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Information technology - Data centre facilities and infrastructures - Part 99-1: Recommended practices for energy management

Informationstechnik - Einrichtungen und Infrastrukturen von Rechenzentren - Teil 99-1: Empfohlene Praktiken für das Energiemanagement

Technologies de l'information - Installations et infrastructures de centres de traitement de données - Partie 99-1 : Pratiques recommandées relatives à la gestion énergétique

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European foreword

This document (CLC/TR 50600-99-1:2016) has been prepared by CLC/TC 215 "*Electrotechnical aspects of telecommunication equipment*" in conjunction with the Directorate-General Joint Research Council (DG JRC) of the European Commission (EC).

This document aligns with the Best Practices document of the Code of Conduct for Data Centre Energy Efficiency (CoC) scheme operated by the DG JRC and continues to be prepared by data centre experts from operators, vendors, consultants, academics, professional and national bodies.

The publication of this Technical Report is intended to integrate recommended Practices of energy management into the EN 50600 series of standards developed by CLC TC 215 and also to widen accessibility and increase participation in the CoC scheme by ensuring translation of the Best Practices into multiple languages.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CENELEC shall not be held responsible for identifying any or all such patent rights.

This document has been prepared under a mandate given to CENELEC by the European Commission and the European Free Trade Association.

Introduction

The unrestricted access to internet-based information demanded by the information society has led to an exponential growth of both internet traffic and the volume of stored/retrieved data. Data centres are housing and supporting the information technology and network telecommunications equipment for data processing, data storage and data transport. They are required both by network operators (delivering those services to customer premises) and by enterprises within those customer premises.

Data centres need to provide modular, scalable and flexible facilities and infrastructures to easily accommodate the rapidly changing requirements of the market. In addition, energy consumption of data centres has become critical both from an environmental point of view (reduction of carbon footprint) and with respect to economic considerations (cost of energy) for the data centre operator.

The implementation of data centres varies in terms of:

a) purpose (enterprise, co-location, co-hosting, or network operator facilities);

b) security level;

c) physical size;

d) accommodation (mobile, temporary and permanent constructions).

The needs of data centres also vary in terms of availability of service, the provision of security and the objectives for energy efficiency. These needs and objectives influence the design of data centres in terms of building construction, power distribution, environmental control and physical security. Effective management and operational information is required to monitor achievement of the defined needs and objectives.

This series of European Standards specifies requirements and recommendations to support the various parties involved in the design, planning, procurement, integration, installation, operation and maintenance of facilities and infrastructures within data centres. These parties include:

1) owners, facility managers, ICT managers, project managers, main contractors;

2) architects, consultants, building designers and builders, system and installation designers;

3) facility and infrastructure integrators, suppliers of equipment;

4) installers, maintainers.

At the time of publication of this Technical Report, EN 50600 series will comprise the following standards and documents:

EN 50600-1, *Information technology — Data centre facilities and infrastructures — Part 1: General concepts*;

EN 50600-2-1, *Information technology — Data centre facilities and infrastructures — Part 2-1: Building construction*;

EN 50600-2-2, *Information technology — Data centre facilities and infrastructures — Part 2-2: Power distribution*;

EN 50600-2-3, *Information technology — Data centre facilities and infrastructures — Part 2-3: Environmental control*;

EN 50600-2-4, *Information technology — Data centre facilities and infrastructures — Part 2-4: Telecommunications cabling infrastructure*;

EN 50600-2-5, *Information technology — Data centre facilities and infrastructures — Part 2-5: Security systems*;

EN 50600-3-1, *Information technology — Data centre facilities and infrastructures — Part 3-1: Management and operational information*.

EN 50600-4-1, *Information technology — Data centre facilities and infrastructures — Part 4-1: Overview of and general requirements for key performance indicators*

EN 50600-4-2, *Information technology — Data centre facilities and infrastructures — Part 4-2: Power Usage Effectiveness*

EN 50600-4-3, *Information technology — Data centre facilities and infrastructures — Part 4-3: Renewable Energy Factor*

CLC/TR 50600-99-1, *Information technology — Data centre facilities and infrastructures — Part 99-1: Recommended practices for energy management*

The inter-relationship of the standards within the EN 50600 series is shown in Figure 1.

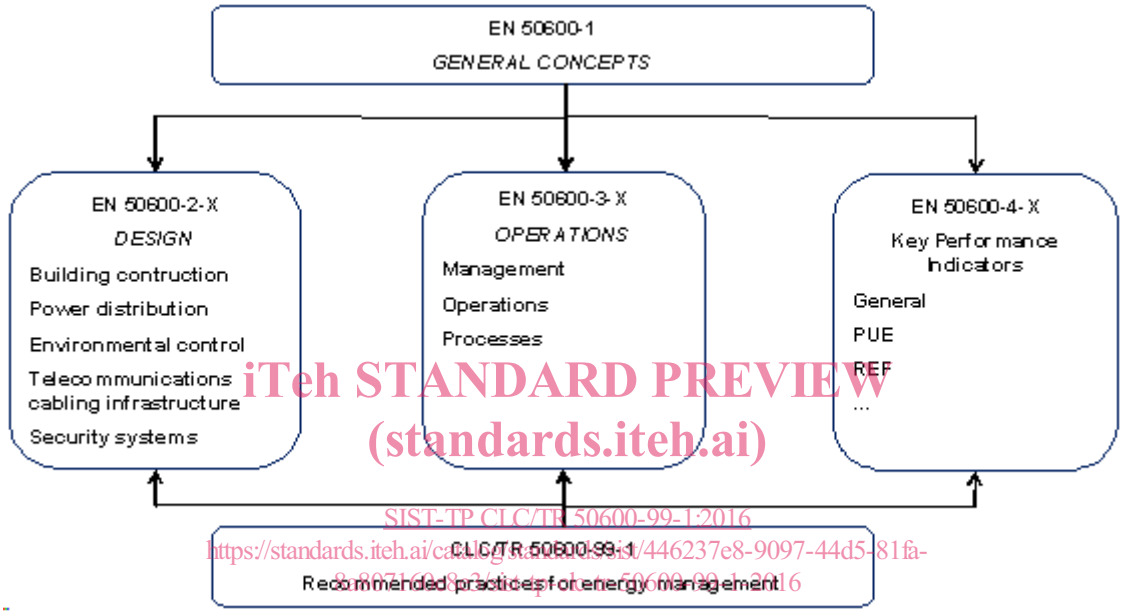

Figure 1 — Schematic relationship between the EN 50600 series of documents

EN 50600-2-X standards specify requirements and recommendations for particular facilities and infrastructures to support the relevant classification for “availability”, “physical security” and “energy efficiency enablement” selected from EN 50600-1.

EN 50600-3-X documents specify requirements and recommendations for data centre operations, processes and management.

EN 50600-4-X documents specify requirements and recommendations for key performance indicators (KPIs) used to assess and improve the resource usage efficiency and effectiveness, respectively, of a data centre.

The Directorate-General Joint Research Council (DG JRC) of the European Commission operates a Code of Conduct for Data Centre Energy Efficiency (CoC) scheme. In support of the scheme, a “best practices” document has been established by DG JRC. To enhance the visibility, these Best Practices have been converted in this Technical Report to create recommended Practices for improving the energy management (i.e. reduction of energy consumption and/or increases in energy efficiency) of data centres.

The areas addressed are:

— physical building;

— mechanical and electrical equipment;

— computer room;

— cabinets/racks;

— ICT equipment;

— operating systems;

— virtualisation;

— software;

— business practices.

The Practices are separated into Expected Practices as referenced in the CoC (see Clause 5) and other Practices which may be employed as optional or alternative solutions in particular cases (see Clause 6). Practices under consideration for the next or future revision/amendment of this Technical Report are included in Clause 7. During the maintenance of this Technical Report, the Practices of Clauses 6 and 7 may be augmented and others may migrate into Clause 5.

The Practices listed in Clauses 5, 6 and 7 are referenced as ×.16.yyy where x is the clause number, 16 refers to the 2016 publication of this document and yyy is a sequential number. Also included is the CoC BP reference (as used in 2016) in order to provide an audit trail. Future versions of this document will use these references to track changes in the Practices, provide a historic record and to simplify translation of the document.

Customers or suppliers of information and communication technology (ICT) services may also find it useful to request or provide a list of the Practices of this Technical Report that are implemented in a data centre to assist in procurement of services that meet their environmental or sustainability standards.

This Technical Report also:

— acts as an education and reference document to assist data centre operators in identifying and implementing measures to improve the energy management of their data centres;

— provides a common terminology and frame of reference for describing an energy management practice, avoiding doubt or confusion over terminology.

1 Scope

This Technical Report is a compilation of recommended Practices for improving the energy management (i.e. reduction of energy consumption and/or increases in energy efficiency) of data centres. It is aligned with the EU Code of Conduct for Data Centre Energy Efficiency (CoC) scheme operated by the Directorate-General Joint Research Council (DG JRC) of the European Commission (EC).

It is recognized that the Practices included may not be universally applicable to all scales and business models of data centres or be undertaken by all parties involved in data centre operation, ownership or use.

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.

EN 50600 series, *Information technology - Data centres facilities and infrastructures*

3 Terms, definitions and abbreviations

3.1 Terms and definitions

For the purposes of this document, the terms and definitions of series EN 50600 and the following apply.

3.1.1
aggregation
consolidation or combination of ICT equipment or services

3.1.2
airflow pathway
route taken by air to reach a specific point

3.1.3
albedo
diffuse reflectivity or reflecting power of a surface

3.1.4
availability
ability of an item to be in a state to perform a required function under given conditions at a given instant of time or over a given time interval, assuming that the required external resources are provided

[SOURCE: EN 50600-1:2012, 3.1.1, modified]

3.1.5
cable management system
system used for the support and/or containment, retention, protection of all types of cables, information and communication lines, electrical power distribution conductors and their associated accessories (includes ducts and tubes housing, or intended to house, blown information technology cables and/or cable elements)

[SOURCE: EN 50174-1:2009+A2:2014, 3.1.7]

3.1.6
co-location data centre
data centre in which multiple customers locate their own network(s), servers and storage equipment

Note 1 to entry: The support infrastructure of the building (such as power distribution and environmental control) is provided as a service by the data centre operator.

[SOURCE: EN 50600-1:2012, 3.1.6]

3.1.7
computer room space
area within the data centre that accommodates the data processing, data storage and telecommunication equipment that provides the primary function of the data centre

[SOURCE: EN 50600-1:2012, 3.1.7]

3.1.8
computer room air conditioning/computer room air handling
CRAC/CRAH
equipment that provides cooling airflow volumes into a computer room as a means of environmental control

Note 1 to entry: Other abbreviations such as CCU, DFU, RACU, UFU are sometimes used to refer to such equipment.

3.1.9
cooling economiser
a system to enable outside air that is cooler than the air inside a refrigerated space to be brought into that space and the same amount of warmer inside air to be exhausted from the space

3.1.10
data centre

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

Note 2 to entry: 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.

[SOURCE: EN 50600-1:2012, 3.1.9]

3.1.11
direct liquid-cooled ICT equipment
ICT equipment that is cooled by a direct flow of liquid into an equipment cabinet or directly to the ICT equipment chassis to provide cooling rather than the use of moving air

3.1.12
energy efficiency
measure of the work done (as a result of design and/or operational procedures) for a given amount of energy consumed

3.1.13
energy management
combination of reduced energy consumption and increased energy efficiency, re-use of energy and use of renewable energy

Note 1 to entry: See also EN 50600-3-1 for another definition of energy management.

3.1.14
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

[SOURCE: EN 50600-1:2012, 3.1.14]

3.1.15
grid (technology)
interconnection of ICT resources in multiple locations to achieve a common objective

3.1.16
hot aisle/cold aisle (system)
construction of cabinets and containment intended to prevent the mixing of ICT equipment intake and exhaust air within computer room space(s)

3.1.17
information and communication technology (ICT) equipment
information technology (IT) and network telecommunications (NT) equipment providing data storage, processing and transport services

Note 1 to entry: Representing the "critical load" of the data centre.

3.1.18
insolation
total amount of solar radiation energy received on a given surface area during a given time

3.1.19
make-up air
air introduced into a data centre space to replace air that is exhausted through ventilation or combustion processes

3.1.20
managed service
data centre operated to provide a defined set of services to its clients either proactively or as the managed service provider (not the client) determines that services are needed

3.1.21
rack
open construction, typically self-supporting and floor-mounted, for housing closures and other information technology equipment

[SOURCE: EN 50174-1:2009, 3.1.31]

3.1.22
resilience
capacity to withstand failure in one or more of the ICT equipment or data centre infrastructures

3.1.23
set-point
desired or target value (maximum or minimum) for either temperature or humidity

3.1.24
Typical Meteorological Year
collation of selected weather data for a specific location, generated from a data bank much longer than a year in duration. It is specially selected so that it presents the range of weather phenomena for the location in question, while still giving annual averages that are consistent with the long-term averages for the location in question

3.1.25
virtualisation
creation of a virtual version of physical ICT equipment or resource to offer a more efficient use of ICT hardware

3.2 Abbreviations

For the purposes of this document, the following abbreviations apply in addition to those of the EN 50600 series of standards.

AC	Alternating current
ASHRAE	Formerly “American Society of Heating, Refrigeration and Airconditioning Engineers”
BIOS	Basic input/output system
BREEAM	Building Research Establishment Environmental Assessment Methodology
CoC	EC DG JRC Code of Conduct for Data Centre Energy Efficiency
CRAC/CRAH	Computer room air conditioning/computer room air handling
DC	Direct current
DCIE	Data centre infrastructure efficiency
DCIM	Data centre infrastructure management
DG JRC	Directorate-General Joint Research Council of the European Commission
DX	Direct expansion
EC	European Commission
IP	Internet protocol
ICT	Information and communications technology
IT	Information technology
ITIL	Information Technology Infrastructure Library
LCA	Life cycle assessment
LEED	Leadership in Energy and Environmental Design
NT	Network telecommunications
PDU	Power distribution unit
PSU	Power supply unit
PUE	Power usage effectiveness
SLA	Service level agreement

SMASH	Systems Management Architecture for Server Hardware
SNMP	Simple network management protocol
UPS	Uninterruptible power supply
SPEC	Standard Performance Evaluation Corporation
SERT™	Server Efficiency Rating Tool

4 Principles

4.1 General

Clauses 5 to 7 contain the full list of energy management Practices of this Technical Report.

Clause 5 contains those Practices that are considered “Expected Practices” of the CoC and which are listed under the following situations:

a) existing data centres (example);

b) ICT equipment (new or replacement);

c) software install or upgrade;

d) new build or refurbishment of data centres.

Clause 6 contains those Practices that are considered as optional or alternative. within the CoC scheme.

Under each heading the recommended Practices of Clauses 5 and 6 are based upon the categories described in 4.2 to 4.8.

Each practice has been assigned a qualitative value (1 to 5) to indicate the level of benefit to be expected from its implementation and, therefore, the relative priorities that should be applied to it. A value of 5 indicates the greatest benefit/priority.

NOTE These values are not intended to be totalled or aggregated to provide an overall ‘operator score’ and should not be mistaken as being quantitative. This would require large scale data on the effects of each practice or technology which is not yet available as well as a complex system of scoring representing the combinational increase or reduction of individual practice values within that specific facility.

Practices under consideration for inclusion in either Clauses 5 or 6 for the next or future revision/amendment of this Technical Report are included in Clause 7. These Practices do not have a qualitative value applied to them.

4.2 Data centre utilization, management and planning

It is important to develop a holistic strategy and management approach to the data centre in order to ensure the required availability and effective delivery of economic and environmental benefits. The sub-headings under this category are:

a) Involvement of organisational groups

   Ineffective communication between the disciplines working in the data centre is a major driver of inefficiency and may create issues of capacity management and reliability.

b) General policies

   These policies apply to all aspects of the data centre and its operation.

c) Resilience level and provisioning

Two of the most significant sources of inefficiency in data centres are the over provisioning of space, power or cooling or the facilities being run at less than full capacity. Monolithic, as opposed to modular design of facilities also represents a significant and frequently unnecessary capital expenditure. Further, as the level of resilience of the data centre increases the inefficiencies due to fixed overheads increase and this is compounded by poor utilization.

4.3 Data centre ICT equipment and services

The ICT equipment creates the demand for power and cooling in the data centre, any reductions in power and cooling used by, or provisioned for, the ICT equipment will have magnified effects at the utility energy supply.

NOTE The specifications of ICT equipment operating temperature and humidity ranges in this section do not indicate that the computer room should be immediately operated at the upper bound of these ranges. This is addressed under the category “Data centre cooling”. The purpose of the equipment environmental specifications in this section is to ensure that new equipment is capable of operating under the wider ranges of temperature and humidity thus allowing greater flexibility in operating temperature and humidity to the operator.

The sub-headings under this category are:

a) Selection and deployment of new ICT equipment

Once ICT equipment is purchased and installed in the data centre it typically spends several years in the data centre consuming power and creating heat. The appropriate selection of hardware and deployment methods may provide significant long term savings.

b) Deployment of new ICT services

The service architecture, software and deployment of ICT services have an impact at least as great as that of the ICT equipment.

c) Management of existing ICT equipment and services

It is common to focus on new services and equipment being installed into the data centre but there are also substantial opportunities to achieve energy and cost reductions from within the existing service and physical estate, for example, by decommissioning hardware no longer in use or implementing energy saving policies.

d) Data management and storage

Storage is a major growth area in both cost and energy consumption within the data centre. It is generally recognized that a significant proportion of the data stored is unnecessary, duplicated or does not require high performance access.

Some sectors have a particular issue due to very broad and non-specific data retention directives from governments or regulating bodies which may cause large volumes of data to be unnecessarily heavily protected and archived.

4.4 Data centre cooling

A major part of the facility infrastructure is the cooling system.

Cooling of the data centre is frequently the largest energy loss in the facility and as such represents a significant opportunity to reduce energy consumption.

The sub-headings under this category are:

a) Airflow management and design

The objective of airflow management is to circulate only the amount of air through the data centre that is necessary to remove the heat created by the ICT equipment (i.e. no air circulates unnecessarily).

Poor airflow management often results in attempts to compensate by reducing air supply temperatures or supplying excessive air volumes, which have an energy penalty.

Improving airflow management will deliver more uniform ICT equipment inlet temperatures and are a prerequisite to increasing temperature set-points and reducing airflow volumes which enable reductions in energy consumption without the risk of equipment overheating.

b) Cooling management

The data centre is not a static system and the cooling systems should be tuned in response to fluctuations in thermal load.

c) Temperature and humidity settings

Operating overly restricted environmental controls (in particular, excessively cooled computer rooms) results in an energy penalty.

Widening the set-point range for temperature and humidity may reduce energy consumption. When reviewing environmental management issues it is recommended that expert advice should be sought before changing the environmental range for the facility (e.g. before set-points are changed) in order to avoid risks to operational integrity.

d) Selection of cooling system

The cooling system typically represents a major part of the energy consumed in the data centre in addition to the critical ICT load. This is also the area with the greatest variation in technologies.

1) Free and economised cooling

Free or economised cooling designs use cool ambient conditions to meet part or all of the facilities cooling requirements hence compressor work for cooling is reduced or removed, which can result in significant energy reduction. Economised cooling can be retrofitted to some facilities.

2) High efficiency cooling system

When refrigeration is used as part of the cooling system design high efficiency cooling system should be selected. Designs should operate efficiently at system level and employ efficient components. This demands an effective control strategy which optimises efficient operation, without compromising reliability. Even in designs where the refrigeration is expected to run for very few hours per year the cost savings in infrastructure electrical capacity and utility power availability or peak demand fees justify the selection of high efficiency equipment.

e) Computer Room Air Conditioner/Computer Room Air Handling (CRAC/CRAH) equipment

These are major components of most cooling systems within the computer room and are frequently unable to provide efficient operation in older facilities.

f) Reuse of data centre waste heat

Data centres produce significant quantities of waste heat. Whilst this is typically at a relatively low temperature there are some applications for reuse of this energy which could offer economic and environmental benefit. As ICT equipment utilization is increased through consolidation and virtualisation the exhaust temperature is likely to increase which will provide greater opportunity for