Telecommunications Industry Association	<b>GHG</b>	Green House Gas
<b>BICSI</b>	Building Industry Consulting Service International	<b>IEC</b>	International Electrotechnical Commission
<b>CEN</b>	European Committee for Standardization	<b>ITE</b>	Information technology equipment
<b>CENELEC</b>	European Committee for Electrotechnical Standardization	<b>ISO</b>	International Standardization Organization
<b>CoC</b>	Code of Conduct	<b>ITU</b>	International Telecommunication Union
<b>ETSI</b>	European Telecommunications Standards Institute	<b>ITU-T</b>	ITU's Telecommunication standardization sector
<b>ESO</b>	European Standards Organization (CEN, CENELEC and ETSI)	<b>KPI</b>	Key Performance Indicator
<b>EU</b>	European Union	<b>UPS</b>	Uninterruptible Power Supply
<b>EU CoC BP</b>	EU Code of Conduct for Data Centres Best Practices		



The European Committee for Standardization (CEN) is a business catalyst in Europe, removing trade barriers for European stakeholders such as industry, public administration, service providers, consumers and other stakeholders. Its mission is to foster the European economy in global trading, the welfare of European citizens, and the environment. Through its services CEN provides a platform for the development of European Standards and other specifications.

CEN's 31 National Members work together to develop voluntary European Standards (ENs) in various sectors to build a European Internal Market for goods and services and to position Europe in the global economy. By supporting research, and helping disseminate innovation, standards are a powerful tool for economic growth. More than 60.000 technical experts as well as business federations, consumer and other societal interest organizations are involved in the CEN network that reaches over 480 million people.

For further information, please visit:  
[www.cencenelec.eu](http://www.cencenelec.eu)



The European Committee for Electrotechnical Standardization is officially responsible for standardization in the electrotechnical field. In an ever more global economy, CENELEC fosters innovation and competitiveness, making technology available not only to major businesses but also to SMEs through the production of voluntary standards. CENELEC creates market access at the European level but also at the international level through its cooperation agreement with the International Electrotechnical Commission (IEC).

Through the work of its 31 Members together with its experts, the industry federations and consumers, Electrotechnical European Standards are created in order to help shape the European Internal Market, to encourage technological development, to ensure interoperability and to guarantee the safety and health of consumers and provide environmental protection.

For further information, please visit:  
[www.cencenelec.eu](http://www.cencenelec.eu)



ETSI produces globally-applicable standards for Information and Communications Technologies (ICT), including fixed, mobile, radio, converged, aeronautical, broadcast and internet technologies and is officially recognized by the European Union as a European Standards Organization.

ETSI is an independent, not-for-profit association whose 700+ member companies and organizations, drawn from 62 countries across 5 continents worldwide, determine the ETSI work programme and participate directly in its work.

For further information, please visit: [www.etsi.org](http://www.etsi.org)