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Information technology — Data centres key performance indicators —

Part 9:
Water usage effectiveness (WUE)

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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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For an explanation of 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/foreword.html. In the IEC, see www.iec.ch/understanding-standards.

This 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 these bodies can be found at www.iso.org/members.html and www.iec.ch/national-committees.

Introduction

The global economy is today 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 information and communications technology hardware. 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 processing and storage are directly linked to increasing power consumption.

With this background, data centre growth, and power consumption in particular, is an inevitable consequence; this 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 water) 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.

Water Usage Effectiveness (WUE) will support the practitioner in obtaining an in depth understanding of the performance of the data centre's cooling installation in comparison with similar systems, thereby creating a tool to improve the sustainability of the data centre. The impact of operational water usage is emerging as being extremely important in the design, location and operation of current and future data centres.

In order to determine the overall resource efficiency of a data centre, a holistic suite of metrics is required. This document is one of a series of International 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 efficiency. This document does not specify limits or targets for the KPI and does not describe or imply, unless specifically stated, any form of aggregation of this KPI into a combination with other KPIs for data centre resource efficiency. This document presents specific rules on WUE's use, along with its theoretical and mathematical development. This document concludes with several examples of site concepts that could employ the WUE metric.

Information technology — Data centres key performance indicators —

Part 9: Water usage effectiveness (WUE)

1 Scope

This document specifies water usage effectiveness (WUE) as a KPI for quantifying the water consumption of a data centre during the use phase of the data centre life cycle.

WUE is a simple method for reporting the water intensity of the data centre operating. By reporting water consumption, it is possible to present the data centre's resource effectiveness.

This document:

a) defines the WUE of a data centre,

b) introduces WUE 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, and

e) provides information on the correct interpretation of the WUE.

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*

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

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.

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

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

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

3.1.1
total data centre energy consumption
total annual energy consumption for all energy types serving the data centre at its boundary

Note 1 to entry: The total data centre energy is measured in MWh; the energy is 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, hydrogen, bioethanol and district utilities such as supplied chilled water or condenser water.

Note 3 to entry: Total annual energy includes supporting infrastructure.

[SOURCE: ISO/IEC 30134-2:2016, 3.1.7, modified.]

3.1.2
IT equipment energy consumption
energy consumed by equipment that is used to manage, process, store or route data within the compute space

Note 1 to entry: IT equipment energy consumption is measured in MWh; examples for IT equipment are servers, storage equipment, and telecommunications equipment.

Note 2 to entry: IT equipment energy use follows the same categories as in ISO 30134-2 Power usage effectiveness.

[SOURCE: ISO/IEC 30134-2:2016, 3.1.1, modified.]

3.1.3
water usage effectiveness
ratio of the data centre water consumption divided by the energy consumed by IT equipment

3.1.4
water use
water that is used by end-users for a specific purpose within a given territory

Note 1 to entry: For the purposes of this document, water use corresponds to the water consumption caused by the processing of data in a data centre.

Note 2 to entry: Domestic use, irrigation or industrial processing are examples of a given territory.

Note 3 to entry: Water use is measured in water volume [m^3] consumed.

3.1.5
reused water
water that is leaving the data centre boundaries for an alternative non-data-centre use

Note 1 to entry: The non-data-centre use of water is usually defined by local regulations for reuse.

3.1.6
potable water
water that is free from contamination and that is safe to drink or to use for food and beverage preparation and personal hygiene

Note 1 to entry: Potable water is also known as drinking water.

Note 2 to entry: The definition of the quality criteria of potable water is usually subject to national or local regulations; if there is no information about the criteria see Reference [2].

3.1.7
energy water intensity factor
amount of water that is used to produce energy

Note 1 to entry: Energy water intensity factor is measured in m^3 per MWh.

3.1.8
water significance
amount of renewable freshwater that is available for each person each year

Note 1 to entry: Within the approach of this document, water significance is categorized by different levels of water stress.

3.1.9
water stress
ability to meet human and ecological demand for freshwater

3.1.10
water quality
physical, chemical and biological characteristics of water concerning its suitability for an intended use by humans, ecosystems or industrial processes

3.1.11
land consumption
loss of water permeability of the soil intended for use by humans, ecosystems or industrial processes

3.2 Abbreviated terms

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

DC	data centre
dWUE	design water usage effectiveness
EWIF	energy water intensity factor
FI	falkenmark indicator
iWUE	interim water usage effectiveness
dWUE	design water usage effectiveness
iWUE	interim water usage effectiveness
peakWUE	peak water usage effectiveness
PUE	power usage effectiveness
pWUE	partial water usage effectiveness
qWUE	quality water usage effectiveness
WRF	water reuse factor
WUE	water usage effectiveness

3.3 Symbols

For the purposes of this document the following symbols apply:

E_{DC}	total data centre energy consumption (annual) in MWh
E_{IT}	IT equipment energy consumption (annual) in MWh
f_{EWI}	energy water intensity factor (EWIF)

$f_{r,w}$	water reuse factor (WRF)
$f_{s(F)}$	drainage factor of fully sealed surfaces
$f_{s(f)}$	drainage factor of few sealed surfaces
$f_{s(h)}$	drainage factor of heavily sealed surfaces
I_w	total water input from outside the data centre boundaries (annual) measured by total volume in m^3
$I_{w,rw}$	water input from rainwater
$I_{w,e}$	water input from water consumption of energy production
$I_{w,p}$	water input from potable water
i_F	falkenmark indicator (FI)
L_{DC}	data centre land consumption
O_w	total water returned out of the data centre boundaries (annual) measured by total volume in m^3
p	population
s_F	fully sealed surface
s_f	few sealed surfaces
s_h	heavily sealed surfaces
s_{run}	surface runoff (annual) measured in m^3
U_w	water usage of the data centre (annual) measured by total volume in m^3
$U_{r,w}$	water reusage of the data centre (annual) measured by total volume in m^3
$U_{r,w,I}$	industrial water reuse
$U_{r,w,NI}$	non-industrial water reuse
$\eta_{U,W}$	water usage effectiveness
$\eta_{U,W,i}$	interim water usage effectiveness

NOTE Unlike for PUE, the unit of the energy used in WUE is MWh.

4 Applicable area of the data centre

WUE as specified in this document:

— is associated with the data centre infrastructure and IT equipment within its boundaries only;

— describes the water usage in relation to facilities with given environmental conditions, IT load characteristics, availability requirements, maintenance and security requirements;

— measures the relationship between the total data centre water usage and the IT equipment energy consumed.

WUE does not:

— account for efficiency of other resources such as human resources, space or CO_2;

— provide a data centre productivity metric;

— provide a standalone, comprehensive efficiency metric;

— account for quality of the water reuse process outside the data centre boundaries;

— account for water down- or upgrade (reducing or improving water quality).

5 Determination of WUE

WUE provides a way to determine the water usage associated with data centres. A value of 0,0 indicates that no water use is associated with the data centre's operations. WUE has no theoretical upper and no theoretical lower boundary.

WUE is defined according to Formula (1):

$$\eta_{U,W} = \frac{U_w}{E_{IT}} \tag{1}$$

Annual water usage is calculated according to Formula (2) as:

$$U_w = I_w - O_w \tag{2}$$

WUE may be applied in mixed-use buildings when measurement of the difference between water used for the data centre and that for other functions is possible.

6 Measurement of WUE

6.1 General

All KPIs of the ISO/IEC 30134 series are defined within the boundaries of a data centre (see ISO/IEC 30134-1).

6.2 Measuring actual water usage

6.2.1 Calculation, measurement period and frequency

The minimum calculation and measurement period requires twelve months of cumulative energy and water values. Annualized data used to calculate WUE shall be documented. The annual energy values for energy consumption of the IT equipment collected shall cover the same time period. It is not necessary to define the frequency of measurement or assessments for the annual WUE determination, as the annual water value is a continuous integration of energy consumed in that timeframe. Examples of the calculation are shown in the Annex A.

NOTE The measurement or assessment frequency can be necessary for subsystem improvements (refer to partial PUE), but is not required for WUE disclosures.