



DPC: 25/30457459 DC

BSI Group Headquarters

389 Chiswick High Road London W4 4AL

Tel: +44 (0)20 8996 9000

Fax: +44 (0)20 8996 7400

www.bsigroup.com

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Part 2: Power usage effectiveness (PUE).

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Introduction

This draft standard is based on national and international discussions. Your comments on this draft are invited and will assist in the preparation of the consequent standard.

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For national standards, comments will be reviewed by the relevant UK national committee and the resulting standards published as a British Standard.

UK Vote

Please indicate whether you consider the UK should submit a negative (with supporting technical reasons) or positive vote on this draft. Please indicate if you are aware of any reason why this draft standard should not be published as a British Standard.

Submission of Comments

- **Annotated drafts are not acceptable and will be rejected.**
- All comments should be submitted online at <https://standardsdevelopment.bsigroup.com/>. You will need to register in order to comment.

Template for comments and secretariat observations

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



DRAFT International Standard

ISO/IEC DIS 30134-2

Information technology — Data centres key performance indicators —

Part 2: Power usage effectiveness (PUE)

ICS: 35.020; 27.015

ISO/IEC JTC 1/SC 39

Secretariat: **ANSI**

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This document is circulated as received from the committee secretariat.

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ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Email: copyright@iso.org
Website: www.iso.org

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Contents

Page

Foreword	v
Introduction	vi
1 Scope	1
2 Normative references	1
3 Terms, definitions, abbreviated terms and symbols	1
3.1 Terms and definitions	2
3.2 Abbreviated terms	3
3.3 Symbols	4
4 Applicable areas of the data centre	4
5 Determination of power usage effectiveness (PUE)	5
5.1 General	5
5.2 Total data centre energy consumption	6
5.3 Total data centre energy consumption in mixed-use buildings	7
6 Measurement of power usage effectiveness	8
6.1 Calculation and measurement of energy consumption	8
6.1.1 General	8
6.1.2 On-Site Electricity Generation	8
6.1.3 Measurement period and frequency	8
6.1.4 Meter and measurement requirements	8
6.1.5 E_{DC} measurement location	8
6.2 Categories of power usage effectiveness	9
6.2.1 General	9
6.2.2 Category 1 (PUE_1) — Basic resolution	9
6.2.3 Category 2 (PUE_2) — Intermediate resolution	9
6.2.4 Category 3 (PUE_3) — Advanced resolution	10
7 Application of PUE	10
8 Reporting of power usage effectiveness	10
8.1 Requirements	10
8.1.1 Standard construct for communicating PUE data	10
8.1.2 Example of reporting PUE values	10
8.1.3 Data for public reporting of PUE	10
8.2 Recommendations	11
8.2.1 Use of PUE category	11
8.2.2 Trend tracking data	11
9 PUE derivatives	12
9.1 General	12
9.1.1 Purpose of PUE derivatives	12
9.1.2 Using PUE derivatives	12
9.2 Interim PUE (iPUE)	12
9.3 Partial PUE (pPUE)	12
9.3.1 General	12
9.3.2 Zoning	13
9.3.3 Metering requirements for pPUE	15
9.3.4 Reporting of pPUE	15
9.3.5 Use of pPUE in energy management	15
9.4 Mixed use PUE (mPUE)	16
9.5 Designed PUE (dPUE)	17
Annex A (normative) Energy measurements	18
Annex B (informative) Calculation of PUE using various energy supplies	20
Annex C (normative) Interpretation of PUE and its derivatives	27

Annex D (informative) Calculating dPUE	29
Annex E (informative) mPUE measurement and calculation method for mixed building	32
Bibliography	35

Foreword

ISO (the International Organization for Standardization) and IEC (the International Electrotechnical Commission) form the specialized system for worldwide standardization. National bodies that are members of ISO or IEC participate in the development of International Standards through technical committees established by the respective organization to deal with particular fields of technical activity. ISO and IEC technical committees collaborate in fields of mutual interest. Other international organizations, governmental and non-governmental, in liaison with ISO and IEC, also take part in the work.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of document should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives or www.iec.ch/members_experts/refdocs).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO and IEC shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents) or the IEC list of patent declarations received (see <https://patents.iec.ch>).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see www.iso.org/iso/foreward.html. In the IEC, see www.iec.ch/understanding_standards.

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

A List of all parts in the ISO/IEC 30134 series can be found on the ISO and IEC websites.

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

Introduction

The global economy is now reliant on information and communication technologies and the associated generation, transmission, dissemination, computation and storage of digital data. All markets have experienced exponential growth in that data, for social, educational and business sectors and, while the internet backbone carries the traffic there are a wide variety of data centres at nodes and hubs within both private enterprise and shared/collocation facilities.

With many governments having “digital agendas” to provide both citizens and businesses with ever faster broadband access, the very increase in network speed and capacity will, by itself, generate ever more usage (Jevons Paradox). Data generation and the consequential increase in data manipulation and storage are directly linked to increasing power consumption.

With this background, it is clear that data centre growth, and power consumption in particular, is an inevitable consequence and that growth will demand increasing power consumption despite the most stringent energy efficiency strategies. This makes the need for key performance indicators (KPIs) that cover the effective use of resources (including but not limited to energy) and the reduction of CO₂ emissions essential.

Within the ISO/IEC 30134 series, the term “*resource usage effectiveness*” is more generally used for KPIs in preference to “*resource usage efficiency*”, which is restricted to situations where the input and output parameters used to define the KPI have the same units.

In order to determine the overall resource effectiveness or efficiency of a data centre, a holistic suite of metrics is required. This part of ISO/IEC 30134 specifies power usage effectiveness (PUE), which has become a popular metric to determine the efficient utilization and distribution of energy resources within a data centre.

NOTE It is recognized that the term “efficiency” is to be employed for PUE but “effectiveness” provides continuity with earlier market recognition of the term.

This part of ISO/IEC 30134 belongs to a series of standards for such KPIs and has been produced in accordance with ISO/IEC 30134-1, which defines common requirements for a holistic suite of KPIs for data centre resource usage effectiveness or efficiency.

The ISO/IEC 30134 series does not specify limits or targets for any KPI and does not describe or imply, unless specifically stated, any form of aggregation of individual KPIs into a combined nor an overall KPI for data centre resource usage effectiveness or efficiency.

Information technology — Data centres key performance indicators —

Part 2: Power usage effectiveness (PUE)

1 Scope

This part of ISO/IEC 30134 specifies the power usage effectiveness (PUE) as a key performance indicator (KPI) to quantify the efficient use of energy.

This part of ISO/IEC 30134

- a) defines the PUE of a data centre,
- b) introduces PUE measurement categories,
- c) describes the relationship of this KPI to a data centre's infrastructure, information technology equipment and information technology operations,
- d) defines the measurement, the calculation and the reporting of the parameter,
- e) provides information on the correct interpretation of the PUE.

PUE derivatives are described in [Clause 9](#).

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 22237-1, *Information technology — Data centre facilities and infrastructures — Part 1: General concepts*

ISO/IEC 22237-3, *Information technology — Data centre facilities and infrastructures — Part 3: Power distribution*

ISO/IEC 22237-4, *Information technology — Data centre facilities and infrastructures — Part 4: Environmental control*

ISO/IEC 30134-1:2016, *Information technology — Data centres — Key performance indicators — Part 1: Overview and general requirements*

ISO/IEC/TS 8236-1, *Information Technology – Provisioning, Forecasting & Management – Part 1: Data Centre IT Equipment*

ISO/IEC/TS 8236-2, *Information Technology – Provisioning, Forecasting & Management – Part 2: Data Centre Facility*

3 Terms, definitions, abbreviated terms and symbols

For the purposes of this document, the terms and definitions given in ISO/IEC 30134-1 and the following apply.

ISO and IEC maintain terminological 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 Terms and definitions

3.1.1

information technology equipment energy consumption

IT equipment energy consumption

energy consumed, measured in kilowatt-hour (kWh), by equipment that is used to store, process, and transport data within the computer room, telecommunication room and control room spaces

Note 1 to entry: Examples are servers, data storage, network, communications and telecommunications equipment, to be referred as a single definition “IT”, also referred to as “ICT” in the industry.

3.1.2

power usage effectiveness

PUE

calculated ratio of the data centre total energy consumption, within a 12-month continuous period, to information technology equipment energy consumption measured across the same period

Note 1 to entry: Sometimes the inverse value of PUE, referred to as Data Centre Infrastructure Efficiency (DCiE), is used.

3.1.3

partial power usage effectiveness

pPUE

derivative of PUE, which is the ratio of the total energy consumption within a defined boundary to the information technology equipment energy consumption within that same boundary

3.1.4

primary distribution equipment

equipment which is required to manage, control and convert incoming power supplies (primary, secondary and, where appropriate, additional) in a form suitable for distribution by secondary distribution equipment ([3.1.8](#))

Note 1 to entry: See ISO/IEC 22237-3:2021.

3.1.5

designed power usage effectiveness

dPUE

derivative of PUE, which is a projected PUE determined by the design targets of the data centre

3.1.6

interim power usage effectiveness

iPUE

derivative of PUE, which is measured over a specified time other than a continuous 12-month period

3.1.7

mixed use building power usage effectiveness

mPUE

derivative of PUE, which is the ratio of the total energy consumption of a data centre within a mixed use building measured and calculated to the information technology equipment energy consumption within that same data centre

3.1.8

primary distribution equipment

PDE

equipment which is required to manage, control and convert incoming power supplies (*primary, secondary and, where appropriate, additional*) in a form suitable for distribution by *secondary distribution equipment*

3.1.9

secondary distribution equipment

SDE

equipment which is required to manage, control and distribute the power provided by the *primary distribution equipment* to the *short-break, protected* and *unprotected sockets* within the data centre and to the *tertiary distribution equipment*

Note 1 to entry: See ISO/IEC 22237-3:2021.

3.1.10

tertiary distribution equipment

power supply equipment, typically accommodated within the cabinets, frames and racks of the data centre spaces, which directly feeds the protected sockets therein

Note 1 to entry: See ISO/IEC 22237-3:2021.

3.1.11

total data centre energy consumption

total energy consumption for all energy types serving the data centre, measured at the data centre boundary and expressed in kWh or the energy's equivalent kWh

Note 1 to entry: The total data centre energy is measured in kWh with energy metering devices, or the energy's equivalent kWh, at the boundary of the data centre or points of generation within the boundary.

3.2 Abbreviated terms

For the purposes of this document, the abbreviated terms given in ISO/IEC 30134-1 and the following apply:

CER	cooling efficiency ratio (see ISO/IEC 30134-7)
dPUE	designed power usage effectiveness
DCiE	data centre infrastructure efficiency
DX	direct expansion
iPUE	interim power usage effectiveness
IT	information technology
KPI	key performance indicator
kW	kilowatt
kWh	kilowatt-hour
KVM	keyboard/video/mouse
PDE	primary distribution equipment
mPUE	mixed use building power usage effectiveness
pPUE	partial power usage effectiveness
PUE	power usage effectiveness
r.m.s.	root mean square
ROI	return on investment
SDE	secondary distribution equipment

UPS uninterruptible power system

3.3 Symbols

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

B	data centre boundary
C_F	volumetric specific heat capacity of fluid in $J \cdot K^{-1} M^{-3}$
E_{DC}	total data centre energy consumption (continuous 12-month period) in kWh
E_{IT}	total IT equipment energy consumption (continuous 12-month period) in kWh
E_O	Other electrical energy consumption (continuous 12-month period) in kWh (e.g. cooling, air handling, lighting and controllers)
E_T	electrical kWh equivalent of fluid thermal kWh energy (Q_T) measured by delta T, flow rate of fluid, and volumetric heat capacity of the fluid type, multiplied by conversion factor
E_{sub}	energy usage of a sub-system (e.g. electrical, computer room cooling, HVAC, etc.)
HP	heat pump
M	measurement point
$pPUE_{sub}$	pPUE of a sub-system (e.g. electrical, computer room cooling, HVAC, etc.)
Q_T	thermal energy kWh of fluid measured by delta T and flow, multiplied by the volumetric heat capacity of the fluid
S_{CW}	energy supplied by chilled fluid, hot water or steam, purchased from external source and supplied to the data centre
S_E	energy usage supplied by the utility or vendor
$S_{E,O}$	energy usage supplied by on-site backup generation (e.g. diesel generator, natural gas generator, fuel cell, solar, wind, etc.)
T_C	cold fluid, measured in °C or K
T_H	hot fluid, measured in °C or K
U_E	electrical energy measured in kWh at the boundary
V	fluid volume in m^3
$\eta_{U,P}$	power usage effectiveness
$\eta_{U,P,I}$	interim power usage effectiveness
$\eta_{U,P,d}$	designed power usage effectiveness
$\eta_{U,P,p}$	partial power usage effectiveness

4 Applicable areas of the data centre

PUE as specified in this part of ISO/IEC 30134

- is associated with the data centre infrastructure within its boundaries only, the boundary of the data centre aligns with industry standards (see ISO/IEC 22237-1 Clause 6.2 [Figure 3.](#)), and

- describes the infrastructure's energy efficiency relative to facilities with given environmental conditions, IT load characteristics, availability requirements, maintenance, and security requirement, and
- illustrates the energy allocation of a data centre.

When viewed in the proper context, PUE provides effective guidance and useful insight into the design and efficiency of power and cooling architectures, the deployment of equipment within those architectures, and the operation of that equipment.

PUE provides a means to determine

- opportunities for the improvement of the operational efficiency of a data centre,
- the improvement of the designs and processes of a data centre over time, and
- a design target or goal for new data centres across the anticipated IT load range.

PUE does not take into account the

- energy efficiency of the IT load, its utilization or productivity,
- efficiency of on-site electricity generation,
- efficiency of other resources such as human resource, space or water, and
- use of renewable energy resources or accounts for re-use of waste by-products (such as heat).

PUE is not a

- data centre productivity metric, and
- standalone, comprehensive data centre resource efficiency metric.

Derivatives of PUE which are useful in certain circumstances are described in [Clause 9](#).

PUE and PUE derivatives shall not be used to compare different data centres as there are many characteristics or variables that effect PUE and PUE derivatives, and might result in mis-leading comparisons. Some examples are:

- Local weather conditions
- IT equipment provisioning profile
- IT equipment utilization
- Level of data centre critical infrastructure redundancy or resiliency

5 Determination of power usage effectiveness (PUE)

5.1 General

PUE is defined using [Formula \(1\)](#):

$$\eta_{U,P} = \frac{E_{DC}}{E_{IT}} \quad (1)$$

where

E_{DC} is the total data centre energy consumption (continuous 12-month period), in kWh;

E_{IT} is the total IT equipment energy consumption (continuous 12-month period), in kWh.

By definition, the calculated PUE is always greater than 1.