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Information technology — Data centres key performance indicators —

Part 2: Power usage effectiveness (PUE)

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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).

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

This second edition cancels and replaces the first edition (ISO/IEC 30134-2:2016), which has been technically revised.

The main changes are as follows:

— required measurements at the data centre boundary have been updated;

— on-site electricity generation has been changed to be measured in kWh;

— 12 months recording and documentation of E_{DC} and E_{IT} has changed;

— use of watt meters to measure E_{DC} and E_{IT} has changed;

— requirement for electrical energy required to export other non-electric energy sources outside the data centre boundary has been added;

— new requirement has been added for situations when E_{DC} or E_{IT} cannot be accounted for, or measured, as specified;

— mixed use PUE (mPUE) derivative has been added for mixed use buildings;

— additional provisioning examples of calculating designed PUE (dPUE) have been added.

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.

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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 digital data, for social, educational and business sectors. 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 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 CO_2 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 document 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 1 The term "efficiency" is employed for PUE but "effectiveness" provides continuity with earlier market recognition of the term.

This document 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.

NOTE 2 The PUE KPI was originally developed by The Green Grid.

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Information technology — Data centres key performance indicators —

Part 2: Power usage effectiveness (PUE)

1 Scope

This document specifies power usage effectiveness (PUE) as a key performance indicator (KPI) to quantify the efficient use of energy.

This document:

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

IEC 62052 (all parts), *Electricity metering equipment (AC) — General requirements, tests and test conditions*

IEC 62053 (all parts), *Electricity metering equipment (a.c.) — Particular requirements*

ISO 8601-1, *Date and time — Representations for information interchange — Part 1: Basic rules*

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 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/

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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 (e.g.: 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 *power usage effectiveness (PUE)* (3.1.2), 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
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(SDE)* (3.1.8)

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

3.1.5
designed power usage effectiveness
dPUE
derivative of *power usage effectiveness (PUE)* (3.1.2), which is a projected PUE determined by the design targets of the data centre

3.1.6
interim power usage effectiveness
iPUE
derivative of *power usage effectiveness (PUE)* (3.1.2), 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 *power usage effectiveness (PUE)* (3.1.2), 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

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3.1.8
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* (3.1.9)

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

3.1.9
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.

3.2 Abbreviated terms

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

dPUE	designed power usage effectiveness
DCiE	data centre infrastructure efficiency
DX	direct expansion
ERF	energy reuse factor
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
PSU	power supply unit
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:

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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, heating-ventalation and air conditioning (HVAC))
E_{HP}	heat pump energy consumption
M	measurement point
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)
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 document:

— is associated with the data centre infrastructure within its boundaries only, the boundary of the data centre aligns with industry standards (see ISO/IEC 22237-1:2021 Figure 3, ISO/IEC 30134-1, ISO/IEC 30134-6), boundary conditions may be based on spatial and logical considerations or include other parameters;;

— describes the infrastructure's energy efficiency relative to facilities with given environmental conditions, IT load characteristics, availability requirements, maintenance and security requirements;

— illustrates the energy allocation of a data centre.

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