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Foreword

This Technical Specification (TS) has been produced by ETSI Technical Committee Access, Terminals, Transmission and Multiplexing (ATTM).

The present document is part 2 of a multi-part deliverable. Full details of the entire series can be found in part 1.

Modal verbs terminology

In the present document "**shall**", "**shall not**", "**should**", "**should not**", "**may**", "**need not**", "**will**", "**will not**", "**can**" and "**cannot**" are to be interpreted as described in clause 3.2 of the ETSI Drafting Rules (Verbal forms for the expression of provisions).

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Introduction

The increasing interaction between the different elements of the Information Communication Technology (ICT) sector (hardware, middleware, software and services) supports the concept of convergence in which:

- multi-service packages can be delivered over a common infrastructure;
- a variety of infrastructures is able to deliver these packages;
- a single multi-service-package may be delivered over different infrastructures.

As a result of this convergence, the development of new services, applications and content has resulted in an increased demand for bandwidth, reliability, quality and performance, with a consequent increase in the demand for power which has implications for cost and, in some cases, availability. It is therefore important to maximize the energy efficiency of all the network elements necessary to deliver the required services.

New technologies and infrastructure strategies are expected to enable operators to decrease the energy consumption, for a given level of service, of their existing and future infrastructures thus decreasing their costs. This requires a common understanding among market participants that only standards can produce.

The present document is part 2 of a multi-part deliverable which has been produced by ETSI Technical Committee Access, Terminals and Transmission, Multiplexing (ATTM) in close collaboration with CENELEC via the Co-ordination Group on Installations and Cabling (CGIC). It offers a contribution to the required standardization process by establishing an initial basis for work on ICT general engineering, with active collaboration from a number of other ETSI and CENELEC Technical Bodies.

When complete, the multi-part deliverable will contain information that has been jointly evolved to present developments in installations and transmission implementation, and describing their progress towards energy efficiency in Next Generation Networks (NGN). In order to monitor the implementation and operation of energy efficient broadband deployment, the present document also discusses Data processing and Communication Energy Management (DCEM) for energy efficiency and focus on the possible consequences of standardization of installations, cabling techniques and equipment. In particular, the study will investigate possibilities and suggest solutions for development of processes for optimization in installation techniques and energy consumption.

1 Scope

The present document details measures which may be taken to improve the energy efficiency within ICT sites for broadband deployment. Clauses 2 and 3 contain references, definitions and abbreviations which relate to this part; similar information will be included in the corresponding clauses of the other parts, thus ensuring that each document can be used on a "stand-alone" basis.

Within the present document:

- clause 4 introduces ICT site concepts including those specifically related to network operators;
- clause 5 develops the concept of Data processing and Communication Energy Management (DCEM), introduced in ETSI GS OEU 001 [i.2];
- clause 6 details the approaches that may be employed to improve energy efficiency within the information technology infrastructure;
- clause 7 details the approaches that may be employed to improve energy efficiency within the communication technology infrastructure;
- clause 8 details the approaches that may be employed to improve energy efficiency within the environmental control systems;
- clause 9 details the approaches that may be employed to improve energy efficiency within the power distribution system;
- clause 10 details the approaches that may be employed to improve energy efficiency within the physical infrastructure;
- clause 11 provides a summary of energy efficiency approaches within ICT sites;
- annex A provides indications of the first order effect of applying the approaches outlined in clauses 6, 7 and 9;
- annex B contains the recommendations of the present document.

This will enable the proper implementation of services, applications and content on an energy efficient infrastructure, though it is not the goal of this multi-part deliverable to provide detailed standardized solutions for network architecture.

The present document focuses on energy efficiency. The CO_2 footprint is not taken in account to the present document but in the near future a regulation on CO_2 footprint will be will be created.

Two separate aspects of energy efficiency are considered as shown in figure 1:

- actions to improve energy efficiency in existing ICT sites in the short or medium term;
- actions to improve energy efficiency in new ICT sites, in medium or long term.

The domains under study are:

- in the Information Technology (IT) infrastructure: all aspects of the technical infrastructure in the ICT site, including servers, storage arrays, backup libraries and network equipment including routers, switches, etc.;
- in the IT operational strategy: all consolidation initiatives, such as virtualization, physical consolidations, usage of specific software and processes;
- in the technical environment: all aspects concerning energy usage, cooling and, more generally, all disciplines involved in the technical environment of the ICT site.

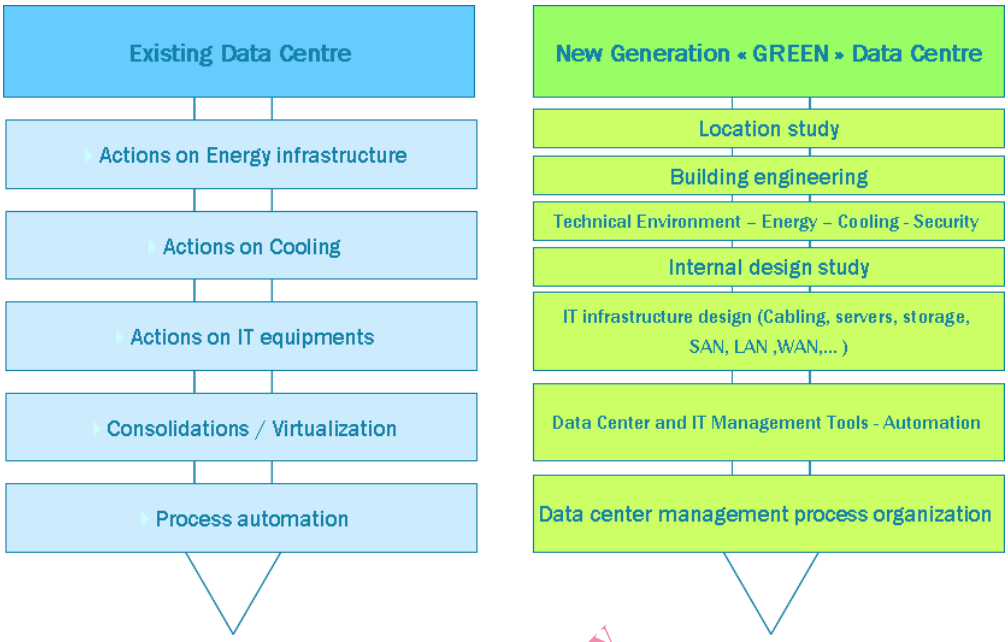

Figure 1: Aspects of data centres under consideration

2 References

2.1 Normative references

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the referenced document (including any amendments) applies.

Referenced documents which are not found to be publicly available in the expected location might be found at https://docbox.etsi.org/Reference/.

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The following referenced documents are necessary for the application of the present document.

[1] CENELEC EN 50600-1: "Information technology - Data centre facilities and infrastructures - Part 1: General concepts".

[2] ISO 14045:2012: "Environmental management - Eco-efficiency assessment of product systems - Principles, requirements and guidelines".

[3] ISO 50001:2011: "Energy management systems - Requirements with guidance for use".

[4] Directive 2002/96/EC of the European Parliament and of the Council of 27 January 2003 on waste electrical and electronic equipment (WEEE).

[5] ETSI TS 103 199: "Environmental Engineering [EE]; Life Cycle Assessment (LCA) of ICT equipment, networks and services; General methodology and common requirements".

[6] ETSI ES 203 199: "Environmental Engineering (EE); Methodology for environmental Life Cycle Assessment (LCA) of Information and Communication Technology (ICT) goods, networks and services".

[7] European Commission: "DG-JRC Code of Conduct on Data Centres Energy Efficiency".

[8] Recommendation ITU-T L.1300: "Best practices for green data centers".

[9] ETSI ES 205 200-1: "Access, Terminals, Transmission and Multiplexing (ATTM); Energy management; Global KPIs; Operational infrastructures; Part 1: General requirements".

[10] CENELEC EN 50600-2-3: "Information technology - Data centre facilities and infrastructures - Part 2-3: Environmental control".

[11] European Commission: "DG-JRC Code of Conduct on Energy Consumption of Broadband Equipment Version 5.0".

[12] ETSI EN 300 019-1-3: "Environmental Engineering (EE); Environmental conditions and environmental tests for telecommunications equipment; Part 1-3: Classification of environmental conditions; Stationary use at weather protected locations".

[13] European commission: "DG JRC Code of Conduct on Energy Efficiency and Quality of AC Uninterruptible Power Systems (UPS)".

[14] ETSI ES 202 336-12: "Environmental Engineering (EE); Monitoring and control interface for infrastructure equipment (power, cooling and building environment systems used in telecommunication networks); Part 12: ICT equipment power, energy and environmental parameters monitoring information model".

[15] ETSI EN 300 132: "Environmental Engineering (EE); Power supply interface at the input to telecommunications and datacom (ICT) equipment".

[16] ETSI EN 301 605: "Environmental Engineering (EE); Earthing and bonding of 400 VDC data and telecom (ICT) equipment".

[17] ETSI ES 202 336-9: "Environmental Engineering (EE); Monitoring and Control Interface for Infrastructure Equipment (Power, Cooling and Building Environment Systems used in Telecommunication Networks); Part 9: Alternative Power Systems".

[18] CENELEC EN 50600 2-4: "Information technology - Data centre facilities and infrastructures - Part 2-4: Telecommunication cabling infrastructure".

[19] ISO 14040: "Environmental management -- Life cycle assessment -- Principles and framework".

[20] ISO 14044: "Environmental management -- Life cycle assessment -- Requirements and guidelines".

[21] ETSI ES 203 237: "Environmental Engineering (EE);Green Abstraction Layer (GAL);Power management capabilities of the future energy telecommunication fixed network nodes".

[22] CENELEC EN 50600-2-2: "Information technology - Data centre facilities and infrastructures - Part 2-2: Power distribution".

[23] ETSI EN 300 132-3-1: "Environmental Engineering (EE); Power supply interface at the input to telecommunications and datacom (ICT) equipment; Part 3: Operated by rectified current source, alternating current source or direct current source up to 400 V; Sub-part 1: Direct current source up to 400 V".

[24] ETSI EN 300 132-3: "Environmental Engineering (EE);Power supply interface at the input to telecommunications equipment; Part 3: Operated by rectified current source, alternating current source or direct current source up to 400 V".

2.2 Informative references

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the referenced document (including any amendments) applies.

NOTE: While any hyperlinks included in this clause were valid at the time of publication, ETSI cannot guarantee their long term validity.

The following referenced documents are not necessary for the application of the present document but they assist the user with regard to a particular subject area.

[i.1] ETSI TR 102 489: "Environmental Engineering (EE); European telecommunications standard for equipment practice; Thermal Management Guidance for equipment and its deployment".

[i.2] ETSI GS OEU 001: "Operational energy Efficiency for Users (OEU); Global KPI for ICT Sites".

[i.3] ETSI ES 205 200-3: "Access, Terminals, Transmission and Multiplexing (ATTM); Energy management; Global KPIs; Operational infrastructures; Part 3: Global KPIs for ICT sites".

3 Definitions and abbreviations

3.1 Definitions

For the purposes of the present document, the following terms and definitions apply:

availability: time or period during the application or the service has to be operational

NOTE: Availability is one of the criticality criteria.

computer room: closed, secured and environmentally controlled room in which IT equipment is operating

criticality: level given to an application or service, linked to the impact for the enterprise in case of crash

NOTE: More the impact is strong, more the application or service is critical.

data centre: centralized repository for the storage, management, and dissemination of data and information organized around a particular body of knowledge or pertaining to a particular business

Data Centre Infrastructure Management (DCIM): set of automation tools for operations for managing and steering ICT site

data processing and communication energy management: overall performance of the operational infrastructures

disk array: cabinet containing physical disks

energy efficiency: search in existing DC, or for new future DC, of all tracks and actions allowing minimizing energy needs and costs

NOTE: Key drivers are Economic to decrease the energy bill by increasing the efficiency of all equipment and minimize power loss.

information technology equipment: equipment such as computers, servers, mainframes, calculators and all storage devices as arrays, libraries, tape robots together with routers and switches within the local area networks

IT equipment power: total power needed for operate servers, racks, disk arrays, libraries, network telecommunications equipment (such as routers and switches), equipment used for monitoring the data centre (PC, laptops, terminals and workstations) and network telecommunications-specific equipment (such as DSLAM and BTS)

green data centre: site that is energy efficient (consumption, energy re-use, renewable energy) and has a minimum carbon footprint

NOTE 1: Energy Efficiency is one way, to decrease CO_2 emissions, but it is not the only one.

NOTE 2: More "sustainable development" objective than economic, the key indicator is carbon footprint. Today, this concept is not still clearly defined, especially since data centres are not major producers of CO_2, but indirectly, due to their energy needs. If the source of power is becoming from renewable energies (hydraulic, solar, etc.) or nuclear (not so green for earth, but not producing CO_2) the carbon footprint of the data centre is low. But if energy is becoming from coal, or fuel the CO_2 emissions are high.

global KPI: KPI of an operational infrastructure which presents information from a number of separate objective KPIs

mainframe: high-performance computer used for large-scale computing purposes that require greater availability and security than a smaller-scale machine can offer

network telecommunications equipment: equipment providing direct connection to core and/or access networks including switches, DSLAM, BTS

objective KPI: KPI assessing one of the objectives of energy management or environmental viability of an operational infrastructure which may be subsequently used to define a global KPI

operator site: premises accommodating network telecommunications equipment providing direct connection to the core and access networks and which may also accommodate information technology equipment

physical server: box containing supplies for energy, mother board, central processing unit, memory, slots

server: computer program that provides services to other computer programs (and their users) in the same or other computers

technical KPI: KPI assessing the energy management or environmental viability of a component, sub-assembly, product or sub-system under a specified set of conditions

total computing load: total computing power in the data centre, that can be evaluated by taking vendors specifications of computational power of each model of server multiplied by the number of servers (transactions per minute is one measure of total computing power)

total facility power: total power used by all power delivery components (such as uninterruptible power supplies, switches, power distribution units, batteries and transformers), cooling system components (such as chillers, computer room air conditioning units, pumps, fans, engines) and the non-technical energy (such as building lighting)

utility computing: service provisioning model in which a service provider makes computing resources and infrastructure management available to the customer needs

NOTE: Like other types of "on-demand computing" (such as grid computing), the utility model seeks to maximize the efficient use of resources and/or minimize associated costs. This approach is becoming increasingly common in enterprise computing and is sometimes used for the consumer market as well, for internet service, web-site access, file sharing, and other applications.

Virtual Machine (VM): emulation of a physical server on a shared infrastructure

NOTE: Virtual machine embeds Operating System, specific software and applications.

virtual server: "piece" of physical server dedicated to run a "virtual machine

virtualization: software that separates applications from the physical hardware on which they run, allowing a "piece" of physical server to support one application, instead of requiring a full server

virtualization ratio: number of Virtual Machines per server

3.2 Abbreviations

For the purposes of the present document, the abbreviations given in ETSI ES 205 200-3 [i.3] and the following apply:

AC	Alternative Current
AC/DC	Alternating Current/Direct Current
ADSL	Asynchronous Digital Subscriber Line
ATTM	Access Transmission Terminal and Multiplexing
BREEAM	Building Research Establishment Environmental Assessment Method
CGIC	Co-ordination Group on Installations and Cabling
CPU	Central Processing Unit
CRAC	Computer Room Air Conditioning
CRIP	Club des Responsables d'Infrastructure et de Production
DC	Data Centre
DCEM	Data processing Communication Energy Management
DCIM	Data Centre Infrastructure Management
DRP	Disaster Recovery Plan

FFS	For Further Study
GAL	Green Access Layer
HQE	Haute Qualité Energétique
HVDC	High Voltage Direct Current
ICT	Information Communication Technology
IEC	International Electrotechnical Commission
IS	Information Systems
ISP	Internet Service Provider
IT	Information Technology
ITIL	IT Information Library
KPI	Key Performance Indicator
LCA	Life Cycle Assessment
LCIA	Life Cycle Impact Analysis
M2M	Machine To Machine
MW	Megawatt
NGN	Next Generation Network
OS	Operating System
PCB	Printed Circuit Board
PDU	Power Distribution Unit
POD	Performance Optimized Datacentre
PUE	Power Usage Effectiveness
RTO	Recovery Time Objective
SAN	Storage Area Network
TCO	Total Cost of Ownership
TN	Terre Neutre

NOTE: Electricity: way Neutral & Protective are implemented.

TNS	Terre Neutre Séparés

NOTE: Electricity: Neutral & Protective using different wires.

TP	Transactional Processing
TV	TeleVision
UPS	Uninterruptible Power Supply
VAC	Volts Alternative Current
VDC	Volts Direct Current
VM	Virtual Machine
VOD	Video On Demand
VOIP	Voice Over IP

4 Overview of ICT sites

4.1 Types of ICT sites

There are a number of different types of ICT site:

- **a network data centre** has the primary purpose of the delivery and management of broadband services to the operator's customers. To enable their functionality, all network data centres shall be connected to at least one core network operator site. For reasons of network resilience, data centres will invariably be connected to more than one operator site and to several other data centres. Data Centres may serve core networks operated by several network operators, thus enabling traffic between customers of different network operators;

- **an enterprise data centre** has similar functions and connectivity functions and connectivity to that of a network data centre but has the primary purpose of the delivery and management of services to its employees and customers;