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GROUP SPECIFICATION

**Operational energy Efficiency for Users (OEU);
Referential specification to define sustainable levels of Fixed
Broadband access networks**

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Foreword

This Group Specification (GS) has been produced by ETSI Industry Specification Group (ISG) Operational energy Efficiency for Users (OEU).

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

Further to the 1997 Kyoto protocol [i.1], the European Commission issues Directives in order to improve energy management of broadband networks of whole industry sectors including sites.

Therefore suppliers and users of information and communication technology (ICT) equipment will implement "Green" tools (indicators, recognized Green levels) to monitor the efficiency of their sustainable networks.

Fixed Broadband Access Networks constitute one area of energy consumption. Consequently, a second target of ETSI ISG OEU is the development of the Referential Specification defining lists of standards and technical documents to be used for designing, refitting, and updating sustainable Fixed Broadband Access Networks.

1   Scope

The present document defines the current position of the ISG OEU members in relation to the Referential Specification to define sustainable levels of Fixed Broadband access networks as defined in European Commission mandate M/462 [i.6].

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 reference document (including any amendments) applies.

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2.2   Informative references

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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]   Kyoto Protocol to the United Nations Framework Convention on Climate Change.

[i.2]   ETSI TS 105 174-4-1: "Access, Terminals, Transmission and Multiplexing (ATTM); Broadband Deployment and Energy Management; Part 4: Access Networks; Sub-part 1: Fixed access networks (excluding cable)".

[i.3]   CENELEC EN 50310: "Application of equipotential bonding and earthing in buildings with information technology equipment".

[i.4]   EC DG JRC: "Code of Conduct on Energy Consumption of Broadband Equipment V5".

[i.5]   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".

[i.6]   EC Mandate M/462: "Standardisation mandate addressed to CEN, CENELEC and ETSI in the field of ICT to enable efficient energy use in fixed and mobile information and communication networks".

[i.7]   ETSI ES 205 200-2-2: "Access, Terminals, Transmission and Multiplexing; Energy management; Global KPIs: Operational infrastructures: Fixed (excluding cable) access networks;".

[i.8]   CENELEC EN 50600-1: "Information technology - Data centre facilities and infrastructures: General concepts".

[i.9]   CENELEC EN 50600-2-1: "Information technology - Data centre facilities and infrastructures: Building construction".

[i.10]   CENELEC EN 50600-2-2: "Information technology - Data centre facilities and infrastructures:
              Power distribution".

[i.11]   CENELEC EN 50600-2-3: "Information technology - Data centre facilities and infrastructures:
              Environmental control".

[i.12]   ISO EN 50001: "Energy management systems".

[i.13]   ETSI GS OEU 012: "Operational energy Efficiency for Users (OEU); Technical Global KPIs for
              Fixed Access Networks".

3　　Definitions and abbreviations

3.1　　Definitions

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

application: single program or a set of several programs executing a function or a service

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

> NOTE:　　Availability is one of the criticality criteria.

blade server: server chassis housing multiple thin, modular electronic circuit boards, known as server blades

> NOTE:　　Each blade is a server in its own right, often dedicated to a single application. The blades are literally servers on a card, containing processors, memory, integrated network controllers, an optional fibre channel host bus adaptor (HBA) and other input/output (IO) ports.

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.

Disaster Recovery Plan (DRP): all processes (technical, organizational, people) to launch in case of continuity disruption

disk array: cabinet containing physical disks

DSLAM: network device, located in indoor (for instance, a telephone exchange) or Outdoor site, that connects multiple customer digital subscriber line (DSL) interfaces to a high-speed digital communications channel using multiplexing techniques

energy consumption: total consumption of electrical energy by an operational infrastructure

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

energy re-use: transfer or conversion of energy (typically in the form of heat) produced by the operational infrastructure to do other work Environmental control system facilities and infrastructures necessary to maintain the equipment of a data centre within its required environmental performance range

Fixed broadband Access Node (FAN): structure, or group of structures, dedicated to broadband, being a network device, located in indoor (often in telephone exchanges) or outdoor site that connects multiple customer digital or/and optical subscriber line interfaces to a high-speed digital communications channel using multiplexing techniques

> NOTE:　　A structure can consist of multiple shelves and/or racks with specific functions to support the primary function.

green data centre: in addition to energy efficiency, the "Green" approach will focus on 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 if we now that Fixed broadband Access nodes are not directly 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 Fixed broadband Access nodes is low. But if energy is becoming from coal, or fuel the CO_2 emissions are high.

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)

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

logical consolidation ratio: number of application instances per operating system image

logical server: one single instance of operating system

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

Multi Service Access Node (MSAN): device typically installed in indoor (for instance, a telephone exchange) or Outdoor site which connects customers lines to the core network, to provide telephone, ISDN, and broadband (such as DSL or FTTx) all from a single platform

> NOTE: Prior to the deployment of MSANs, telecom providers typically had a multitude of separate equipment including DSLAMs and OLT to provide the various types of services to customers.

network telecommunications equipment: equipment providing direct connection to core and/or access networks including switches, Fixed broadband Access Node (MSAN, DSLAM, OLT), 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

operational infrastructure: combination of information technology equipment (ITE) together with the power supply and environmental control systems necessary to ensure provision of service

Optical Distribution Network (ODN): point-to-multipoint optical fibre infrastructure.

> NOTE: A simple ODN is entirely passive and is represented by a single-rooted point-to-multipoint tree of optical fibres with splitters, combiners, filters, and possibly other passive optical components. A composite ODN consists of two or more passive segments interconnected by active devices, each of the segments being either an Optical trunk line segment or an Optical distribution segment. A Passive optical distribution segment is a simple ODN itself. Two ODNs with distinct roots can share a common subtree.

Optical Distribution Segment (ODS): simple ODN, that is, a point-to-multipoint optical fibre infrastructure that is entirely passive and is represented by a single-rooted tree of optical fibres with splitters, combiners, filters, and possibly other passive optical components

Optical Network Terminal (ONT): ONU supporting a single subscriber

Optical Line Termination (OLT): network element in an ODN-based optical access network that terminates the root of at least one ODN and provides an OAN SNI

Optical Network Unit (ONU): network element in an ODN-based optical access network that terminates a leaf of the ODN and provides an OAN UNI

Passive Optical Network (PON) system: combination of network elements in an ODN-based optical access network that includes an OLT and multiple ONUs and implements a particular coordinated suite of physical medium dependent layer, transmission convergence layer, and management protocols

Power Usage Effectiveness (PUE): metric used to determine the energy efficiency of a data centre that is determined by "Total facility power" divided by "IT equipment power", expressed as a ratio (PUE is expressed as a ratio, with overall efficiency improving as the quotient decreases toward 1)

power supply and distribution system: facilities and infrastructures necessary to provide power to the equipment of a data centre to meet desired operational objectives

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

renewable energy: energy produced from dedicated generation systems using resources that are naturally replenished

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

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 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)

3.2   Abbreviations

For the purposes of the present document, the following abbreviations apply:

ADSL	Asymmetric Digital Subscriber Line
AS	Application Server
ATTM	Access Transmission Terminal and Multiplexing
CEN	European Committee for Standardization
CENELEC	European Committee for Electrotechnical Standardization
CoC	Code of Conduct
DCEM	Dataprocessing Communication Energy Management
DG	Directorate General
DSLAM	Digital Subscriber Line Access Multiplexer
EC	European Commission
EE	Energy Efficiency
ETSI	European Telecommunications Standards Institute
EU CoC	EU Code of Conduct
EU	European Union
FAN	Fixed Access Node
GPON	Gigabit Passive Optical Network
ICT	Information Communication Technology
IEC	International Electrotechnical Commission
IS	Information Systems
ISO	International Standardization Organization
IT	Information Technology
ITU	International Telecommunication Union
ITU-T	ITU's Telecommunication standardization sector
JRC	Joint Research Centre
KPI	Key Performance Indicator
LTE	Long Term Evolution
MTBF	Mean Time Between Failures
MTTR	Mean Time To Repair
OLT	Optical Line Termination
ONT	Optical Network Termination

NOTE: Single user type of ONU used in FTTH.

ONU   Optical Network Unit

NOTE: Generic name for remote optical termination, to be used for shared ONU and those with a secondary monitored transmission.

OS   Operator Site
PON   Passive optical Network

NOTE: using optical passive splitters sharing an OLT port capacity across a plurality of ONUs.

PUE   Power Usage Effectiveness
TR   Trouble Report
UPS   Uninterruptible Power Supply

4   Fixed broadband Access Node

4.1   Generalities

Fixed broadband Access Node (FAN) is a shelf, or group of shelves, dedicated to broadband, being a network device, located in indoor (often in telephone exchanges) or outdoor site that connects multiple customer digital or/and optical subscriber line interfaces to a high-speed digital communications channel using multiplexing techniques.

In order to distinguish the different levels of Fixed Broadband Access Networks, many classifications have been established. The most widely used standards are:

- ETSI TS 105 174-4-1 [i.2]

- CENELEC EN 50600-1 [i.8]

Different qualitative Availability Classes for the overall set of nodes facilities and infrastructures are defined as shown in table 1. The availability of the entire nodes depends on the Availability Classes of its individual infrastructures such as power sourcing and distribution, environmental control and security.

In order for the set of facilities and infrastructures of nodes to be considered to be of a given Availability Class, the design of each individual facility and infrastructure listed in table 1 should meet or exceed that Availability Class.

The provision of higher Availability Classes generally requires greater investment, for example in design, construction, components, systems and human resources. For example, greater investment in components can result in greater Mean Time between Failures (MTBF) or Reduced Mean Time to Recovery (MTTR).

Table 1: Different qualitative Availability Classes

	Availability Class 1	Availability Class 2	Availability Class 3	Availability Class 4
Availability of overall set of facilities and infrastructures	Low	medium	High	very high
Example for power distribution	Single-path (no redundancy of components)	Single-path (resilience provided by redundancy of components)	Multi-path (resilience provided by redundancy of systems)	Multi-path (fault tolerant even during maintenance)
Example for environmental control	No specific requirements	Single-path (no redundancy of components)	Single-path (resilience provided by redundancy of components)	Multi-path (resilience provided by redundancy of systems), allows maintenance during operation
Example for telecommunications cabling	Single-path using direct connections	Single-path using fixed infrastructure	Multi-path using fixed infrastructure	Multi-path using fixed infrastructure with diverse pathways

4.2   Informative documents

ETSI TS 105 174-4-1 [i.2] introduces the issue of energy consumption and efficiency within Fixed broadband Access Nodes and addresses the associated operational best practices to meet the objectives of reduced consumption and increased efficiency - containing clauses on power distribution infrastructures, environmental control. It also reviews the possible Key Performance Indicators which would indicate improvement against the primary objectives of reduced energy consumption and increased energy efficiency.

CENELEC EN 50600-2-1 [i.9] defines the requirements and recommendation for building construction, independent of the size and function of the data centre. It addresses a wide range of situations including the choice of location and site selection for a new data centre to the assessment of existing buildings and structures.

5   Energy management methodology

5.1   General

Energy management is done by a global monitoring of energy of the operational Fixed Access Node. Every local energy should be taken into account. From water flow engine to solar power system, a local electrical power source distributed by a micro grid by opposition to a centralized power plant improved a better use of energy.

It can include energy sources or storage or cogeneration of heat and electricity using any primary energy renewable or not. FAN produce significant quantities of waste heat, there are some applications for reuse of this energy.

Successful implementation of energy management requires both process definition and monitoring of relevant KPIs.

5.2   Energy management process

Energy management processes should be based on the ISO EN 50001 [i.12] standards.

5.3   Monitoring of energy management performance

Energy management is combination of reduced energy consumption and increased task efficiency, re-use of energy and use of renewable energy.

Energy management is done by a global monitoring of energy of the operational data centre.

In relation to energy management for Fixed Access Node a Global Key Performance Indicator (KPI $_{DCEM}$) has been defined and addresses the following four Objective KPIs:

- energy consumption (KPI$_{EC}$);

- task efficiency (KPI$_{TE}$);

- energy re-use (KPI$_{REUSE}$);

- renewable energy (KPI$_{REN}$).

5.4   Informative documents

- EC DG JRC [i.4].

- ETSI ES 205 200-2-2 [i.7]

- ISO EN 50001 [i.12].

- ETSI GS OEU 012 [i.13].

6 Power distribution systems

6.1 General

The power distribution systems consider the distribution of energy from public grid to the MSAN equipment (hosted equipment, cooling, facilities) including locally generated energy.

The power distribution should be designed in accordance with the chosen availability class as defined in CENELEC EN 50600-1 [i.8].

Then design of the power distribution infrastructure should take into account:

- Scalability for ramp-up needs.

- Performance of equipment in accordance with the predicted load.

- Consumption metering points in accordance with CENELEC EN 50600-2-2 [i.10].

New technologies have to be considered:

- 400 Volts Direct Courant distribution.

- On-line UPS.

- No-break UPS.

- By pass UPS.

6.2 Informative documents

- ETSI TS 105 174-4-1 [i.2].

- EC DG JRC [i.4].

- ETSI EN 300 132-3-1 [i.5].

The European Standard CENELEC EN 50600-2-2 [i.10] addresses power distribution within data centres based upon the criteria and classifications for "availability", "physical security" and "energy efficiency enablement" within CENELEC EN 50600-1 [i.8].

The European Standard CENELEC EN 50600-1 [i.8] specifies requirements and recommendations for the following:

a) power supplies to data centres;

b) power distribution systems within data centres;

c) facilities for both normal and emergency lighting;

d) equipotential bonding and earthing (by reference to CENELEC EN 50310 [i.3]);

e) lightning protection (by reference to CENELEC EN 50310 [i.3]);

f) electrostatic discharge;

g) devices for the measurement of the power consumption characteristics at points along the power;

h) distribution system and their integration within management tools.

7   Environmental control

7.1   General

The environment control is defined as systems required to maintain environmental condition in accordance with hosted equipment vendor specifications.

Conditions per equipment category are defined taking into account:

- Temperature of IT equipment Air Intake.

- Limit Temperature of Air Intake to operate.

- Widest operating range (T°, Rh%) for reliability and performance.

- Position of the controlling measurements.

- Tolerated variation in °C/Hour and Rh%/Hour.

The couple, humidity and temperature, should be adapted according to hosted equipment specifications in order to minimize the energy consumption.

7.2   Informative documents

- EC DG JRC [i.4].

CENELEC EN 50600-2-3 [i.11]: "Information technology - Data centre facilities and infrastructures: Environmental control" defines environmental control within data centres based upon the criteria and classifications for "availability", "security" and "energy efficiency enablement" within CENELEC EN 50600-1 [i.8].

Annex A (informative):
Authors and Contributors

The present document has been developed by ISG OEU members (ICT world Users) in order to define the most efficient tools.

Annex B (informative):
Bibliography

- ETSI GS OEU 001: "Operational energy Efficiency for Users (OEU); Global KPIs for ICT Sites".

- ETSI EN 300 019 series: "Environmental Engineering (EE); Environmental conditions and environmental tests for telecommunications equipment".

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

- CENELEC EN 50173-2: "Information technology - Generic cabling systems - office premises".

- CENELEC EN 50173-6: "Information technology - Generic cabling systems - Distributed building services".

- CENELEC EN 50174-1: "Information technology - Cabling installation - Installation specification and quality assurance".

- CENELEC EN 50174-2: "Information technology - Cabling installation - Planning and Installation practices inside buildings".

- ISO/IEC TR 30133: "Information technology - Data centres - Guidelines for resource efficient data centres".

- Recommendation ITU-T G.992.3: "Asymmetric digital subscriber line (ADSL) transceivers".

- Recommendation ITU-T G.993.2: "Very high speed digital subscriber line transceivers 2 (VDSL2)".

- Recommendation ITU-T G.992.5: "Asymmetric digital subscriber line 2 transceivers (ADSL2)- Extended bandwidth ADSL2 (ADSL2plus)".

- Recommendation ITU-T G.984: "Series describing Gigabit-capable passive optical networks (GPON)".

- Recommendation ITU-T G.987: "Series describing 10 Gigabit-capable passive optical networks (XG-PON)".

- Recommendation ITU-T G.989: "Series describing 40 Gigabit-capable passive optical networks (NG-PON2)".

- Recommendation ITU-T G.991.1: "High bit rate digital subscriber line (HDSL) transceivers .

- Recommendation ITU-T G.991.2: "Single-pair high-speed digital subscriber line (SHDSL) transceivers".

- ETSI TR 102 530: "Environmental Engineering (EE); The reduction of energy consumption in telecommunications equipment and related infrastructure".

- ETSI TS 102 533: "Environmental Engineering (EE); Measurement Methods and limits for Energy Consumption in Broadband Telecommunication Networks Equipment".

- ETSI ES 203 215 (V1.3.1): "Environmental Engineering (EE);Measurement Methods and Limits for Power Consumption in Broadband Telecommunication Networks Equipment".

- CENELEC EN 50584: "Information technology - CENELEC/ETSI Glossary of terms and definitions for broadband deployment including sustainability aspects".

- Recommendation ITU-T G.986: "Series describing Gigabit Point to Point transmission".

History

Document history		
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