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**Information technology — Data  
centres — Key performance  
indicators —**

**Part 2:  
Power usage effectiveness (PUE)**

*Technologies de l'information — Centres de données — Indicateurs de  
performance clés —*

*Partie 2: Efficacité dans l'utilisation de la puissance (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. In the field of information technology, ISO and IEC have established a joint technical committee, ISO/IEC JTC 1.

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](http://www.iso.org/directives)).

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](http://www.iso.org/patents)).

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 meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT), see the following URL: [Foreword — Supplementary information](#).

The committee responsible for this document is ISO/IEC JTC 1, *Information technology*, Subcommittee SC 39, *Sustainability for and by Information Technology*.

ISO/IEC 30134 consists of the following parts, under the general title *Information technology — Data centres — Key performance indicators*:

- *Part 1: Overview and general requirements*
- *Part 2: Power usage effectiveness (PUE)*
- *Part 3: Renewable energy factor (REF)*

The following parts are under preparation:

- *Part 4: IT Equipment Energy Efficiency for Servers (ITEESv)*
- *Part 5: IT Equipment Utilization for Servers (ITEUsv)*

## 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.

The historical data generation growth rate exceeds the capacity growth rate of the information and communications technology hardware and, with less than half (in 2014) of the world's population having access to an internet connection, that growth in data can only accelerate. In addition, 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 CO<sub>2</sub> 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.

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# 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 in the form of electricity.

This part of ISO/IEC 30134

- a) defines the power usage effectiveness (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 [Annex D](#).

### 2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

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

### 3 Terms, definitions, abbreviated terms and symbols

#### 3.1 Terms and definitions

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

##### 3.1.1

##### **information technology (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, storage equipment, and telecommunications equipment.

##### 3.1.2

##### **power distribution unit**

##### **PDU**

equipment that allocates or partitions power for other energy consuming equipment

### 3.1.3

#### **power usage effectiveness**

##### **PUE**

ratio of the data centre total energy consumption to information technology equipment energy consumption, calculated, measured or assessed across the same period

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

### 3.1.4

#### **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

### 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 year

### 3.1.7

#### **total data centre energy consumption**

total energy consumption for all energy types serving the data centre, measured in kWh at its boundary

Note 1 to entry: Energy measured with energy metering devices at the boundary of the data centre or points of generation within the boundary.

Note 2 to entry: This includes electricity, natural gas and district utilities such as supplied chilled water or condenser water.

## 3.2 Abbreviated terms

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

|        |                                     |
|--------|-------------------------------------|
| CRAC   | computer room air conditioner units |
| CRAH   | computer room air handler units     |
| dPUE   | designed power usage effectiveness  |
| DX     | direct expansion                    |
| iPUE   | interim power usage effectiveness   |
| PDU    | power distribution unit             |
| pPUE   | partial power usage effectiveness   |
| r.m.s. | root mean square                    |
| ROI    | return on investment                |
| UPS    | uninterruptible power supply        |

## 3.3 Symbols

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

|          |                                                      |
|----------|------------------------------------------------------|
| $E_{DC}$ | total data centre energy consumption (annual) in kWh |
| $E_{IT}$ | IT equipment energy consumption (annual) in kWh      |

## 4 Applicable areas of the data centre

Power usage effectiveness (PUE) as specified in this part of ISO/IEC 30134

- is associated with the data centre infrastructure within its boundaries only,
- 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 of efficient 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 resource efficiency metric.

Derivatives of PUE which are useful in certain circumstances as described in [Annex C](#). PUE should not be used to compare different data centres.

## 5 Determination of power usage effectiveness (PUE)

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

$$PUE = \frac{E_{DC}}{E_{IT}} \quad (1)$$

where

$E_{DC}$  is the total data centre energy consumption (annual), in kWh;

$E_{IT}$  is the IT equipment energy consumption (annual), in kWh.

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

Where the only energy source is from the electrical utility, then  $E_{DC}$  is determined by the location of the utility meter. PUE may be applied in mixed use buildings that allow of the differentiation between the energy used for the data centre and that for other functions. Alternatively, the derivative partial PUE (pPUE) may be applied (see [Annex C](#)).