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**Access, Terminals, Transmission and Multiplexing (ATTM);
Broadband Deployment and Lifecycle Resource Management;
Part 5: Customer network infrastructures;
Sub-part 1: Homes (single-tenant)**

Reference

REN/ATTM-008

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Foreword

This European Standard (EN) has been produced by ETSI Technical Committee Access, Terminals, Transmission and Multiplexing (ATTM).

The present document is part 5, sub-part 1 of a multi-part deliverable. Full details of the entire series can be found in part 1 [i.25].

National transposition dates	
Date of adoption of this EN:	26 June 2018
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Modal verbs terminology

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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;
- an associated continuous evolution of ICT equipment.

It is therefore important to consider the environmental viability of all network elements necessary to deliver the required services in terms of the management of their operational aspects i.e. energy management (including energy efficiency) and the management of the End-of-Life (EoL) of the ICT equipment.

NOTE: The term "environmental viability" is used while recognizing that well established treatments of "sustainability" feature three separate viability objectives (environmental, economic and social). For the purposes of the multi-part deliverable, only operational aspects of environmental viability are considered. A wider approach to environmental viability takes other factors into account including the use of raw materials and avoidance of hazardous substances in the construction of infrastructure or ICT equipment- these factors are not considered.

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 multi-part deliverable specifies the general engineering of various broadband infrastructures to enable the most effective energy management (and management of other resources) and the appropriate measures for EoL treatment of ICT equipment. Certain of the standards may specify requirements for interoperability.

The present document is part 5, sub-part 1 of a multi-part deliverable and specifies requirements for customer network infrastructures within homes (single-tenant) as recipients of broadband deployment in response to the increasing amount of ICT equipment and demand for services. As energy costs in homes continues to rise, strategies are required to optimize energy consumption of all segments of ICT.

The present document been produced by ETSI Technical Committees Access, Terminals, Transmission and Multiplexing (ATTM) and Cable in close collaboration with CENELEC via the Installations and Cabling Co-ordination Group (ICCG).

1 Scope

The present document specifies the general engineering of various broadband infrastructures to enable the most effective energy management (and management of other resources) and the appropriate measures for EoL treatment of ICT equipment.

The present document specifies the requirements for resource management of customer network infrastructures within homes (single-tenant), as recipients of broadband services, as a combination of:

- Energy management while maintaining or even improving the level of service is supported by requirements for:
 - i) in new, refurbished and existing buildings: the selection of customer premises equipment and associated power supplies which meet specific energy consumption and energy efficiency requirements (by means of external references);
 - ii) in new or refurbished buildings: the provision of appropriate spaces and pathways to accommodate cabling infrastructure.
- EoL of ICT equipment by reference to ETSI EN 305 174-8 [7].

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 50173-4:2018: "Information technology - Generic cabling systems - Part 4: Homes".
- [2] CENELEC EN 50173-6: "Information technology - Generic cabling systems - Part 6: Distributed building services".
- [3] CENELEC EN 50174-2: "Information technology - Cabling installation - Part 2: Installation planning and practices inside buildings".
- [4] CENELEC EN 50491-6-1: "General requirements for Home and Building Electronic Systems (HBES) and Building Automation and Control Systems (BACS) - Part 6-1: HBES installations - Installation and planning".
- [5] ETSI EN 301 575: "Environmental Engineering (EE); Measurement method for energy consumption of Customer Premises Equipment (CPE)".
- [6] ETSI EN 303 423: "Environmental Engineering (EE); Electrical and electronic household and office equipment; Measurement of networked standby power consumption of Interconnecting equipment; Harmonised Standard covering the measurement method for EC Regulation 1275/2008 amended by EU Regulation 801/2013".
- [7] ETSI EN 305 174-8: "Access, Terminals, Transmission and Multiplexing (ATTM); Broadband Deployment and Lifecycle Resource Management; Part 8: Management of end of life of ICT equipment (ICT waste/end of life)".

- [8] ETSI ES 202 874-1: "Access, Terminals, Transmission and Multiplexing (ATTM); External Common Power Supply for Customer Premises Network and Access Equipment; Part 1: Functional requirements".
- [9] ETSI ES 203 199: "Environmental Engineering (EE); Methodology for environmental Life Cycle Assessment (LCA) of Information and Communication Technology (ICT) goods, networks and services".
- [10] ETSI TS 102 874-2: "Access, Terminals, Transmission and Multiplexing (ATTM); External Common Power Supply for Customer Premises Network and Access Equipment; Part 2: Integrated Broadband Cable and Television Networks".
- [11] ETSI TS 102 874-3: "Access, Terminals, Transmission and Multiplexing (ATTM); External Common Power Supply for Customer Premises Network and Access Equipment; Part 3: CPS Type 1 implementation details".
- [12] ETSI TS 102 874-4: "Access, Terminals, Transmission and Multiplexing (ATTM); External Common Power Supply for Customer Premises Network and Access Equipment; Part 4: CPS Type 2.b implementation details".
- [13] ETSI TS 102 874-5: "Access, Terminals, Transmission and Multiplexing (ATTM); External Common Power Supply for Customer Premises Network and Access Equipment; Part 5: CPS Type 2.c implementation details".
- [14] ETSI TS 102 874-6: "Access, Terminals, Transmission and Multiplexing (ATTM); External Common Power Supply for Customer Premises Network and Access Equipment; Part 6: CPS Type 2.d implementation details".
- [15] EU Code of Conduct on Energy Efficiency of External Power Supplies - Version 5.
- NOTE: Available at https://e3p.jrc.ec.europa.eu/sites/default/files/documents/publications/code_of_conduct_for_eps_version_5_-_final.pdf.
- [16] EU Code of Conduct on Energy Consumption of Broadband Equipment - Version 6.
- NOTE: Available at http://publications.jrc.ec.europa.eu/repository/bitstream/JRC106039/ictcoc-ecbe-v6_feb_2017_final.pdf.
- [17] EU Code of Conduct on Energy Efficiency for Digital TV Services Systems - Version 9.
- NOTE: Available at https://e3p.jrc.ec.europa.eu/sites/default/files/documents/publications/code_of_conduct_digital_tv_service_systems_v9_final.pdf.
- [18] IEEE Std 802.3™: "IEEE Standard for Ethernet".

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] Void.
- [i.2] CENELEC EN 50174-1: "Information technology - Cabling installation: Installation specification and quality assurance".

- [i.3] CENELEC EN 50174-3: "Information technology - Cabling installation: Installation planning and practices outside buildings".
 - [i.4] CENELEC EN 50491 series: "General requirements for Home and Building Electronic Systems (HBES) and Building Automation and Control Systems (BACS)".
 - [i.5] CENELEC EN 60603-7 series: "Connectors for electronic equipment".
 - [i.6] Commission Regulation (EC) No 278/2009 of 6 April 2009 implementing Directive 2005/32/EC of the European Parliament and of the Council with regard to ecodesign requirements for no-load condition electric power consumption and average active efficiency of external power supplies.
 - [i.7] Commission Regulation (EC) No 642/2009 with regard to ecodesign requirements for televisions.
- NOTE: Commission Regulation (EC) No 642/2009 is subsequently amended by Commission Regulation (EU) 2016/2282 with regard to the use of tolerances in verification procedures.
- [i.8] Commission Regulation (EC) No 1275/2008 with regard to ecodesign requirements for standby, off mode electric power consumption of electrical and electronic household and office equipment.
- NOTE: Commission Regulation (EC) No 1275/2008 is subsequently amended by Commission Regulation (EU) 2016/2282 with regard to the use of tolerances in verification procedures.
- [i.9] Commission Regulation (EU) No 801/2013 of 22 August 2013 amending Commission Regulation (EC) No 1275/2008 and Regulation (EC) No 642/2009 by introducing requirements for networked standby.
 - [i.10] ETSI TS 102 973: "Access Terminals, Transmission and Multiplexing (ATTM); Network Termination (NT) in Next Generation Network architectures".
 - [i.11] ETSI TS 103 247: "Access, Terminals, Transmission and Multiplexing (ATTM); Singlemode Optical Fibre System Specifications for Home Cabling".
 - [i.12] ETSI TS 105 175-1: "Access, Terminals, Transmission and Multiplexing (ATTM); Plastic Optical Fibre System Specifications for 100 Mbit/s and 1 Gbit/s".
 - [i.13] ETSI EN 305 174-2: "Access, Terminals, Transmission and Multiplexing (ATTM); Broadband Deployment and Lifecycle Resource Management; Part 2: ICT Sites".
 - [i.14] ETSI EN 305 200 series: "Access, Terminals, Transmission and Multiplexing (ATTM); Energy management; Operational infrastructures; Global KPIs".
 - [i.15] ISO 14040: "Environmental management -- Life cycle assessment -- Principles and framework".
 - [i.16] ISO/IEC 11801-4: "Information technology - Generic cabling for customer premises: Part 4: Homes".
 - [i.17] ISO/IEC 11801-6: "Information technology - Generic cabling for customer premises: Part 6: Distributed building services".
 - [i.18] Recommendation ITU-T L.113: "Vocabulary of terms for broadband aspects of ISDN".
 - [i.19] Recommendation ITU-T L.1000: "Universal power adapter and charger solution for mobile terminals and other hand-held ICT devices".
 - [i.20] Recommendation ITU-T L.1001: "External universal power adapter solutions for stationary information and communication technology devices".
 - [i.21] Recommendation ITU-T L.1002: "External universal power adapter solutions for portable information and communication technology devices".
 - [i.22] Recommendation ITU-T L.1005: "Test suites for assessment of the universal charger solution".
 - [i.23] Recommendation ITU-T L.1006: "Test suites for assessment of the external universal power adapter solutions for stationary information and communication technology devices".
 - [i.24] Home Gateway Initiative HGI-GD035: "HGI Smart Home Use Cases".

- [i.25] ETSI EN 305 174-1: "Access, Terminals, Transmission and Multiplexing (ATTM); Broadband Deployment and Lifecycle Resource Management; Part 1: Overview, common and generic aspects".
- [i.26] ISO/IEC 15018: "Information technology -- Generic cabling for homes".
- [i.27] ETSI TR 105 174-4: "Access, Terminals, Transmission and Multiplexing (ATTM); Broadband Deployment - Energy Efficiency and Key Performance Indicators; Part 4: Access networks".
- [i.28] Guide for the EMC Directive 2004/108/EC.

3 Definitions and abbreviations

3.1 Definitions

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

access network: functional elements (that is equipment and infrastructure) that enable communication between an operator site (OS) and a customer network

access provider: operator or other entity providing the means to enable external telecommunications service provision to a subscriber

NOTE: Source: CENELEC EN 50174-3:2013 [i.3], clause 3.1.2.

application: system, with its associated transmission and power feeding method that is supported by telecommunications cabling

NOTE: This corresponds to a Layer One application in the OSI 7-layer model.

broadband: telecommunications service capable of providing more than 2 048 kbit/s (Recommendation ITU-T L.113 [i.18]) full-rate capacity in at least one direction

NOTE: Integrated Synchronous Digital Network (ISDN) is not considered to be a broadband technology and is not addressed in the present document.

Broadcast Communication Technology (BCT) application: system, with its associated transmission method dedicated to the distribution of radio, television and two-way data services (including in-home inter-networking)

cable access network: access network provided by cable operators comprising optical fibre and metallic cabling providing direct connection to customer premises

Command, Control and Communications in Buildings (CCCB) application: system, with its associated transmission method dedicated to appliance and building controls

customer network: functional elements (that is equipment and infrastructure) that enable communication between a network interface unit (NIU), network termination point (NTP) or external network interface (ENTI), as appropriate, and one or more pieces of terminal equipment (TE)

Customer Premises (CP): any location which is the sole responsibility of the customer

Customer Premises Equipment (CPE): any device, either provided by a telecommunications service provider or owned directly by the customer, installed at customer premises and adopted for using the telecommunication services, typically provided by means of a fixed access network (but not necessarily excluding wireless access)

End-of-Life (EoL): established point in a product life cycle after a period of primary use and at which a decision is required with regard to reuse, recycling or disposal

end-use IT equipment: Terminal Equipment (TE) of a fixed access network, User Equipment (UE) of a mobile access network or Network Interface Unit (NIU) of a cable access network

External Network Test Interface (ENTI): point in or near the customer premises (inside or outside the customer network) accessible to the fixed access network operator for testing purposes

fixed access network: access network provided by telecommunications operators comprising optical fibre and metallic cabling providing direct connection to customer premises

Home Gateway (HG): gateway between the access network and a customer premises network

Information Communication Technology (ICT) application: system, with its associated transmission method for the communication of information

Information Communication Technology (ICT) equipment: equipment providing data storage, processing and transport services

NOTE: A combination of Information Technology Equipment and Network Telecommunications Equipment.

Information Communication Technology (ICT) site: site containing structures or group of structures dedicated to the accommodation, interconnection and operation of ICT equipment 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

Information Technology Equipment (ITE): equipment providing data storage, processing and transport services for subsequent distribution by Network Telecommunications Equipment (NTE)

Internet of Things (IOT) application: systems, with their associated transmission methods extending the scope of Command, Control and Communications in Buildings (CCCB) applications

mobile access network: telecommunications network in which the access to the network (connection between user equipment and network) is implemented over the air interface

network convergence: ability of a network, by virtue of the applications it supports, to deliver multiple ICT, BCT and IOT-SH services

Network Data Centre (NDC): data centre embedded within the core network

NOTE: A network data centre of a cable access network may be termed a master head-end.

Network Distribution Node (NDN): grouping of NTE equipment within the boundaries of an access network providing distribution of service from an Operator Site (OS)

NOTE: Where all the Network Telecommunications Equipment (NTE) at a given location is under common governance, any supporting infrastructure for power distribution and environmental control together with the necessary levels of resilience and security required to provide the desired service availability is included as part of the NDN.

Network Interface Unit (NIU): principal device within customer premises allowing user access to the services provided by the cable access network

Network Telecommunications Equipment (NTE): equipment between the boundaries of, and dedicated to providing connection to, core and/or access networks

Network Termination Point (NTP): physical point(s) at which a subscriber is provided with access to the operator network (this may be co-located with an external network test interface)

Operator Site (OS): premises accommodating Network Telecommunications Equipment (NTE) providing direct connection to the core and access networks and which may also accommodate Information Technology Equipment (ITE)

NOTE 1: An Operator Site that is only connected to the core network is considered as a network data centre.

NOTE 2: An Operator Site of a cable access network may be termed a local head-end.

service provider: operator of any service that furnishes telecommunications content (transmissions) delivered over access provider facilities

NOTE 1: The access provider and the service provider can be a single entity.

NOTE 2: Source: CENELEC EN 50174-3:2013 [i.3], clause 3.1.15.

Smart Home (SH) application: See Internet of Things (IoT) application.

subscriber: identifiable entity within the premises that requires or may require a direct connection to the access network

Terminal Equipment (TE): principal device within customer premises allowing user access to the services provided by the fixed access network

User Equipment (UE): device allowing user access to the services provided by the mobile access network

3.2 Abbreviations

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

AC	Alternating Current
APD	Auto-Power Down
ATTM	Access, Terminals, Transmission and Multiplexing
AVC	Advanced Video Coding
BACS	Building Automation and Control Systems
BCT	Broadcast Communications Technology
BEF	Building Entrance Facility
BO	Broadcast Outlet
CAT	Category
CATV	CABLE TeleVision
CCCB	Command Control and Communications in Buildings
CENELEC	European Committee for Electrotechnical Standardization
CP	Customer Premises
CPE	Customer Premises Equipment
CPS	Common Power Supply
CPU	Central Processor Unit
DBS	Digital Broadcast Service
DC	Direct Current
DECT	Digital Enhanced Cordless Telecommunications
DOCSIS	Data-Over-Cable Service Interface Specifications
DSL	Digital Subscriber Line
DTT	Digital Terrestrial Television
DVD	Digital Video Disk
DVR	Digital Video Recording
EC	European Commission
EEE	Energy Efficient Ethernet
EMC	ElectroMagnetic Compatibility
ENI	External Network Interface
ENTI	External Network Termination Interface
EoL	End-of-Life
FTTH	Fibre-To-The-Home
FXO	Foreign eXchange Office
FXS	Foreign eXchange Subscriber interface
HBES	Home and Building Electronic Systems
HD	High Definition
HEVC	High Efficiency Video Coding
HG	Home Gateway
HGI	Home Gateway Initiative
ICCG	CENELEC/ETSI Installation Cabling Coordination Group
ICT	Information Communications Technology
IEA	International Energy Agency
IoT	Internet of Things
IoT-SH	Internet of Things and Smart Home
IP	Internet Protocol
ISDN	Integrated Synchronous Digital Network
KPI	Key Performance Indicator
LAN	Local Area Network
LCA	Life Cycle Assessment
MIMO	Multiple Input Multiple Output

MPEG	Motion Picture Experts Group
NDC	Network Data Centre
NTE	Network Telecommunication Equipment
NTP	Network Termination Point
OEM	Original Equipment Manufacturer
OIE	Operator Independent Equipment
OS	Operator Site
OSE	Operator Specific Equipment
PHD	Primary Home Distributor
PSTN	Public Switched Telephone Network
SCP	Service Concentration Point
SD	Service Distributor
SH	Smart Home
SHD	Secondary Home Distributor
SO	Service Outlet
TE	Terminal Equipment
TO	Telecommunications Outlet
TV	Television
UCS	Universal Charger Solution
UE	User Equipment
UPA	Universal Power Adapter
USB	Universal Serial Bus
WAN	Wide Area Network
xDSL	x Digital Subscriber Line

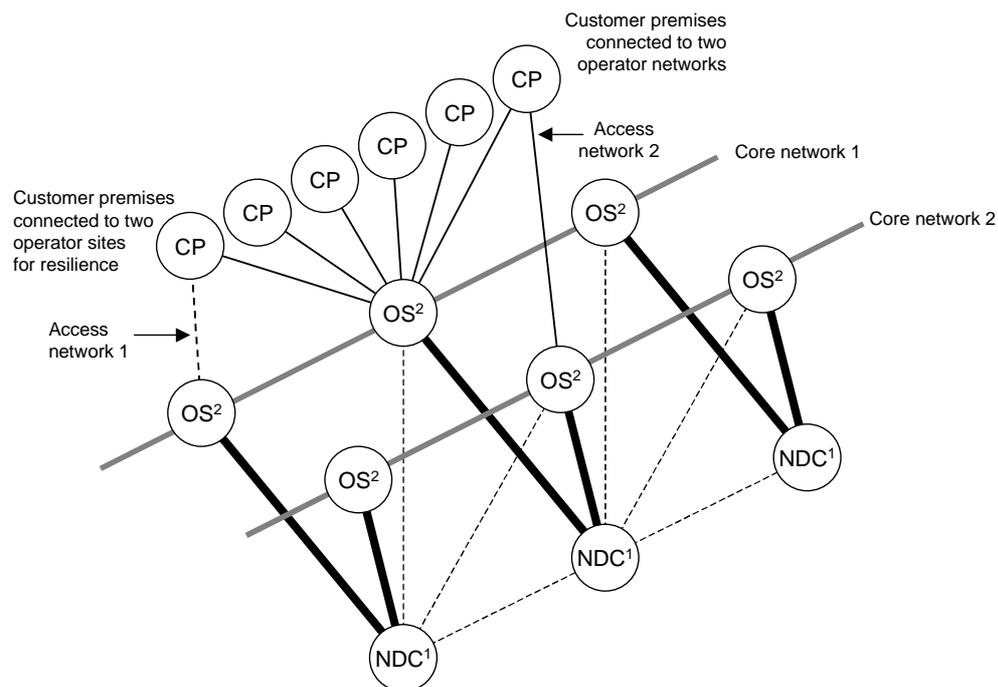
NOTE: Of any type, e.g. Asymmetrical, Symmetrical, etc.

4 Homes (single-tenant)

4.1 Broadband deployment to customer premises

4.1.1 General

Figure 1 is a technology-agnostic diagram depicting a segment of a broadband network showing the interconnection of ICT sites and customer premises installations for fixed (broadband) and cable access networks. In principle, every operator network can contain any number of each of these elements and may be connected to any number of other operator networks.



¹ For cable access networks this is termed "Master head-end/OS"

² For cable access networks this is termed "Local head-end/OS"

Figure 1: Network sub-systems of fixed broadband access network infrastructure

Broadband provision is an enabling technology capable of supporting a reduction of global energy consumption (for example, by providing facilities such those listed in Table 1 which may reduce the demand for travel). This requires an increasing amount of ICT equipment that often needs to be always active (and consuming energy). For this reason, it may not be the case that the total energy consumption of broadband networks will be reduced, though the application of effective energy efficiency measures will minimize any increases due to predicted service evolution.

The scale of reductions in energy consumption and/or improvements of energy efficiency is:

- dependent on the network sub-systems;
- generally greater at the design stage rather than following improvements to existing infrastructures.

The potential reductions in energy consumption and/or improvements of energy efficiency in ICT sites as described in ETSI EN 305 174-2 [i.13] are expected to be substantial but apply in only a relatively small number of locations (i.e. Operator Sites (OS) and Network Data Centres (NDC)) and may prove vital where availability of power is restricted at those locations. These clearly defined premises are provided with appropriate Key Performance Indicators (KPIs) to determine relative performance levels in terms of energy management (see ETSI EN 305 200 series [i.14]).

By comparison to ICT sites the saving at the various network distribution nodes and within the cabling infrastructures of the individual access networks may be very much smaller but the aggregation of those savings may outweigh the energy efficiency gains elsewhere due to the very large number of customers, thus justifying their consideration and implementation. The communities served by customer networks are the recipients of the "energy efficiency enabling" technologies provided by broadband services and the relevant parts of this multi-part deliverable serves to indicate strategies/approaches that maximize the opportunities presented.

Within customer premises, it is generally the customer rather than the operator that funds the energy costs. Potential reductions in energy consumption may well be identifiable in design terms but they are generally not individually quantifiable due to the diversity of customer networks.

4.1.2 Telecommunications services within homes

Historically, telecommunications services within homes (and customer premises in general) have been grouped as:

- Broadcast Communications Technology (BCT);
- Command, Control and Communications in Buildings (CCCB);
- Information Communications Technology (ICT).

It is important to differentiate between the "service" delivered in the home and the "application" used to deliver it.

EXAMPLE: Many people receive television (a BCT service) via their personal computers or tablet device using wired or wireless Ethernet connection (an ICT application). Similarly, homes connected to cable access networks may use DOCSIS (a BCT application) to communicate data (an ICT service). However within the home, the distribution of the ICT services within DOCSIS is generally implemented via an ICT application.

Until recently, CCCB services have been dominated by CCCB applications which have tended to be proprietary with each one implemented using a particular infrastructure design. The reluctance of the CCCB industry to adopt a common infrastructure has restricted the concept of pre-cabling within homes - which is a foundation of the generic cabling concept adopted by both BCT and ICT applications.

The extension of Ethernet applications to support remotely powered devices - using the standardized 4-pair balanced cabling infrastructure already specified for ICT applications - has resulted in a massive increase in the number of services that the ICT applications can support. Future developments include the use of 1-pair applications, also providing remote powering, which will allow support for devices to support the "Internet of Things" and which are integral to Sustainable Digital Multi-Service ("Smart") City concepts.

This convergence of delivery of ICT and CCCB services using common applications and a common cabling infrastructure provides the opportunity for the holistic management of the entire home environment - including energy management.

An extension of this convergence between ICT and CCCB services is now recognized, particularly within the home, within the concepts of Internet of Things and Smart Home (IoT-SH) as described in HGI-GD035 [i.24].

As can be seen in Table 1, BCT applications are restricted to the delivery of BCT services by virtue of their coaxial cabling background - but are important due to their dominance in the market. IoT services are generally delivered using ICT applications whereas SH services may be delivered using ICT applications or specific SH applications (as reflected in the contents of Table 1). However, it is expected that the majority of IoT-SH services will be delivered using ICT applications.

As a result, ICT applications are capable of support all the service types and standards have been developed to specify the design and installation of generic cabling for these applications (see clause 5).

For this reason, clause 6 of the present document focuses on the following aspects:

- the planning of pathways and spaces within the home to maximize the opportunities for energy management (see clause 6.1.1);
- the selection of Terminal Equipment (TE) to maximize the opportunities for energy management (see clause 6.1.2);
- the design of cabling infrastructure to maximize the opportunities for interoperability of equipment in support of energy management (see clause 6.2.1);
- the requirements for energy performance of CPE providing the BCT and ICT applications to and from the premises (see clause 6.3);
- the requirements for End-of-Life of the CPE (see clause 6.3.3.4).

Table 1: Services and applications

		Applications		
		BCT	IOT-SH	ICT
BCT services				
Entertainment	Television and radio	•		•
ICT services				
Entertainment	Broadband video - live or on demand (streamed or download)			•
	Audio - live or on demand (streamed or download)			•
	Gaming (on-line and solo)			•
	e-Reading			•
Socio-cultural	Tele-learning			•
	Tele-working, cooperative working			•
	Home banking			•
	On-line shopping			•
Communications	Telephony (voice and video)			•
	Integration with mobile phones			•
	e-mail			•
	Internet access			•
IOT-SH services				
	Security: Anti-intrusion		•	•
	Security: Access control/video surveillance		•	•
	Safety: Ambient control (e.g. fire, gas, water)		•	•
	Motor control (e.g. rolling shutter)		•	•
	Lighting (scenarios)		•	•
	Assisted living		•	•
	Energy management and load control		•	•
e-Health and comfort	Homecare			•
	Remote assistance			•
	Remote monitoring			•
	Tele-medicine			•

5 Standardization review for homes (single-tenant)

5.1 General

With regard to the distribution of services to spaces within customer premises, homes are unique for the following general reasons:

- there are limited or non-existent cabling infrastructures within the home for the distribution of ICT services (either from fixed access networks, cable access networks or internal ICT sources);
- residents tend to situate their living space(s) according to the availability of the BCT services - although the increasing use of both "wired" and wireless ICT applications to deliver BCT services is reducing this aspect.

However, neither the growth of ICT applications within the home or the advent of access to BCT services using ICT applications has resulted in the large scale re-installation of home cabling infrastructures as a means of distribution since:

- aesthetic and cost considerations have prominence in homes;
- refurbishment of the building structures is uncommon.

Instead there has been a substantial investment in wireless infrastructures within the home to provide those ICT applications.

NOTE: The EU Code of Conduct of Broadband Equipment [16] suggests that the limits for energy consumption of wireless equipment are substantially higher than the equivalent equipment for use over the cabled infrastructures in accordance with CENELEC EN 50173-4 [1] and CENELEC EN 50173-6 [2] as required in clause 6.

However, in order for home to benefit from an holistic approach to energy management it is necessary to plan the pathways and spaces within the home to:

- accommodate the cabling necessary for ICT applications to support the evolving range of devices supported - these devices comprise both wired and wireless solutions;
- to centralize the accommodation of equipment that is necessary to monitor and control the key areas of energy consumption within the home.

5.2 Cabling design

5.2.1 CENELEC EN 50173-4

CENELEC EN 50173-4 [1] specifies the requirements for generic, structured, cabling for use in home (single-tenant) to support the distribution of both ICT and BCT services. The cabling media comprise balanced and coaxial metallic implementations (although optical fibre implementations are also supported by CENELEC EN 50173-4 [1]).

The requirements of the present document are based on those of CENELEC EN 50173-4 [1] but include additional requirements as specified in clause 6.2.1.

CENELEC EN 50173-4 [1] requires the application of CENELEC EN 50174-2 [3] as detailed in clause 5.3.

5.2.2 CENELEC EN 50173-6

As indicated in clause 4.1.2, CCCB and IOT-SH services are increasingly delivered by ICT applications. This led to the removal of CCCB cabling concepts within CENELEC EN 50173-4 [1].

Instead, the concept of distributed building services (DBS) cabling to serve purposes that are non-user specific (which includes IOT-SH and ICT services) was developed as specified in CENELEC EN 50173-6 [2].

EXAMPLE: CENELEC EN 50173-4 [1] specifies the distribution of outlets around the home for connection to user equipment such as personal computers and televisions whereas CENELEC EN 50173-6 [2] specifies the distribution of connection points, which are not user-specific, serving door access controls, environmental control etc. and for wireless access points (serving many other devices).

CENELEC EN 50173-6 [2] specifies the requirements for generic, structured, cabling for use in all premises to support distributed building services. These services cover a wide range of applications and include support for future developments for 1-pair applications in support of future IoT applications. As such they are integral to support Sustainable Digital Multi-Service ("Smart") City concepts.

The cabling specified in CENELEC EN 50173-6 [2] comprises balanced metallic implementations (although optical fibre implementations are supported by the standard). The balanced cabling solution is dominant because the services supported by cabling in accordance with CENELEC EN 50173-6 [2] are commonly also those supported by remote powering of the terminal devices.

The provision of power of up to 30 W per 4-pair balanced cable has been specified in conjunction with 10/100/1000BASE-T applications in IEEE 802.3 [18] since 2009. This approach is now being extended to 90 W per 4-pair balanced cable and will include 10GBASE-T as a supported application.

The emergence and further development of remote powered devices encourages the use of cabled infrastructure installations since:

- both existing residents and developers of new homes will recognize the benefits of being able to control and provide power to a wide range of equipment (for example, surveillance systems, door access control, environmental control system) that can be managed from a central location and via a common infrastructure;

- residents will see an increase in equipment without the need for external power supplies and with a common connection style (CENELEC EN 60603-7 series [i.5], also known as the RJ-45).

The requirements of the present document are based on those of CENELEC EN 50173-6 [2] but include additional requirements as specified in clause 6.2.1.

CENELEC EN 50173-6 [2] requires the application of CENELEC EN 50174-2 [3] (see clause 5.3).

5.2.3 CENELEC EN 50491-6-1

The CENELEC EN 50491 series of standards [i.4] is entitled "General requirements for Home and Building Electronic Systems (HBES) and Building Automation and Control Systems (BACS)" and contains requirements for HBES devices including CENELEC EN 50491-6-1 [4] covering planning and installation.

HBES is a generic term applicable to all telecommunication services within a home which are as IoT-SH, BCT and ICT and also as HBES Classes:

- CCCB (and associated IoT-SH) services are sometimes referred to as HBES Class 1;
- BCT services are sometimes referred to as HBES Class 3;
- ICT services are sometimes referred to as HBES Class 2.

CENELEC EN 50491-6-1 [4] requires the application of CENELEC EN 50174-2 [3] but contains additional planning guidance for specific groups of services and terminal devices.

5.3 Cabling planning and installation

5.3.1 CENELEC EN 50174 series

CENELEC EN 50174 series standards specify requirements for the planning and installation of installations of telecommunications cabling - independent of the cabling media involved. In relation to the present document, these media comprise metallic and optical fibre cabling including but not restricted to:

- balanced copper cabling in accordance with CENELEC EN 50173-4 [1] and CENELEC EN 50173-6 [2];
- other metallic cables in accordance with the CENELEC EN 50491 series [i.4] which are considered to be standards supporting application-specific implementations of IoT-SH cabling;
- coaxial cabling in accordance with CENELEC EN 50173-4 [1];
- all-silica multimode optical fibre cabling in accordance with CENELEC EN 50173-4 [1] and CENELEC EN 50173-6 [2];
- all-silica single mode optical fibre cabling in accordance with CENELEC EN 50173-4 [1], CENELEC EN 50173-6 [2] and ETSI TS 103 247 [i.11];
- plastic optical fibre cabling in accordance with ETSI TS 105 175-1 [i.12].

CENELEC EN 50174-1 [i.2] specifies requirements for the development of installation specification and quality plans to support the installations. CENELEC EN 50174-2 [3] specifies requirements for the installation planning and practices for telecommunications cabling inside buildings (and CENELEC EN 50174-3 [i.3] specifies such requirements outside buildings).

Within CENELEC EN 50174-2 [3], the general requirements for all premises are supplemented by specific requirements applicable to single-tenant homes. The requirements of clause 6.1.1 of the present document make reference to specific aspects of CENELEC EN 50174-2 [3].

5.4 Broadband Customer Premises Equipment (CPE)

5.4.1 General

A number of documents has been produced over the years, concerning guidelines, requirements, test methods for improving the energy and environmental efficiency of products and solution for broadband telecommunication services (leveraging on a type of Digital Subscriber Line (xDSL) and optical fibre technologies on the Wide Area Network (WAN) side and wired and wireless technologies for CPE connectivity on the Local Area Network (LAN) side).

5.4.2 Home Gateway Initiative deliverables

The HGI (Home Gateway Initiative) Forum, active since 2005 until 2016, produced a number of deliverables in the field of the energy efficiency optimization for Home Gateway (HG) equipment and CPE which have led to the development of EU Codes of Conduct of clause 5.4.3 and ETSI documents of clause 5.4.4.

5.4.3 EU Codes of Conduct

The following activities produced documents which are regularly updated:

- The EU Code of Conduct on Energy Consumption of Broadband Equipment [16].
- The EU Code of Conduct for Digital TV services [17].
- The EU Code of Conduct on Energy Efficiency of External Power Supplies [15].

5.4.4 ETSI ES 202 874-1 and associated TS documents

ETSI TC ATTM have produced a number of specifications related to functional requirements and implementation and operational aspects of external Common Power Supply (CPS) for CP network and access equipment as described below.

ETSI ES 202 874-1 [8]:

- defines functional requirements applicable to an external common power supply (CPS) converting and adapting AC mains to DC power for customer premises network equipment. It does not address other methods for providing power to end devices (e.g. Power Over Ethernet, power on USB, etc.);
- specifies operating conditions, energy efficiency and eco-design aspects for a number of types of power supplies, depending on market applicability and power needs of the targeted CPEs.

Additional TSs address the implementation aspects for each of the CPS types defined in ETSI ES 202 874-1 [8] including the choice of connectors as follows:

- CPS Type 1 (5 V, 2A): ETSI TS 102 874-3 [10];
- CPS Type 2.a (12 V, 1A): ETSI TS 102 874-2 [11];
- CPS Type 2.b (12 V, 2A): ETSI TS 102 874-4 [12];
- CPS Type 2.c (12 V, 5A): ETSI TS 102 874-5 [13];
- CPS Type 2.d (12 V, 3,2A): ETSI TS 102 874-6 [14].

5.4.5 ETSI EN standards for measurement methods

ETSI TC EE have produced ETSI EN documents that provide measurement methods for various network and CPE, to promote energy efficiency verification.

ETSI EN 301 575 [5] and ETSI EN 303 423 [6] take into account both the Commission Regulation (EU) No 801/2013 [i.9] and the EU Code of Conduct on Energy Consumption of Broadband Equipment [16].

5.4.6 ETSI EN standards for Life Cycle Assessment (LCA) methods

ETSI TC EE have produced ETSI ES 203 199 [9] detailing the application of the Life Cycle Assessment (LCA) in accordance with ISO 14040 [i.15] in order to evaluate the environmental impact of the ICT activities throughout the life cycle of products and services.

5.4.7 ETSI EN standards for End of Life (EoL) of Customer Premises Equipment (CPE)

ETSI TC ATTM has produced ETSI EN 305 174-8 [7] detailing the EoL management of CPE.

5.4.8 ITU-T standards for Universal Power Supplies

According to the trend set up by ETSI with the activities mentioned in the previous clause, ITU-T has produced a number of Recommendations as detailed in annex B.

6 Requirements for homes (single-tenant)

6.1 General engineering to support energy management

6.1.1 Design

6.1.1.1 Spaces

In the homes of new and refurbished buildings, adequate space shall be allocated to the Primary Home Distributor (PHD) and, where appropriate, any Secondary Home Distributors (SHDs). The dimension of the space shall be, as a minimum, in accordance with those specified in CENELEC EN 50174-2 [3] and shall be adequate to accommodate connections and associated equipment to support the potential cabling installation into the pathways of clause 6.2.1.2.

In the homes of existing buildings, the availability of space to accommodate the distributors and pathways specified in clause 6.2.1.2 will be restricted and this can encourage the use of wireless technologies despite their lower levels of energy efficiency (see clause 5.1) and energy management will be more dependent on the selection of equipment compliant with clause 6.4.

6.1.1.2 Pathways

In the homes of new and refurbished buildings, pathways should be designed and created in accordance with CENELEC EN 50174-2 [3] to support cabling in accordance with CENELEC EN 50173-4 [1] and CENELEC EN 50173-6 [2].

This requires the provision of an adequate number of dedicated routes (implemented using the cable management systems of CENELEC EN 50174-2 [3]) to:

- the Telecommunications Outlets (TOs) and Broadcast Outlets (BOs) within the rooms specified in CENELEC EN 50173-4 [1] and detailed in clause 6.2.1;
- the Service Consolidation Points (SCPs) and potential locations of Service Outlets (SOs) distributed throughout the home as specified in CENELEC EN 50173-6 [2] and detailed in clause 6.2.1.

The distribution of SOs shall at least support controls of lighting, energy management and load control (e.g. heating, cooling, lighting) and consumption monitoring (e.g. via connection to Smart meters, etc.).

6.1.2 Operation

The principal strategy to be adopted includes:

- the use of devices in accordance with the EU Code of Conduct on Energy Consumption of Broadband Equipment [16];
- the use of devices in accordance with the EU Code of Conduct for Digital TV services [17];
- the use of devices in accordance with the EU Code of Conduct on Energy Efficiency of External Power Supplies [15];
- the implementation and use of automatic transition to lower power or standby modes, whenever the higher operating modes are not used;
- the use of devices in accordance with the Energy Efficient Ethernet (EEE) requirements of IEEE 802.3 [18] defining power saving mechanisms for wired, customer-side Ethernet ports;

NOTE 1: This approach is only effective if the equipment serving the CP also meets the same requirements.

- the use of low consumption visual interfaces;
- the use of common visual interfaces (acting as displays for ICT and BCT services, independent of the type of application used to deliver the BCT service);
- not just using standby modes for attached devices (opting to turn them off instead).

NOTE 2: The use of equipment meeting the requirements of European Commission Regulation (EC) No 1275/2008 [i.8] will assist in observing this strategy.

6.2 General engineering to support interoperability

6.2.1 Cabling infrastructure

6.2.1.1 Requirements

For rooms that are not specifically excluded by local regulations, CENELEC EN 50173-4 [1] requires that:

- each room of up to 10 m², and each additional area of up to 10 m² in a larger room, shall be provided with a minimum of one TO for ICT applications and should be provided with a minimum of one BO for BCT applications;
- the TOs and BOs shall be installed in close proximity to single, or groups of, low voltage power supply interfaces;
- where multiple TOs or BOs are installed in a room they shall be spaced approximately evenly around the perimeter of the room.

For the purposes of energy management the entire area of the home shall be served by SCPs installed (typically above ceilings) on a 3,0 m × 3,0 m grid and SCP shall be served by at least two cables from the PHD (or SHD). This will allow the potential implementation of:

- utility metering (with the SO located where the service enters the home);
- metering and controlling energy consumption (with an SO located at each power distribution panel);
- lighting control (with at least one SO located in each room);
- environmental control (with at least one SO located in each room to monitor or control temperature).

The selection of cabling media shall be as follows:

- TOs, SCPs and SOs shall be implemented using the reference implementations of CENELEC EN 50173-4 [1] and CENELEC EN 50173-6 [2] by using Category 6_A components to deliver Class E_A links/channels of those standards.

NOTE 1: Class E_A performance is higher than the minimum requirement of CENELEC EN 50173-4 [1] but there is no value in differentiating between cabling interfaces for TOs and SOs.

NOTE 2: The use of optical fibre is supported by the referenced standard but should only be considered where the option for the provision of remote powered devices attached the TOs and SOs is confirmed to be unnecessary.

- BOs shall be implemented using the reference implementations of CENELEC EN 50173-4 [1] by using Category BCT-C components to deliver Class BCT-C links/channels of those standards.

6.2.1.2 Recommendations

For rooms other than those of clause 6.2.1.1, the distribution of TOs and BOs of clause 6.2.1.1 should be applied.

6.3 Energy performance of customer premises equipment (CPE)

6.3.1 General

The connection between the operators access network and the PHD as shown in annex A (or the equivalent in non-generic cabling) is provided by network access cabling and some type of network telecommunication equipment as shown in Figure 2.

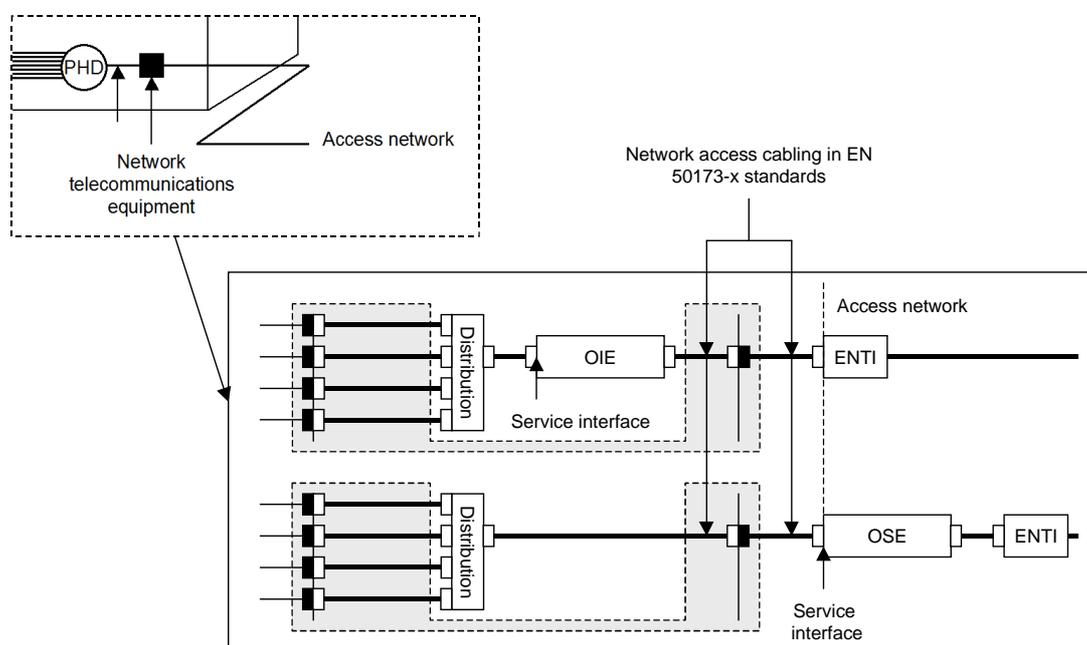


Figure 2: Network access cabling and equipment

The network telecommunications equipment typically comprises a passive External Network Test Interface (ENTTI) and an optional item of CPE. The CPE may be specific to the network operator, designated Operator-Specific Equipment (OSE), or may be independent of the network operator, designated Operator Independent Equipment (OIE), as described in the following examples:

- OIE: DSL modem, Fibre-To-The-Home (FTTH) modem (where interoperability standards exists).

NOTE: See ETSI TS 102 973 [i.10].

- OSE: CATV modem, FTTH modem (where no interoperability standard exists).

The OSE is part of the access network whereas the OIE is part of the customer premises infrastructure.

In some cases the OIE, or part of it, is powered from the access network. In some cases the OSE is powered from the CP.

For this reason, the energy efficiency of the access network takes into account any power required to maintain the functionality at the service interface, whether or not it is part of the access network (and is covered in ETSI TR 105 174-4 [i.27]).

The EU Code of Conduct on Energy Consumption of Broadband Equipment [16] provides a framework for ensuring operational energy efficiency consumption of NTE and CPE.

6.3.2 Categorization of Customer Premises Equipment (CPE)

The present document defines a system of CPE Categories (CATs) which takes account of how the CPE makes use of the energy to support their functionalities and distinguishes between equipment with continuous and non-continuous energy consumption needs.

The CPE Categories are as follows:

- CAT 1: "always-on" devices connected to the telecommunications network e.g. some OSE or OIE e.g. HG, modem, etc.;
- CAT 2: remotely managed auto-"power-down" devices connected to the telecommunications network e.g. set top box with wake up capabilities;
- CAT 3: unmanaged auto-"power-down" devices connected to the telecommunications network e.g. LAN-connected, Digital Video Disk (DVD) or audio player;
- CAT 4: other equipment connected to telecommunications or other legacy networks e.g. Internet Protocol (IP) telephone, Digital Enhanced Cordless Telecommunications (DECT) telephone connected to Public Switched Telephone Networks (PSTN);
- CAT 5: other "stand-alone" equipment not connected to any network powered by mains or battery (e.g. televisions (TV), music players, stand-alone Blue-Ray, DVD or audio players).

In terms of energy efficiency, the most critical equipment is of CAT 1, 2 and 3. Of these, CAT 1 and CAT 2 types of devices are deployed in the largest quantities, so that identifying improvements for these categories will produce the most beneficial global advantage.

For CAT 1 and CAT 2 it is possible to consider analysing the operational states and the consequent impact on energy consumption, in order to define requirements and design guidelines (see clause 6.5) aimed at optimizing the overall efficiency in the use phase while guaranteeing the necessary user experience.

NOTE: According to the EU Code of Conduct for Digital TV services [17], an OFF mode is not defined, but it may be implemented where a specific use of the ON/OFF button (example: pressing it for a time higher than 5 seconds) allow the complete switch off of the system:

- i) HiNA equipment: networked equipment with high network availability i.e. equipment with one or more of the following functionalities but no other, as the main function(s): router, network switch, wireless network access point, hub, modem, VoIP telephone, video phone;
- ii) LoNA equipment: networked equipment with low network availability i.e. edge devices such as TV's, imaging equipment, projectors, complex set top boxes which have network ports which can go to a lower power mode when they are not performing a main function. This power management function typically starts after a period of inactivity of several minutes.

Generally, HiNA equipment correspond to CAT 1 while LoNA equipment correspond to higher categories.

6.3.3 CAT 1 and CAT 2 Customer Premises Equipment (CPE)

6.3.3.1 CAT 1 operational states

The principal example for CAT 1 device is a HG.

This sub-clause contains the description of the operational states for a typical CPE. This description should be considered as valid for such products but also constitutes a guideline for defining the operational states of all the CAT 1 products.

The variety of CPEs and the associated differences in terms of their interfaces and configurations prevents the definition of valid operational states for some CAT 1 devices.

The combination of the operational states and the power management capabilities of a CPE can be an enabler of actions for energy efficiency improvements.

The operational modes below described correspond to the most common sets of states of the individual product subcomponents (main chip, other electronics, interfaces). Some of these also correspond to the states defined in the EU Code of Conduct on Energy Consumption of Broadband Equipment [16].

A typical CAT 1 device is considered to be a product equipped with:

- an ON/OFF button (optional) and, in some cases, an ON/OFF button for the Wi-Fi and LEDs;
- a Central Processor Unit (CPU) subsystem, memory and associated electronics;
- one or more WAN interfaces (metallic, optical fibre or wireless);
- one or more LAN interfaces: Ethernet switch (typically 4 ports), Wi-Fi and associated electronics;
- at least one USB port;
- telephone interfaces: Foreign eXchange Subscriber interface (FXS) for fixed telephone connections, DECT interface for wireless connection;
- a row of LEDs;
- internal power supply (converters and distribution of power on the main board);
- external power supply.

Three operational states can be identified based upon the activation/deactivation of some of these subcomponents (linked to the need for supporting services by the product) taking into account Commission Regulation (EC) No 278/2009 [i.6], Commission Regulation (EC) No 1275/2008 [i.8] and Commission Regulation (EU) No 801/2013 [i.9] as follows:

- **DISCONNECTED:** all connections to mains power sources of the CPE are physically removed or switched off at the mains outlet.
- **OFF:** the CPE is connected to the mains power source and is only providing an indication of ON/OFF-mode condition and functions associated with the ON/OFF switch and those ensuring electromagnetic compatibility (EMC directive 2004/108/EC [i.28]).
- **ACTIVE:** the CPE is connected to the mains power source and at least one of the main function(s) providing the intended service of the CPE has been activated.

NOTE 1: Standby is not applicable to the main functions of the CAT 1 devices, as they will be in active mode most of the time, but can be applied to some of their interfaces when not used (e.g. USB, FXS and FXO). In active mode, there will be a large number of sub-modes that are also considered to be active modes. They correspond to the possible combinations of active subcomponents. The "low-power state" and the "on state" defined in the EU Code of Conduct on Energy Consumption of Broadband Equipment [16] are also examples of active modes that enable a different level of service while implying different energy consumption.

NOTE 2: OFF mode can be simply achieved by integrating an ON/OFF switch into the CPE. However in certain cases it may not be desirable for the user to switch the CPE off e.g. when voice, utility services, security services or guest access are being provided. For example, some service providers may not want to have an ON/OFF button on their CPE.

The possible transitions among modes shown in Table 2.

Table 2: Services and applications

Operational modes transitions for CAT 1 CPEs	
From Disconnected to OFF	connect the CPE to the mains (i.e. connect the power supply to the mains and the CPE to the power supply)
From OFF to Active	switch the CPE on (should take less than 30 seconds to reach the active mode)
From Active to OFF	switch the CPE off
From Active to Disconnected	disconnect the CPE from the mains (e.g. by removing the power supply from the mains or by unplugging the power supply from the CPE)

The various subcomponents of the product can assume different energy states according to the actual level of operation. Each of them has a different capability to switch to different energy levels, and the combination of these capabilities produces the different operational states whose the previous classification is a simplified example (note that the active mode can have many sub-modes). Examples related to the various subsystems include the following:

- The CPU can work at different voltages and clock frequencies, and usually there are at least three different levels of power consumption, controlled automatically by a power management block specific for this subsystem as a function of the workload it is experiencing.
- The WAN interface (e.g. DSL, DOCSIS, optical fibre and wireless) can work at different energy levels, either triggered by the whole system (the product) or negotiated with the network. They are defined by the various DSL standards.
- The LAN Ethernet interface can also enter a low power mode (i.e. EEE) depending on the amount of traffic managed by the switch.

Reductions in energy consumption provided by EEE can only be achieved when both ends of each LAN link support the EEE protocol. All LAN-based equipment is required to support EEE to enable relevant energy efficiency improvements.

- The Wi-Fi interface has typically at least four states: off, beacon only (announcing the access point or client presence, but without traffic), low traffic and full traffic. In case of MIMO solutions, in addition, there are specific power saves modes allowing to use a subset of the antennas available for the traffic management.
- FXS ports are usually in ON Hook state, which is corresponding to a minimum amount of energy consumption, then they make the transition to active states when used for calls.
- CPE contains multiple ports/functionalities. Often, although physically present, some are not enabled depending on the services subscribed or on the firmware of the CPE (e.g. an FXS port where no VoIP service is subscribed or a USB port not enabled by the firmware). Such ports will then be disabled within the CPE, tending to their minimum energy consumption impact.

Similar concepts can be applied to the DECT interface power management (a number of solutions for ECO modes are available) and USB interfaces.

The CPE can enter the different operational states either manually (e.g. manual activation of the ON/OFF switch by the user) or automatically via triggers typically based on:

- stimulus from the user, network or from other connected equipment;
- traffic thresholds; or
- remote management system intervention (e.g. to activate a service or an interface).

If available, a time-based schedule is also possible as a sort of hybrid solution, because it is an automatic trigger based on a programmed task typically defined by the user via web interface.

6.3.3.2 Energy consumption of CAT 1 Customer Premises Equipment

CAT 1 CPE shall comply with the EU Code of Conduct on Energy Consumption of Broadband Equipment [16].

The relevant energy consumption shall be measured according to ETSI EN 301 575 [5] or ETSI EN 303 423 [6] as appropriate.

NOTE: Energy consumption of CAT 1 CPE is addressed by Commission Regulation (EC) No 801/2013 [i.9].

6.3.3.3 CAT 2 operational states

The principal example for CAT 2 device is a set top box for multimedia service use.

This kind of product is typically connected to the network, via modem, for connection to the Video on Demand or streaming server platforms, but its mode of use does not require a full operation like a modem, because there are long inactivity periods during which the equipment does not perform any operation, if not keeping track of a registration schedule or, if implemented, being able of getting a connection request from the remote management system.

This clause contains the description of the operational states for a set top box according to the EU Code of Conduct for Digital TV services [17] as follows:

- **USER-Auto Power Down (APD) STANDBY:** a state entered automatically switching from the On/Active mode after a period of time without user input in the ON/ACTIVE mode. Before switching to APD STANDBY a graphical user interface may prompt the user to confirm that the CPE is still in use; in such case the transition takes place only if the user provides no response within a (further) timeout.
- **SYSTEM-APD STANDBY:** a state entered automatically switching from the On/Active mode after a period of time without user input in the ON/ACTIVE mode. No user intervention is provided. The EU Code of Conduct for Digital TV services [17] also defines a default value for the timer. In terms of energy consumption levels the two APD-STANDBY modes are identical.
- **ON/ACTIVE:** the CPE is actively delivering at least one of the functionalities it implements, not necessarily limited to the base functionality defined below. For example, a hybrid set top box providing IPTV and Digital Terrestrial Television (DTT) could be considered in an ON/ACTIVE mode when either or both IPTV or DTT functionality is operational.
- **USER-INITIATED STANDBY** (Headed equipment as defined in the EU Code of Conduct for Digital TV services [17]): a state entered when the CPE is switched when the user presses the standby button on the remote control or, if applicable, the standby switch on the front panel of the CPE. In this mode the CPE shall at least be able to be reactivated by using the remote control.

NOTE: According to the EU Code of Conduct for Digital TV services [17], an OFF mode is not defined, but it may be implemented where a specific use of the ON/OFF button (example: pressing it for a time higher than 5 seconds) allow the complete switch off of the system.

CAT 2 CPE supports a base functionality which typically includes the reception of digital TV signals from one or more cable, satellite, IP or terrestrial distribution systems with Conditional Access to allow audio video content descrambling and local consumption.

However, as for CAT 1 CPE, CAT 2 CPE may support additional functions which increases energy consumption. The overall optimization of the energy efficiency of the CAT 2 product is then achieved by playing with the activation/deactivation of the additional functions at the appropriate time.

The most common additional functionalities for a set top box are, amongst others:

- **Advanced Video Processing:** a set of advanced methods for video encoding, transcoding or decoding, giving compression efficiency significantly beyond MPEG-2 (e.g.H.264/AVC).
- **High Efficiency Video Processing:** high efficiency methods for video encoding, transcoding or decoding, giving compression efficiency significantly beyond H.264/AVC (for example HEVC).

- High Definition (HD) Resolution: video decoding & outputting capability with resolutions greater than or equal to 720p (1 280 pixels x 720 lines at 50 frames/s progressive) or 1 080i (1 920 pixels x 1 080 lines at 25 frames/s interlaced).
- Full High Definition Processing: video decoding & outputting capability with resolutions greater than or equal to 1 080p (1 920 pixels x 1 080 lines at 50 frames/s progressive).
- Ultra-High Definition Processing: video decoding & outputting capability with resolutions greater or equal to 4K x 2K (3 840 pixels x 2 160 lines at 50 frames/s progressive).
- Multi Display: provision of independent content streams to multiple locations within the home.
- Home Network Interface: a IEEE 802.3 wired Ethernet Network interface port.
- Digital Video Recording (DVR): storing digital video, and possibly other media, to a rewritable disk drive or other non-volatile storage media local to the unit. Functionalities offered by DVR are not limited to recording, e.g. they could 'live pause'. Server-based DVR capabilities are excluded from this definition.
- Speculative Recording: Automated recording based on customer profiling.

6.3.3.4 Energy consumption of CAT 2 Customer Premises Equipment

CAT 2 CPE shall comply, as relevant, with:

- the EU Code of Conduct on Energy Consumption of Broadband Equipment [16];
- the EU Code of Conduct for Digital TV services [17].

NOTE: Energy consumption of CAT 2 CPE is addressed by Commission Regulation (EC) No 801/2013 [i.9].

6.3.4 Power supplies

6.3.4.1 General

The power supply has a significant influence on the energy consumption of the CPE.

NOTE 1: Power supplies such as the AC/DC converters of CPEs are typically responsible of 10 % to 20 % of the overall consumption of the equipment.

Power supply circuitry exhibits a range of energy efficiency behaviour.

The majority of the CPE is provided with an external power supply, normally developed by OEM companies. CPE designers shall consider the energy efficiency characteristics when sourcing external power supplies for their equipment.

NOTE 2: The Eco-standby and Ecodesign Regulations ([i.7], [i.8] and [i.9]) and associated technology developments lead CPEs to dynamically minimize their consumption when all or part of its functions are not in use. As many of the CPE functions are little or not used the energy consumption of the CPE tends to be variable and trends to its minimum consumption. As the power supplies are selected so to satisfy the maximum consumption, plus an industrial and safety margin, it is increasingly common that they mostly operate in the lower load range, typically between 10 % and 40 % of the rated consumption.

Power supplies such as the AC/DC converters are typically responsible of 10 % to 20 % of overall CPE consumption of the equipment and their efficiency tends to reduce when the load is lower which can limit the benefits achievable by the Regulations. It is therefore important that power supplies are designed to optimize their efficiency in the lower range (10 % to 50 %) and, possibly, are optimized so to maximize efficiency in that range.

6.3.4.2 Energy consumption of external power supplies

External power supplies shall comply with ETSI ES 202 874-1 [8] and the EU Code of Conduct on Energy Efficiency of External Power Supplies [15].

NOTE: External power supplies used in CPEs are addressed by Commission Regulation (EC) No 278/2009 [i.6].

6.4 Managing EoL of Customer Premises Equipment

Management of the EoL aspects of CPE shall comply with ETSI EN 305 174-8 [7].

6.5 Eco-design aspects

Appropriate eco-design rules shall be applied:

- taking into account of the functional and end user requirements;
- having considered the LCA of the CPE in accordance with ETSI ES 203 199 [9];
- to support the EoL management processes specified in ETSI EN 305 174-8 [7].

For example:

- if multiple choices exist for a material selection which provide the required function and durability for the intended life the CPE then the selection shall be influenced by the material with the best recycling characteristics;
- if a CPE is designed without considering how the product could be disassembled at the end of its life to allow easy separation between electronics and plastic parts, the recycling process will be unnecessarily complicated and costly;
- if a plastic blend is adopted instead of a single polymer, the possibilities of feeding a sustainable recycling process for the single material will be substantially limited.

The following non-exhaustive list of objectives shall be considered during the design phase of a CPE as a first step to guarantee that EoL procedures will be identified with a good degree of flexibility and easily sustainable from the point of view of the ratio between environmental advantage and costs:

- The minimum number of different materials shall be used, be as thermally stable as possible and not mixed between each other. The materials shall not contain additives, such as some types of plastics, they shall be stable and not toxic. More specifically, for plastic parts, the use of a unique material instead of "blends" is preferable.
- Device parts shall be made of "recyclable" materials, i.e. reusable to manufacture new devices of the same type or any other object to be used for completely different applications, even not related to the telecommunications field.
- The use of varnished plastic surfaces or metallic pastes shall be reduced to a minimum extent in order to avoid mixing different materials which would be difficult to separate.
- The CPE case plastic material shall be highly recyclable, e.g. acrylonitrile butadiene styrene (alone or with polycarbonate).
- The CPE case plastic material should contain a significant percentage of recycled material.
- CPE case materials shall be halogen-free.
- The package of the product shall be manufactured using one material only. The possible usage of plastic strips for protection of specific parts is acceptable but shall be minimized.

Annex A (informative): Generic cabling designs of CENELEC EN 50173-4 and CENELEC EN 50173-6

A.1 CENELEC EN 50173-4

CENELEC EN 50173-4 [1] specifies two layers of infrastructure - one for ICT applications and the other for BCT applications. Both layers are fed from a PHD (or one or more SHDs where required by the dimensions, configuration or complexity of the home). The PHD is connected to external services via an External Network Interface (ENI) to network access cabling of various types (as shown in Figure A.1).

NOTE: CENELEC EN 50173-4:2018 [1] is technically equivalent to ISO/IEC 11801-4 [i.16] (which replaces ISO/IEC 15018 [i.26]).

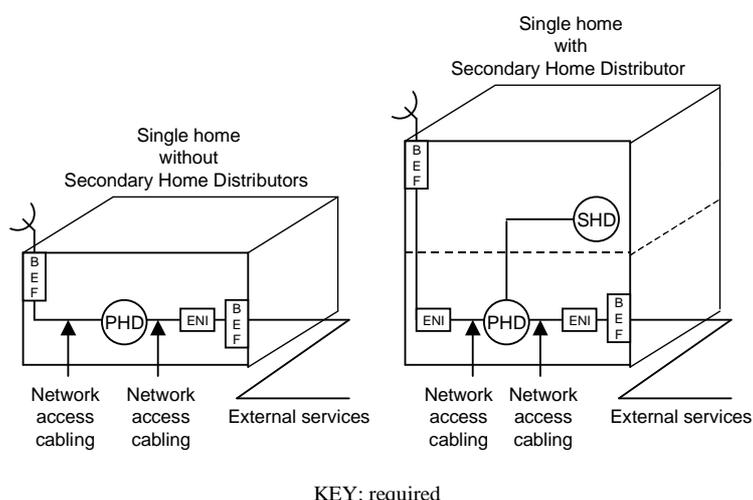


Figure A.1: Examples of generic cabling within the home according to CENELEC EN 50173-4 [1]

The provision of ICT and BCT services is achieved by the connection of:

- terminal equipment (e.g. telephones, computers and television receivers) at the Telecommunications Outlet (TO) and Broadcast Outlet (BO) respectively - both of which adopt a point-to-point star topology to the relevant distributor;
- the relevant system equipment at the HD/SHD.

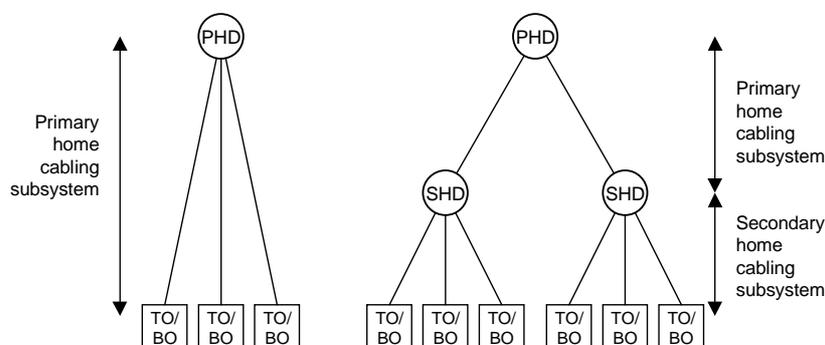


Figure A.2: BCT/ICT cabling topologies of CENELEC EN 50173-4 [1]

A.2 CENELEC EN 50173-6

Generic cabling in accordance with CENELEC EN 50173-6 [2] (which is technically equivalent to ISO/IEC 11801-6 [i.17]) is, for the present document, an overlay where the Service Distributor (SD) is co-located with the PHD or SHD of CENELEC EN 50173-4 [1] (see Figure A.3).

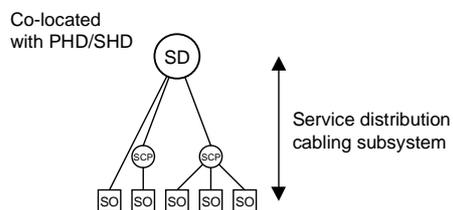


Figure A.3: Distributed building services cabling topologies of CENLEC EN 50173-6 [2]

Annex B (informative): ITU-T standards for Universal Power Supplies

Recommendation ITU-T L.1000 [i.19] defining high level requirements for a universal power adapter and charger solution that will reduce the number of power adapters and chargers produced and recycled by widening their application to more devices and increasing their lifetime. The solution also aims to reduce energy consumption. The universal power adapter and charger solution is designed to serve the vast majority of mobile terminals and other ICT devices.

Recommendation ITU-T L.1001 [i.20] defining requirements for a universal power adapter solution for "stationary" ICT devices that will reduce the number of power adapters that are produced by widening their application by more devices, thus enabling their reuse and increasing their life expectancy. The solution also aims to reduce energy consumption. The universal power adapter solution for stationary ICT equipment is designed to serve the vast majority of ICT devices.

Recommendation ITU-T L.1002 [i.21] defining the requirements, and provides guidelines on the environmental aspects, of universal power adapter solutions (UPA) designed for use with portable information and communication technology (ICT) devices. It is complementary to Recommendations ITU-T L.1000 [i.19] and ITU-T L.1001 [i.20] and aims to cover the widest possible range of ICT devices for portable use within identified voltage and power ranges. It firstly describes basic configurations of UPAs, consisting of a power adapter block with a detachable input cable and a detachable output cable to the ICT device. Then, it defines different general recommendations for UPAs and their interfaces, including cables, connectors, voltage, current, ripple noise, energy efficiency, no-load power, safety, electromagnetic compatibility, resistibility and eco-environmental specifications. All the recommendations have been set with the aim to reduce e-waste and increase usability.

Recommendation ITU-T L.1005 [i.22] defining specific test suites to assess certain functional aspects of the energy efficiency, interworking, safety and electromagnetic compatibility (EMC) of the universal charger solution (UCS). Such testing is required to guarantee a minimum quality level of the UCS in conformance with the target basic configuration of the UCS and charger described in Recommendation ITU-T L.1000 [i.19].

Recommendation ITU-T L.1006 [i.23] defining the general test suites applicable to the universal power adapter solution (UPA) designed for ICT devices for stationary (non-portable) use defined in Recommendation ITU-T L.1001 [i.20]. It considers the creation of specific test suites to assess certain functional aspects of the energy efficiency, interworking, safety and electromagnetic compatibility (EMC) of universal power adapter solution (UPA) designed for ICT devices for stationary (non portable) use. Such testing is required to guarantee a minimum quality level of the universal charging solution (UCS) in conformance with the target basic configuration of UPA described in Recommendation ITU-T L.1001 [i.20]. With regard to electromagnetic compatibility (EMC) and safety aspects, additional requirements to those listed in Recommendation ITU-T L.1001 [i.20] are necessary for a product to be available for use by the general public.

Annex C (informative): Bibliography

- Home Gateway Initiative HGI-RD009-R3: "Requirements for an energy efficient home gateway".
- Home Gateway Initiative HGI-RD015-R3: "Energy Efficiency and Ecodesign requirements for a common power supply (CPS) for home gateway, home networking equipment and end devices".
- IEA report: "Beyond network standby".
- IEA report: "More data less energy".

History

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