Final draft ETSI ES 205 200-2-2 V1.0.0 (2016-01)

Access, Terminals, Transmission and Multiplexing (ATTM); Energy management; Global KPIs; Operational infrastructures; Part 2: Specific requirements; Sub-part 2: Fixed broadband access networks

Reference
DES/ATTM-02026

Keywords
broadband, energy efficiency

ETSI

650 Route des Lucioles
F-06921 Sophia Antipolis Cedex - FRANCE

Tel.: +33 4 92 94 42 00 Fax: +33 4 93 65 47 16

Siret N° 348 623 562 00017 - NAF 742 C
Association à but non lucratif enregistrée à la
Sous-Préfecture de Grasse (06) N° 7803/88

Important notice

The present document can be downloaded from:
http://www.etsi.org/standards-search

The present document may be made available in electronic versions and/or in print. The content of any electronic and/or print versions of the present document shall not be modified without the prior written authorization of ETSI. In case of any existing or perceived difference in contents between such versions and/or in print, the only prevailing document is the print of the Portable Document Format (PDF) version kept on a specific network drive within ETSI Secretariat.

Users of the present document should be aware that the document may be subject to revision or change of status.
Information on the current status of this and other ETSI documents is available at
http://portal.etsi.org/tb/status/status.asp

If you find errors in the present document, please send your comment to one of the following services:
https://portal.etsi.org/People/CommiteeSupportStaff.aspx

Copyright Notification

Contents

Intellectual Property Rights

IPRs essential or potentially essential to the present document may have been declared to ETSI. The information pertaining to these essential IPRs, if any, is publicly available for **ETSI members and non-members**, and can be found in ETSI SR 000 314: *"Intellectual Property Rights (IPRs); Essential, or potentially Essential, IPRs notified to ETSI in respect of ETSI standards"*, which is available from the ETSI Secretariat. Latest updates are available on the ETSI Web server (https://ipr.etsi.org/).

Pursuant to the ETSI IPR Policy, no investigation, including IPR searches, has been carried out by ETSI. No guarantee can be given as to the existence of other IPRs not referenced in ETSI SR 000 314 (or the updates on the ETSI Web server) which are, or may be, or may become, essential to the present document.

Foreword

This final draft ETSI Standard (ES) has been produced by ETSI Technical Committee Access, Terminals, Transmission and Multiplexing (ATTM), and is now submitted for the ETSI standards Membership Approval Procedure.

The present document is part 2, sub-part 2 of a multi-part deliverable covering operational energy management and sustainability of broadband deployment, as identified below:

Part 1: "General requirements".

Part 2: "Specific requirements":

Sub-part 1: "Data centres";

Sub-part 2: "Fixed broadband access networks";

Sub-part 3: "Mobile access networks";

Sub-part 4: "Cable Access Networks".

Part 3: "Global KPIs of ICT Sites";

Part 4: "Monitoring of sustainability".

NOTE 1: Additional documents are in development by ETSI Technical Committee Access, Terminals, Transmission and Multiplexing (ATTM) which include:

- ETSI ES 205 200-1-1: "Energy management: Global KPIs: Operational infrastructures: Guidance" (see NWIP DES/ATTM-02025).
- ETSI ES 205 200-3: "Monitoring of other environmental viability aspects of sustainability" (see NWIP DES/ATTM-02027).

NOTE 2: A further document is under consideration ETSI Technical Committee CABLE to address "cable access networks".

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).

"**must**" and "**must not**" are **NOT** allowed in ETSI deliverables except when used in direct citation.

Introduction

Energy costs continue to increase, a trend that will continue in the future, while broadband penetration is introducing new active equipment to the network architecture. In this context, and to reflect other environmental aspects of sustainability, it is vital that the main telecommunication actors implement effective general engineering of fixed and mobile broadband networks and sites provisioning, managing or using those networks (i.e. operator sites, operator data centres and customer data centres) in order to respond to critical issues of energy consumption while proposing essential solutions to true broadband deployment. To guide this process, it is essential that metrics are defined, termed Global Key Performance Indicators (KPI_{EM}), that enable energy usage to be managed more effectively.

The ETSI ES 205 200 series of standards comprises:

- ETSI ES 205 200-1 [1]: a generic requirements document addressing Global KPIs for operational infrastructures;

NOTE: Global KPIs do not address design/operation of components or subsystems of broadband deployment networks.

- a sub-series ETSI ES 205 200-2 that defines the Global KPIs, and drives energy management targets, for specific operational networks and sites and which describes how the Global KPIs are to be applied (which may be used to support future regulatory objectives):
  - ETSI ES 205 200-2-1 [i.14]: Data centres;
  - ETSI ES 205 200-2-2 (the present document): Broadband access networks;
  - ETSI ES 205 200-2-3 [i.15]: Mobile access networks;
  - ETSI ES 205 200-2-4 [i.16]: Cable Access Networks.

  These documents do not define KPI limits or targets (which is outside the scope of the ETSI ES 205 200 series of standards).

These documents will accelerate:

- availability of operational infrastructure architectures and network implementations that use energy more efficiently;
- the definition and attainment of sustainability objectives for operational broadband networks.

Within the present document:

- clause 4 explains the definition of a Broadband access network in terms of the systems it comprises and the boundaries that apply;
- clause 5 describes how the Objective KPIs of the present document meet the requirements of ETSI ES 205 200-1 [1];
- clause 6 describes the specific requirements of the Global KPI and the supporting Objective KPIs for mobile access networks;
- Annex A discusses the roles of different types of Key Performance Indicators i.e. Technical, Objective and Global in relation to the overall energy management concepts of the present document.

1 Scope

The present document specifies Global Key Performance Indicators (KPI_{EM}) in relation to energy management of fixed broadband access networks, e.g. DSLAM, OLT and MSAN depending on the transmission technology and the media. It does not take into account the ONU but it can include the MDU in case of FTTB configurations. The present document addresses the following objectives:

- energy consumption;
- task efficiency;
- energy re-use;
- renewable energy.

The definition of the Global KPIs (clause 6) are in accordance with requirements of ETSI ES 205 200-1 [1] (as described in clause 5) in relation to:

- infrastructure scalability;
- infrastructure evolution;
- formulae and definitions of terms;
- measurement points and procedures.

The present document also provides information on system definition and boundaries (clause 4) and on existing Technical KPIs (within informative annexes).

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.

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

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 necessary for the application of the present document.

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

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 reference 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] EC Mandate M/462: "Standardisation mandate addressed to CEN, CENELEC and ETSI in the field of Information and Communication Technologies".

[i.2] ETSI ES 203 215 (V1.3.1): "Environmental Engineering (EE); Measurement Methods and Limits for Power Consumption in Broadband Telecommunication Networks Equipment".

[i.3] ISO Guide 82: "Guide for addressing sustainability in standards".

[i.4] European Commission DG JRC Code of Conduct on Energy Consumption of Broadband Equipment.

[i.5] Recommendation ITU-T G.992.3: "Asymmetric digital subscriber line (ADSL) transceivers".

[i.6] Recommendation ITU-T G.993.2: "Very high speed digital subscriber line transceivers 2 (VDSL2)".

[i.7] Recommendation ITU-T G.992.5: "Asymmetric digital subscriber line 2 transceivers (ADSL2) - Extended bandwidth ADSL2 (ADSL2plus)".

[i.8] Recommendation ITU-T G.986: "Series describing Gigabit Point to Point transmission".

[i.9] Recommendation ITU-T G.984: "Series describing Gigabit-capable passive optical networks (GPON)".

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

[i.11] Recommendation ITU-T G.989: "Series describing 40 Gigabit-capable passive optical networks (NG-PON2)".

[i.12] Recommendation ITU-T G.991.1: "High bit rate digital subscriber line (HDSL) transceivers".

[i.13] Recommendation ITU-T G.991.2: "Single-pair high-speed digital subscriber line (SHDSL) transceivers".

[i.14] ETSI ES 205 200-2-1: "Access, Terminals, Transmission and Multiplexing (ATTM); Energy management; Global KPIs; Operational infrastructures; Part 2: Specific requirements; Sub-part 1: Data centres".

[i.15] ETSI ES 205 200-2-3: "Access, Terminals, Transmission and Multiplexing (ATTM); Energy management; Global KPIs; Operational infrastructures; Part 2: Specific requirements; Sub-part 3: Mobile access networks".

[i.16] ETSI ES 205 200-2-4: "Integrated broadband cable telecommunication networks (CABLE); Energy management; Global KPIs; Operational infrastructures; Part 2: Specific requirements; Sub-part 4: Cable Access Networks".

3 Definitions, symbols and abbreviations

3.1 Definitions

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

energy consumption: total electrical consumption of 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

fixed access network: functional elements that enable wired (including optical fibre) communications to customer equipment

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

Network Telecommunications Equipment (NTE): equipment dedicated to providing direct connection to core and/or access networks

objective KPI: KPI assessing one of the objectives of operational energy performance which is subsequently used to define a Global KPI for energy management (KPI_{EM})

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) and/or network telecommunications equipment (NTE) together with the power supply and environmental control systems necessary to ensure provision of service

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

3.2 Symbols

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

Δt	the maximum time variation between measurement points of the different Objective Key Performance Indicators within a given Global Key Performance Indicator
KPI_{EM}	Global Key Performance Indicator of energy management
KPI_{EC}	Objective Key Performance Indicator of energy consumption
KPI_{TE}	Objective Key Performance Indicator of task efficiency
KPI_{REN}	Objective Key Performance Indicator of renewable energy usage
KPI_{REUSE}	Objective Key Performance Indicator of energy re-use
P	projection factor applied to sample results used in calculation of m to KPI_{EM}
T_{KPI}	period of time over which Objective KPIs are assessed
T_{REPEAT}	the minimum time between which the Objective KPIs can be assessed to determine relevant trend information
W_{EC}	weighting factor applied to KPI_{EC}
W_{TE}	weighting factor applied to KPI_{TE}
W_{REN}	weighting factor applied to KPI_{REN}
W_{REUSE}	weighting factor applied to KPI_{REUSE}

3.3 Abbreviations

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

ADSL	Asymmetric Digital Subscriber Line
BB CoC	Broadband Code of Conduct
CO	Central Office
DSL	Digital Subscriber Line
DSLAM	Digital Subscriber Line Access Multiplexer
EC DG JRC	European Commission Directorate General Joint Research Centre
EE	Energy Efficiency
EU	European Union
FAN	Fixed Access Node (please, it is different to fan)
FTTB	Fibre To The Building
FTTH	Fibre To The Home
GPON	Gigabit Passive Optical Network
HDSL	High-bit-rate Digital Subscriber Line
ICT	Information and Communication(s) Technology
ISO	International Organization for Standardization
ITU-T	International Telecommunication Union-Telecommunication
KPI	Key Performance Indicator
LON	Last Operator Node
LPM	Low Power Mode
LT	Line Terminal
LTE	Long Term Evolution

MDU Multi Dwelling Unit

NOTE: Collective ONU used in FTTB architecture.

MSAN Multi Service Access Node
NT Network Termination
NTE Network Telecommunications Equipment
ODN Optical Distribution Network

NOTE: Provides fibre connectivity between OLT & ONU.

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.

SHDSL Single-pair High-speed Digital Subscriber Line
TE Task Efficiency

NOTE: In the rest of the present document.

TE Terminal Equipment

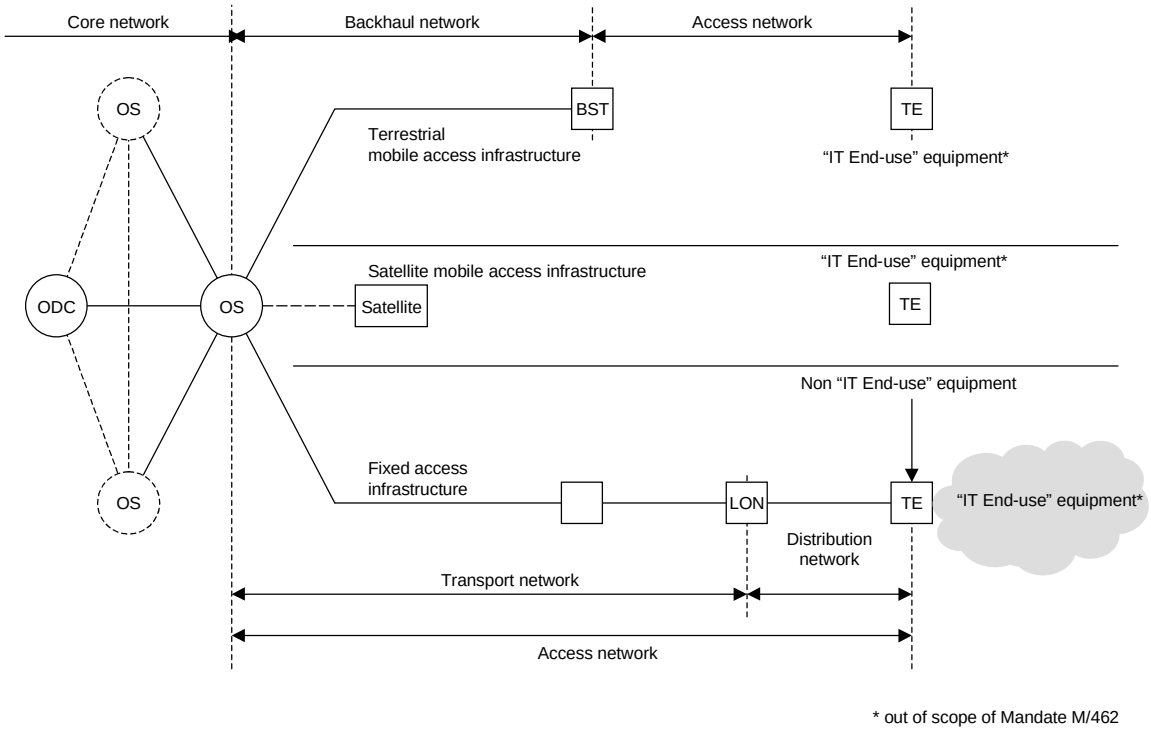
NOTE: In architecture figures.

VDSL Very High Speed Digital Subscriber Line

4 System definition and boundaries

4.1 Fixed access networks

Figure 1 shows the schematic of the operational infrastructures of broadband deployment as contained with the ESO response to the EC Mandate M/462 [i.1].



NOTE: Not all the terms and abbreviations of this Figure are included in clause 3 of the present document.

Figure 1: Schematic of core network together with fixed and mobile access infrastructures

The present document considers:

- Figure 1 to be an effective basis for establishment of KPI_{EM} and is consistent with the Optical Access Networks Architectures defined in Recommendation ITU-T G.992.5 [i.7], Recommendation ITU-T G.984 [i.9], Recommendation ITU-T G.987 [i.10] and Recommendation ITU-T G.989 [i.11]);
- the term OS shown in Figure 1 represents the operator sites containing the fixed broadband access nodes, under the generic name of FAN. It may be based on MSAN, DSLAM and OLT according to the access technology.

For the purposes of energy management, the fixed broadband access network comprises all sites/elements between the operator sites (OS) included and the LON (not included), as shown in Figure 1. Thus:

- There can be a simple FAN without other nodes in remote and the FAN will be in the OS.
- Or, there can be a Master in a CO (here the OS) and several Slave in remote CO.

An OS, master or remote, will be able to be either indoor site or outdoor site (in the street cabinet, for instance).

4.2 Topography

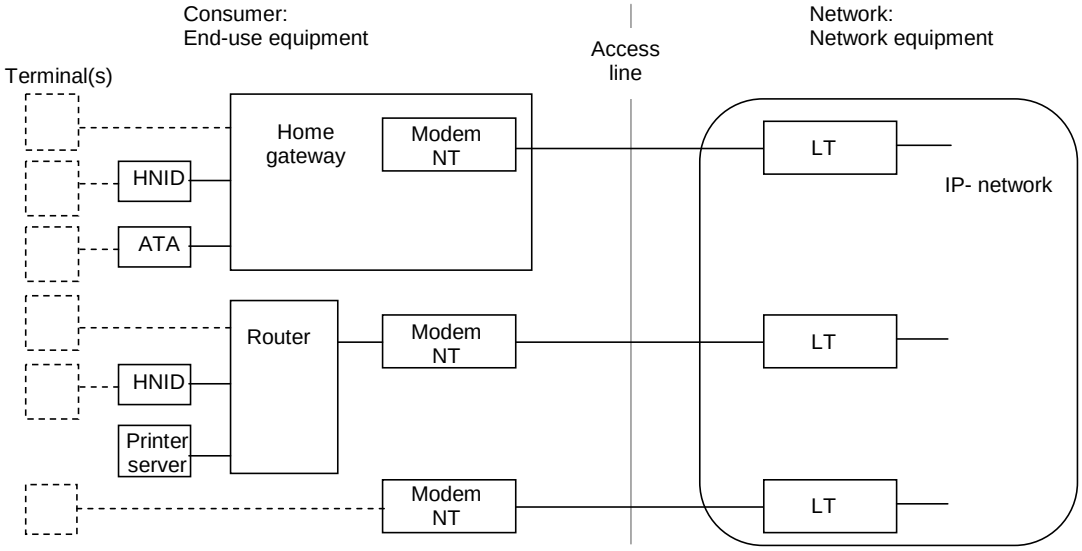
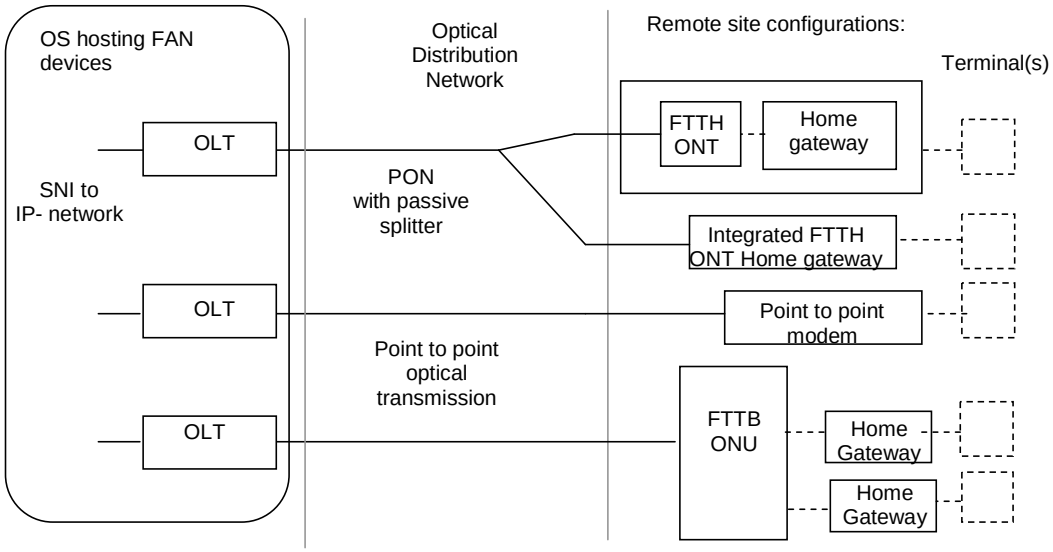
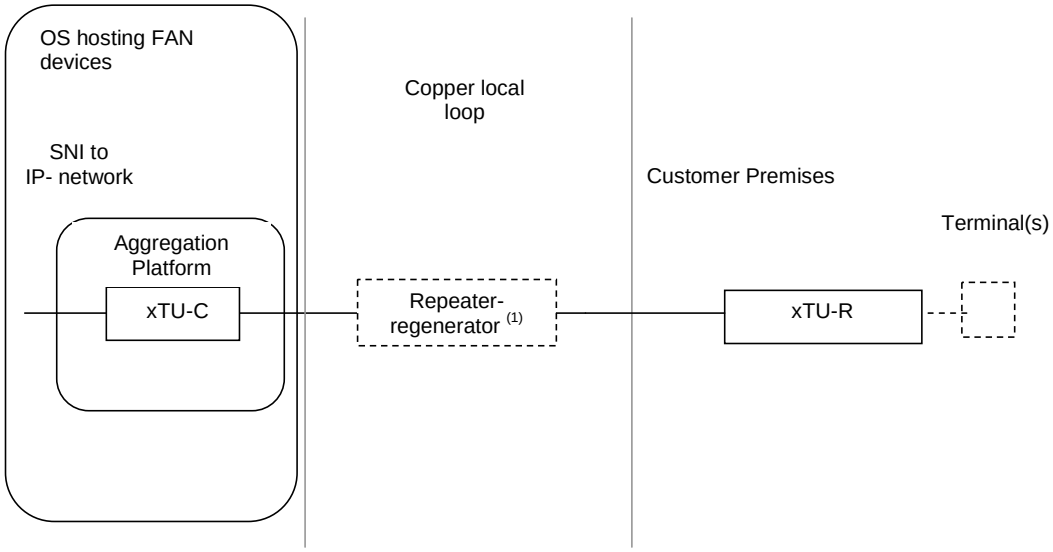


Figure 2: On the right, location of the FAN

Figure 2 describes the different possibilities of connexions between the fixed network equipment (for instance, the MSAN) and the customer (represented by the terminal in the Figure 2).



3a: Example of Optical access network configurations



3b: Example of DSL access network configurations

Figure 3: Example of Fixed Access Networks

The first part of Figure 3 present an example of Optical access network configurations, it proposes PON solution with passive splitter or Point to point optical transmission. Figure 3b is an example of the configuration for DSL technologies, for A/VDSL but also for SHDSL [i.13] (Repeater-Regenerators are mainly used on HDSL [i.12] and SHDSL links).

5 Mapping to the objectives of ETSI ES 205 200-1

5.1 Energy consumption

A reduction in the energy consumption required to provide a given level of service is a primary objective of the present document.

The KPI for energy consumption (KPI_{EC}) applies to an OS (which may contain a single fixed broadband access node or a group of FAN in a same site). A site can be either an indoor or outdoor (that is a street cabinet).

The KPI_{EC} is improved by actions including the following:

- reduction of number of FAN installed for a given coverage (a number of end users, for a given service data rate);
- swap from an old FAN to a new equipment with a better Energy Efficiency;
- reduction of the energy consumption of one or more FAN:
  - static power reduction of FAN (for instance, L3 mode, flat power management or the unused port switch-off), dynamic power reduction of FAN (Low Power mode on ADSL or sleep modes on GPON).

Requirements or recommendations in relation to the reduction of the energy consumption within the fixed access network are not within the scope of the present document.

Objectives for reduction of energy consumption in the FAN are included in BroadBand Code of Conduct V5 (BB CoC V5) [i.4] and the future versions. They give some target values for the main levels of a port (L0, L3 and Low Power Modes (LPM) modes) for ADSL [i.5], VDSL [i.6], point to point and PON [i.8] and [i.11] technologies.

5.2 Task efficiency

An improvement in task efficiency is a primary objective of the present document.

The KPI_{TE}, while maintaining acceptable coverage and traffic capacity at all times, is improved by actions including:

- re-engineering of fixed access networks to optimize the number of FAN (that includes the swap of an old node towards a new node);
- optimization of operational processes;
- automation of network management including energy efficiency constraints.
- optimization of the FANs with possible sustainable features.

The KPI_{TE} applies to an OS which can include a single broadband fixed access node or a group of FAN in a same site.

Such a site can be either an indoor or outdoor (in a street cabinet). This distinction will be taken into account in the KPI_{TE}, during it measurement (see clause 6.3.1.3 and clause 6.3.1.4).

Moreover, in a OS including one or a group of FAN, an improvement of the KPI for task efficiency (KPI_{TE}) reflects a reduction of the overall energy consumption required to both power a given NTE load and to support (e.g. cool) the equipment associated with that load over a given period of time.

5.3 Energy re-use

KPI_{REUSE} is a secondary objective in the present document since:

- in general, fixed access network sites are geographically scattered what limits the possibility for merging any heat generated at each site;
- however, in certain circumstances, local renewable energy sources may produce more energy than that required by a fixed access network site, allowing its reuse for other purposes.

Thus, it can be considered that:

- "non-use" is better than "re-use" and therefore the application of KPI_{REUSE} within KPI_{EM} will reflect a preference for energy consumption reduction rather than re-use;
- any KPI_{REUSE} shall reflect a preference for re-use of energy in the form of heat generated from by NTE rather than from poorly designed facilities and infrastructures.

The KPI_{REUSE} applies to an OS, which may be a single broadband fixed access node or a group of FAN in a same site. A site can be either an indoor or outdoor (in the street cabinet).

5.4 Renewable energy

The use of renewable energy is a secondary objective of the present document.

The energy provided to FAN comes from either utility (grid) or local sources (non-renewable or renewable).

FAN may meet all their energy needs from local, renewable (like solar or wind energy) sources on a continuous basis.

The scope of the KPI for renewable energy use (KPI_{REN}) only takes locally generated renewable energy into account.

NOTE: This does not, as yet, take into consideration any proportion of utility supplies certified as "green" by nationally recognised schemes or the carbon footprint of the energy source.

The KPI_{REN} applies to an OS, which may be a single broadband fixed access node or a group of FAN in a same site. A site can be either an indoor or outdoor (in the street cabinet).

6 Global operational KPIs

6.1 Scale

KPI_{EM} is measured in kWh.

The dominant factor in the calculation of KPI_{EM} is the Objective KPI for energy consumption (KPI_{EC}).

The value of KPI_{EC} is mitigated by the weighted subtraction of any valid energy re-use (KPI_{REUSE}) and any energy contribution from locally generated renewable sources (KPI_{REN}).

This modified consumption value is multiplied by the Objective KPI for task efficiency (KPI_{TE}) which increases the value of the KPI_{EM} in direct proportion to the lack of task efficiency i.e. FAN sites with poor task efficiency will be adversely affected.

6.2 Evolution

Operational fixed broadband access networks and the number of FAN used respond to traffic demands and:

- generally do not go from "zero" to full utilisation on Day One;
- tend to feature power demands that grow from Day One, moving towards the maximum level of traffic at peak hours at which point strategic changes may take place.

KPI_{EM} is measured in kWh. This allows a given fixed access network to be assessed throughout its operational life and utilization levels.

6.3 Formulae

6.3.1 KPI_{EM}

6.3.1.1 Formula

KPI_{EM} is defined mathematically as:

$$KPI_{EM} = KPI_{EC} \times KPI_{TE} \times \left(1 - \left(KPI_{REN} \times W_{REN}\right)\right) \times \left(1 - \left(KPI_{REUSE} \times W_{REUSE}\right)\right),$$

subject to a minimum value of 0.

This is shown schematically in Figure 4.

Default weighting factors are detailed in clause 6.4.

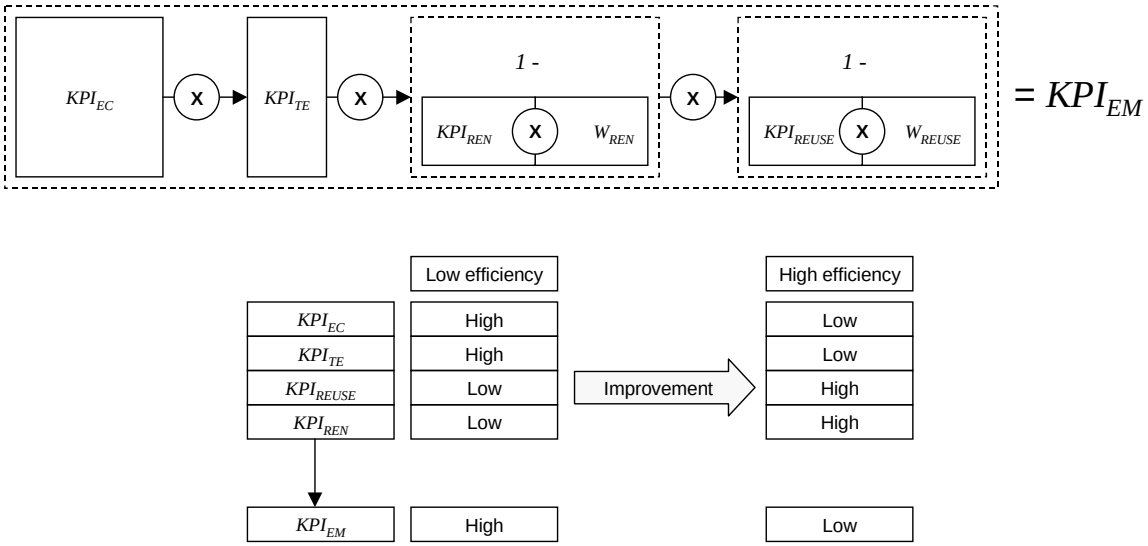


Figure 4: Schematic of fixed access network objective and global KPIs

6.3.1.2 Definitions of terms

See clause 3.

6.3.1.3 Measurement procedures

The objectives KPIs shall be measured on the combined sample of fixed access networks over the same period of time (T_{KPI}) subject to the allowed variation (Δt) as shown in Figure 5.

6.3.1.4 Criteria

The default value of T_{KPI} as shown in Figure 5 shall be 365,25 days (in order to take account of the traffic and climatic variations that will be experienced by the operational infrastructure). T_{REPEAT} shall be one week for taking into account the daily profile, and the notion of working days and week-end.

The maximum time difference in the periods of assessment of the objective KPIs (Δt as shown in Figure 5) shall be 7 days.

In order to make effective comparisons between different periods of assessment, the weighting factors (W_{REN}, W_{REUSE}) employed shall be the same in each period.

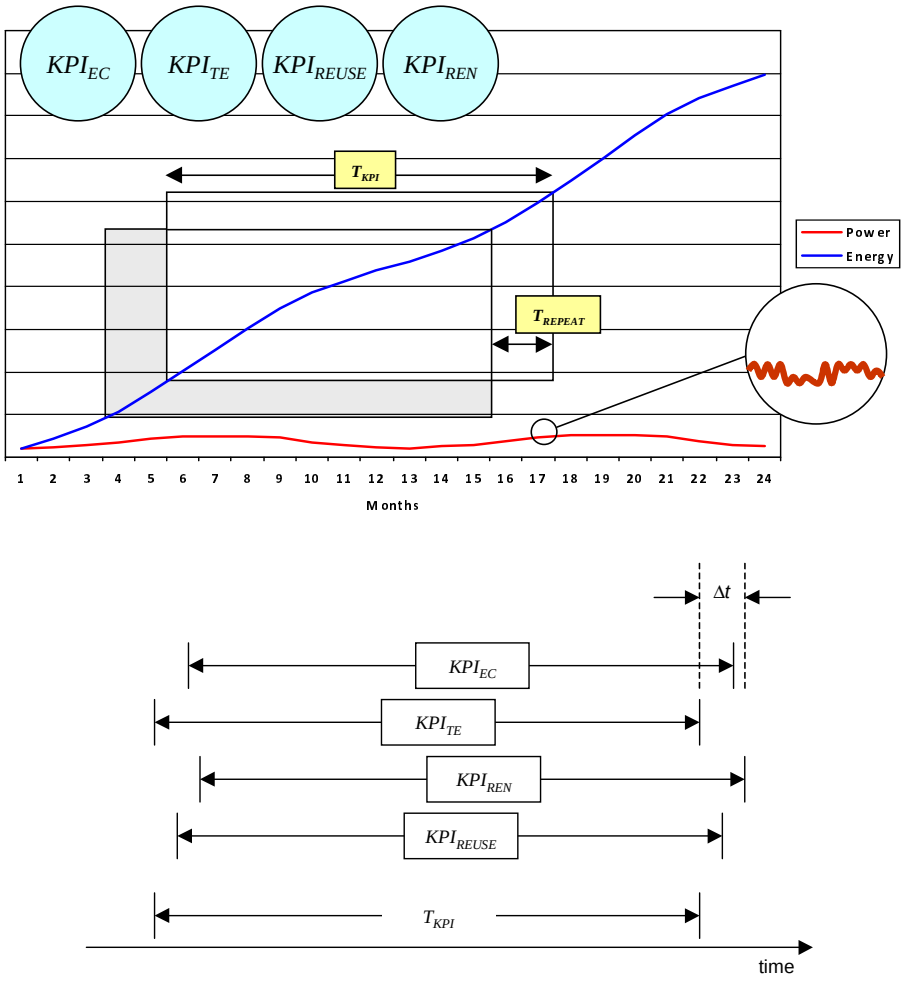


Figure 5: Schematic of KPI assessment periods

6.3.2 KPI_{EC}

6.3.2.1 Formula

KPI_{EC} for assessment period *k* is defined mathematically as:

$$KPI_{EC}\left(t_k^{(EC)}\right) = KPI_{EC}^{(k)} = \sum_{n=1}^{N} C_n^{(k)} \quad \text{for k = 1, 2, 3, ...}$$

6.3.2.2 Definitions of terms

n = Fixed access network site (OS) number.

N = Total number of fixed access network sites (OS).

$C_n^{(k)}$ = Total energy consumption by fixed access network site (OS) *n* during the KPI assessment interval between t_{k-1}^{begin} and t_{k-1}^{end} as described in detail in ETSI ES 205 200-1 [1].

6.3.2.3 Measurement points

Measurement points are addressed in ETSI ES 203 215 [i.2].

6.3.2.4 Measurement procedures

Measurement of energy consumption is addressed in ETSI ES 203 215 [i.2].

$C_n^{(k)}$ for each fixed access network site is defined as the difference in energy consumption (kWh) recorded by all meters (utility (grid) supply(s) and local sources) over the specified time period used to assess KPI_{EM} (i.e. T_{KPI} between t_{k-1}^{begin} and t_{k-1}^{end} subject to the allowed variation (Δt) as shown in Figure 5 and described in more detail in ETSI ES 205 200-1 [1]).

6.3.2.5 Criteria

The fixed broadband access network site shall operate at its design level of service availability during the period of assessment. This includes any circumstances during which fault conditions exist and alternative sources are used.

All the energy required to maintain the fixed broadband access network site at its design level of service availability shall be included any measurements of $C_n^{(k)}$.

6.3.3 KPI_{TE}

6.3.3.1 Formula

KPI_{TE} for assessment period k is defined mathematically as:

$$KPI_{TE}\left(t_k^{(TE)}\right) = KPI_{TE}^{(k)} = \sum_{n=1}^{n=N} \frac{C_n^{(k)}}{L_n^{(k)}} \text{ for k = 1, 2, 3, …..}$$

where:

$$L_n^{(k)} = \sum_{j=1}^{J_n} \left[L_{j,n}^{(k)} \times (1 - MP_{j,n}^{(TE)}) \right]$$

6.3.3.2 Definitions of terms

n = FAN OS number (if the assessment is applied to a common set of FAN).

N = Total number of FAN OS (if the assessment is applied to a common set of FAN).

$C_n^{(k)}$ = Total energy consumption of FAN OS n during the KPI assessment interval t_{k-1}^{begin} to t_{k-1}^{end} as described in detail in ETSI ES 205 200-1 [1].

$L_n^{(k)}$ = Total energy consumed by NTE load in FAN OS n during the KPI assessment interval between t_{k-1}^{begin} and t_{k-1}^{end} as described in detail in ETSI ES 205 200-1 [1].

j = NTE load measurement point number.

J_n = Total number of measurement points of NTE load in FAN OS n.

$L_{j,n}^{(k)}$ = Energy consumed by NTE load at the measurement point j in FAN OS n.

$MP_{j,n}^{(TE)}$ = Measurement penalty for NTE load measurement point j in FAN OS n.

6.3.3.3 Measurement points

See clause 6.3.3.1.

6.3.3.4 Measurement procedures

See clause 6.3.3.1.

KPI_{TE} will be assessed over the specified time period used to assess KPI_{EM} (i.e. T_{KPI} between t_{k-1}^{begin} and t_{k-1}^{end} subject to the allowed variation (Δt) as shown in Figure 5 and described in more detail in ETSI ES 205 200-1 [1]).

6.3.3.5 Criteria

See clause 6.3.3.1.

All tasks done by organisations to reduce energy consumption in the future (more than one year) should be taken into account.

6.3.4 KPI_{REUSE}

The present document does not specify a KPI for energy re-use (see clause 5.3).

6.3.5 KPI_{REN}

6.3.5.1 Formula

KPI_{REN} for assessment period k is defined mathematically as:

$$KPI_{REN}\left(t_k^{(REN)}\right) = KPI_{REN}^{(k)} = \sum_{n=1}^{N} REN_n^{(k)} \quad \text{for k = 1, 2, 3, ...}$$

6.3.5.2 Definitions of terms

n = Fixed access network site (OS) number in the combined sample.

N = Total number of fixed access network sites (OS) in the combined sample.

$REN_n^{(k)}$ = Energy input (kWh) from local, renewable, sources to the fixed access network site (OS) n during the KPI assessment interval between t_{k-1}^{begin} and t_{k-1}^{end} as described in detail in ETSI ES 205 200-1 [1], see clause 6.3.2.2.

6.3.5.3 Measurement points

Measurement points for $REN_n^{(k)}$ shall be at the output from renewable power sources (including those provided only during fault conditions).

6.3.5.4 Measurement procedures

$REN_n^{(k)}$ for each fixed access network site is defined as the difference in energy consumption (kWh) of all renewable energy meters recorded over the specified time period used to assess KPI_{EM} (i.e. T_{KPI} between t_{k-1}^{begin} and t_{k-1}^{end} subject to the allowed variation (Δt) as shown in Figure 5 and described in more detail in ETSI ES 205 200-1 [1]).

6.3.5.5 Criteria

The reused energy shall be calculated for each fixed access network system within a selected fixed access network site and then all the results will be added.

Only energy from renewable local sources shall be recorded. Utility (grid) energy, whether "green" or not, and energy from non-renewable local sources such as diesel engine generators shall not be taken into account.

6.4 Weighting factors

6.4.1 Renewable energy (W_{REN})

In accordance with ETSI ES 205 200-1 [1], the application of KPI_{REN} shall not undermine efforts to reduce energy consumption. If all energy was generated locally from renewable sources and W_{REN} = 1,0, KPI_{EM} would be zero - independent of total consumption or task efficiency. This situation, although obviously extreme, would be undesirable since if so much energy were available from locally generated renewable sources it should not be "wasted" by profligate energy consumption or poor task efficiency within the infrastructures of broadband deployment.

The general application of this weighting factor requires $0 \leq W_{REN}$.

In order to conform to the present document, the value of W_{REN} employed shall be 0,8.

Organizations that wish to apply the requirements of the present document using a different value of W_{REN} in line with their short, medium or long term objectives do not conform to the present document. This would allow the application of values of $W_{REN} > 1,0$ where specific emphasis on renewable energy sources is desired. In any case would be subject to the criteria requirements of clause 6.3.1.4 in relation to the application of weighting factors.

Annex A (informative): Concepts: Energy management, sustainability and Key Performance Indicators

A.1 Energy management and sustainability concepts

ISO Guide 82 [i.3], entitled "*Guide for addressing sustainability in standards*", defines sustainability as "state of the global system, which includes environmental, social and economic subsystems, in which the needs of the present are met without compromising the ability of future generations to meet their own needs".

The documents in the ETSI ES 205 200 series do not specifically address any social and economic aspects of sustainability but do focus on the environmental issues in relation to the operational performance of infrastructures of deployed broadband.

The documents in the ETSI ES 205 200 series adopt the position that the environmental viability aspects of sustainability comprise:

- those elements that relate directly to energy consumption and its outcomes within the locale of the broadband deployment infrastructures;
- other environmental elements relating to the wider impact of energy generation (e.g. greenhouse gas, carbon), consumption of other resources (e.g. water), and issues such as life cycle assessment.

It is common for equipment suppliers to define the energy efficiency of their products either in terms of the total energy consumed by a device or improvements in the performance of a specific task or outcome for a given energy input. Within the ETSI ES 205 200 series, these are considered, separately, as improvements in "energy consumption" and "task efficiency" respectively.

By comparison, operators and legislators are more interested in the performance of complete systems at an operational level taking into account global management aspects. As a result they apply a wider view of energy management that combines energy consumption and task efficiency with more general objectives such as the re-use of waste heat and the use of renewable energy.

For example, both the EU BroadBand Codes of Conduct [i.4] is actually targeted to reduce energy consumption by increasing task efficiency (i.e. not by reducing service levels) but includes re-use of waste heat as one of its best practices to achieve this goal.

While it is self-evident that if less energy is consumed by an operational infrastructure then the environmental impact of that infrastructure will be reduced, it is equally important to consider:

- the task efficiency of the operation for which that energy is consumed;
- while not wishing to encourage poor task efficiency, some benefit can be seen if waste energy, typically in the form of heat, is able to be re-used - substituting, to some degree, for other utility grid energy, the replacement of utility grid supplies by locally generated energy from renewable sources.

These four aspects: energy consumption, task efficiency, re-use of waste heat and the contribution of locally generated energy from renewable sources are considered to work in concert, albeit to different degrees for different infrastructures - and in the ETSI ES 205 200 series are considered as key objectives for which Objective KPIs are specified and for from which a Global KPI is produced which reflects energy efficiency of operational systems - meeting the needs of operators and legislators alike.

The imperatives placed on the different elements may vary from time to time - regulators specifically encouraging local generation of energy from renewable sources but then shifting focus on to other areas.

A.2 The status of Key Performance Indicators (KPIs)

A.2.1 Technical KPIs

At the most basic level, individual components or sub-assemblies can be designed to have improved task efficiency, i.e. less energy is consumed for a given output or task. Such components or sub-assemblies may be inherently more efficient in the way in which they use energy under specific operating conditions but are essentially unable to manage that consumption. An example of such a product would be a power supply unit which may be more efficient under higher load conditions.

More complex products may contain hardware and/or software which automatically reduces energy consumption under specific operating conditions by putting certain functions into "idle" states if not required. This is distinctly different than that of a single task component or sub-assembly detailed above.

Technical KPIs can be applied to both of the above by assessing energy consumption for a number of specific operating conditions and also across a combination of such operating conditions. Assuming those operating conditions reflect the probable operating environment for the component, sub-assembly or product, a customer may make valued judgements in relation to the appropriateness of the Technical KPI.

For example, two products that have equal "combined" Technical KPIs, may be more efficient under very specific conditions. For example, a design of power supply that is more task efficient under high load conditions may be inappropriate for users who plan to predominantly operate under low load conditions (and vice versa).

A higher level of task efficiency management is also possible where groups of products are managed to reduce energy consumption by either allocating loads in such a way that the group is operating at maximum task efficiency and/or by putting individual products within the group into an "idle" mode. Examples of such managed solutions are seen in data centre software plug-ins (such as those developed under the Fit4Green and GAMES projects funded by the European Commission) and in deliverables developed by ETSI TC EE. Once again, the value of such approaches can be validated by the establishment of Technical KPIs which can be applied to both of the above by assessing energy consumption of a defined group of products for a number of specific operating conditions and also across a combination of such operating conditions.

Figure A.1 provides a schematic in relation to energy-related KPIs. The left-hand side of that schematic relates to the Technical KPIs of the design and engineering phase for components, sub-assemblies, products and systems.

A.2.2 Objective KPIs

The Objective KPIs described in the documents of the ETSI ES 205 200-2 series relate to specific elements of energy management described in clause A.1 for operational infrastructures under the control of operators as follows:

- energy consumption: the total consumption of energy by an operational infrastructure;
- task efficiency: a measure of the work done (as a result of design and/or operational procedures) for a given amount of energy consumed;
- energy re-use: transfer or conversion of energy (typically in the form of heat) produced by the operational infrastructure to do other work;
- renewable energy: energy produced from dedicated generation systems using resources that are naturally replenished.

The procurement of products and systems based upon their Technical KPIs for energy consumption and/or task efficiency underpins the relevant Objective KPIs. However, the ETSI ES 205 200-2 series documents define requirements for the measurement of those Objective KPIs for operational infrastructures, i.e. taking into account the real operating conditions over a defined period of time.

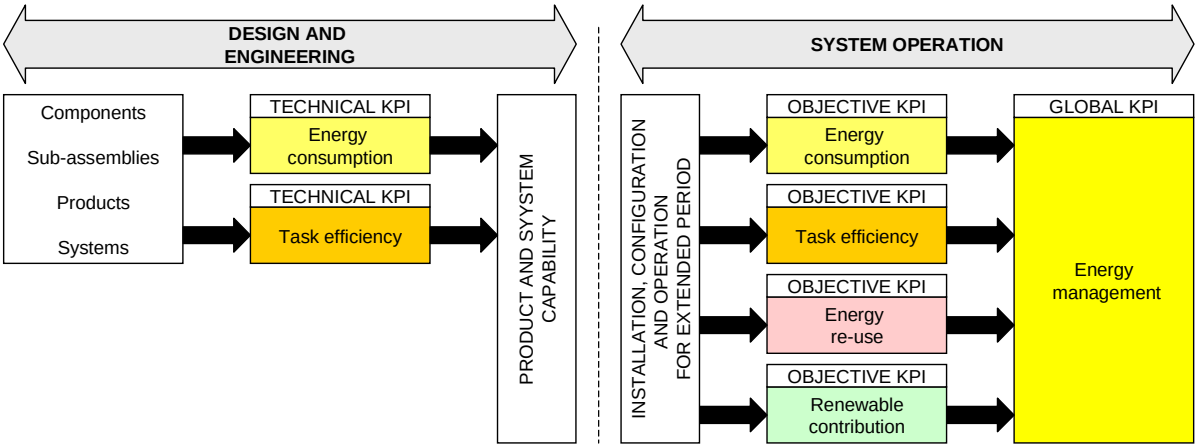


Figure A.1: The relationship of energy-related Technical, Objective and Global KPIs

The performance of products and systems, of proven Technical KPIs performance, may exhibit different energy consumption and task efficiency characteristics when subjected to actual operating conditions which lie outside those of the Technical KPIs applied to those products and systems at the design and engineering stages and, equally importantly, when subjected to user configuration and controls which may undermine the sophisticated systems available.

The right-hand side of the schematic in Figure A.1 relates to the Objective KPIs of complete infrastructures in the operational phase.

A.2.3 Global KPIs

The Objective KPIs, of which task efficiency is only one, are combined using a formula appropriate to the specific operational infrastructure to produce a Global operational KPI which reflects the overall performance of the operational infrastructures against wider energy management targets which may be self-imposed by the operators or externally applied by legislators.

Global KPIs provide a wider view of a user's commitment to strategic energy management practices than the Objective KPIs. For example, a user is not supporting overall energy goals by achieving class-leading provision of local renewable energy if their overall energy consumption is based upon equipment with very poor task efficiency.

A.2.4 Summary

Operational Global and Objective KPIs are fundamentally different to the Technical KPIs applied to products and systems at the design and engineering stages. The former are used to monitor and drive user behaviour whereas the latter are substantial indications of potential operational performance.

It is therefore important to support, but differentiate, the role of the Technical KPIs from the Objective and Global operational KPIs.

History

Document history		
V1.0.0	January 2016	Membership Approval Procedure MV 20160314: 2016-01-14 to 2016-03-14