Final draft ETSI ES 205 200-2-2 V1.1.0 (2018-03)

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
https://portal.etsi.org/TB/ETSIDeliverableStatus.aspx

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

Contents

Intellectual Property Rights

Essential patents

IPRs essential or potentially essential to normative deliverables 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.

Trademarks

The present document may include trademarks and/or tradenames which are asserted and/or registered by their owners. ETSI claims no ownership of these except for any which are indicated as being the property of ETSI, and conveys no right to use or reproduce any trademark and/or tradename. Mention of those trademarks in the present document does not constitute an endorsement by ETSI of products, services or organizations associated with those trademarks.

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 in 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.11]: Data centres;
  - ETSI ES 205 200-2-2 (the present document): Fixed broadband access networks;
  - ETSI ES 205 200-2-3 [i.12]: Mobile access networks;
  - ETSI ES 205 200-2-4 [i.13]: 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 fixed 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 the requirements for a Global KPI for energy management (KPI_{EM}) and their underpinning Objective KPIs addressing the following objectives for the fixed access networks (FANs) of broadband deployment:

- energy consumption;
- task effectiveness;
- renewable energy.

The requirements are mapped to the general requirements of ETSI ES 205 200-1 [1].

Energy management of fixed access networks comprises a number of independent layers. The present document addresses performance of infrastructures that supports the normal function of hosted ICT equipment within the fixed access network (e.g. power distribution, environmental control, security and safety). The present document does not address other layers such as performance of ICT equipment itself, performance of usage of available processing power, and layers related to final service delivered (e.g. processing power required per itemized outcome) or overlay layers (e.g. energy consumption required per itemized outcome).

The environmental impact and management of different energy sources are outside the scope of the present document.

KPI_{EM} may be tailored for specific needs by changing weighting of renewable energies. Calculations should be based on a significant sample of network elements.

The Global KPI alone is not designed for comparison of fixed networks. It does not define a fixed network as good or bad unless combined with other parameters considered relevant for a comparison, such as local climatic conditions, availability requirements or purpose of fixed networks.

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.

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

[i.5] Recommendation ITU-T G.992.5: "Asymmetric digital subscriber line 2 transceivers (ADSL2) - Extended bandwidth ADSL2 (ADSL2plus)".

[i.6] Recommendation ITU-T G.984: "Series describing Gigabit-capable passive optical networks (GPON)".

[i.7] Recommendation ITU-T G.987: "Series describing 10 Gigabit-capable passive optical networks (XG-PON)".

[i.8] Recommendation ITU-T G.989: "Series describing 40 Gigabit-capable passive optical networks (NG-PON2)".

[i.9] Recommendation ITU-T G.991.1: "High bit rate digital subscriber line (HDSL) transceivers".

[i.10] Recommendation ITU-T G.991.2: "Single-pair high-speed digital subscriber line (SHDSL) transceivers".

[i.11] 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.12] 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.13] 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 energy consumption as measured by an operational infrastructure

NOTE: This consumption does not include losses resulting from transportation to the consumption point and transformation of primary energy, if any.

energy management: combination of reduced energy consumption and increased task effectiveness, 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

NOTE: The present document does not take energy re-use into consideration.

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 Element (NE): equipment dedicated to providing connectivity 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})

operational infrastructure: combination of Information Technology Equipment (ITE) and/or network telecommunications equipment (NE) together with the power supply and environmental control systems necessary to ensure provision of service

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

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

task effectiveness: measure of the energy consumed for a given work done (as a result of design and/or operational procedures) [1]

work done: amount of energy directly consumed by NE

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 effectiveness
KPI_{REN}	Objective Key Performance Indicator of renewable energy usage
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}

3.3 Abbreviations

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

ADSL	Asymmetric Digital Subscriber Line
AN	Access Network
DSL	Digital Subscriber Line
DSLAM	Digital Subscriber Line Access Multiplexer
EE	Energy Efficiency
FAN	Fixed Access Node
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
LOC	Last Operator Connection point
LT	Line Terminal

NOTE: Collective ONU used in FTTB architecture.

MSAN Multi Service Access Node
NE Network Element
NDN Network Distribution Node
NT Network Termination
ODC Operator Data Centre
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 Terminal Equipment

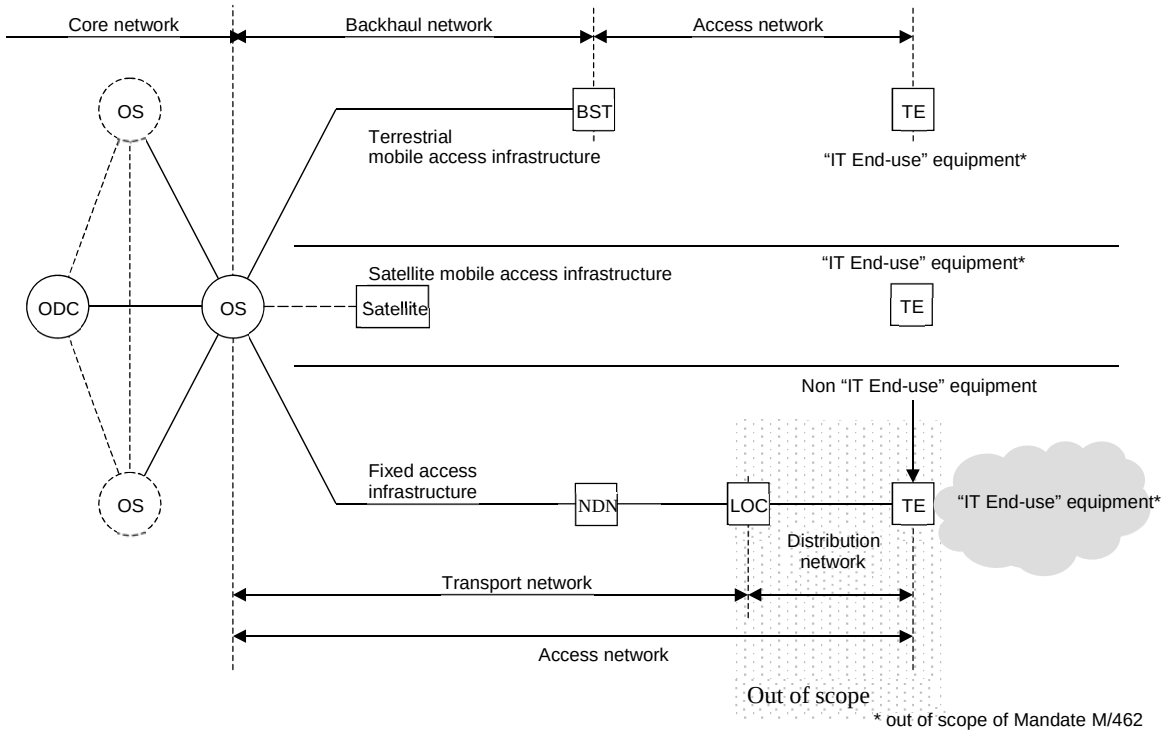
NOTE: In architecture figures.

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 AN technologies defined in Recommendation ITU-T G.992.5 [i.5], Recommendation ITU-T G.984 [i.6], Recommendation ITU-T G.987 [i.7], Recommendation ITU-T G.989 [i.8]) and Recommendation ITU-T G.993.2 [i.4].
- 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 the OSes (included) and the LOCs (not included), as shown in Figure 1. Thus:

- There can be a simple FAN without NDN and the FAN will be in the OS.
- Or there can be several NDN between the OS and the LOC.

An OS could be located either indoors or at an outdoor site (in a street cabinet, for instance).

4.2 Topology

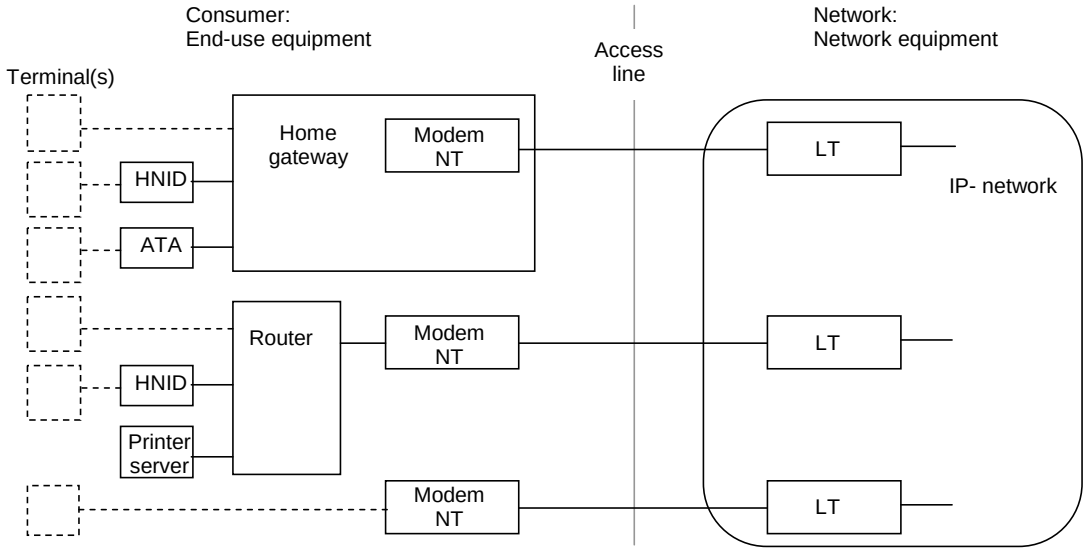
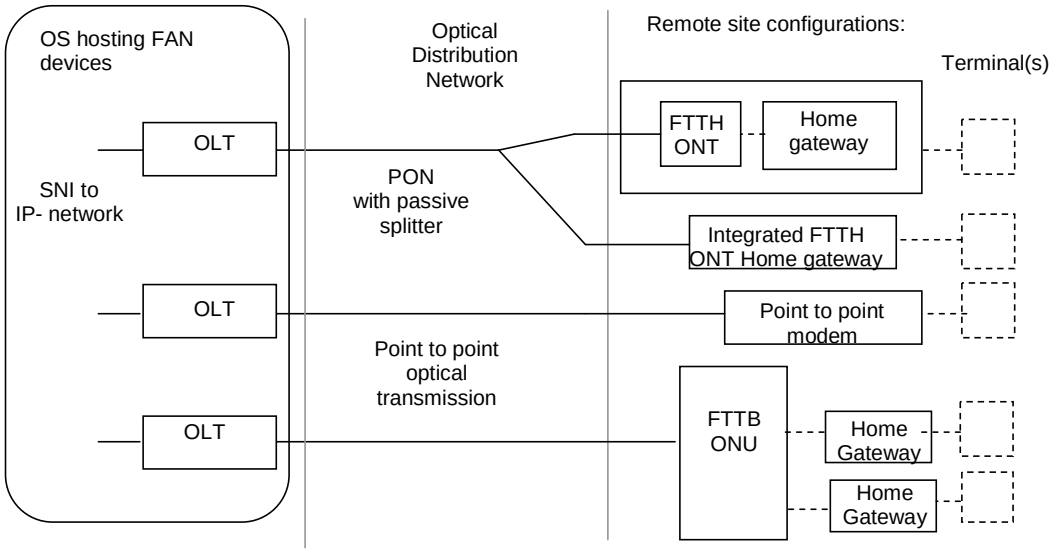
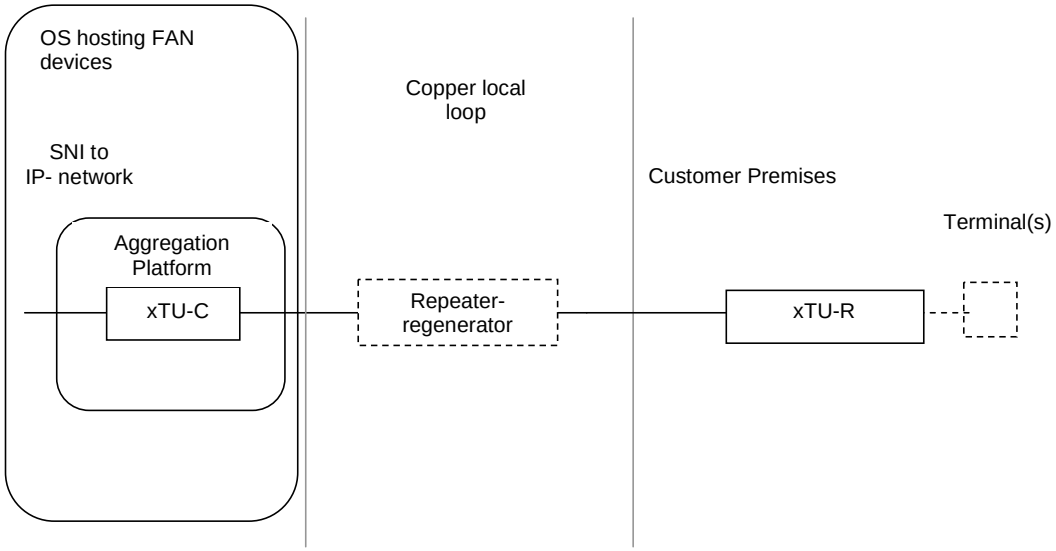


Figure 2: On the right, location of the FAN

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 solutions with passive splitters or Point to point optical transmission. Figure 3b is an example of the configuration for DSL technologies, for ADSL or VDSL but also for SHDSL [i.10] (Repeater-Regenerators are mainly used on HDSL [i.9] 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 FANs on the same site). A site can be either an indoor or outdoor (e.g. a street cabinet).

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

- reducing the number of FANs required for a given coverage (number of end users, for a given service data rate);
- swapping NE by new generation NE with improved Energy Efficiency;
- implementing energy reduction techniques in FANs such as:
  - static power reduction (e.g. L3 mode, flat power management or the unused port switch-off);
  - dynamic power reduction (e.g. Low Power mode on ADSL or sleep modes on GPON).

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

5.2 Task effectiveness

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

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

- re-engineering of fixed access networks to optimize the number of FAN (that includes the swap of old nodes for new nodes);
- optimization of operational processes;
- automation of network management including energy efficiency constraints.

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

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

5.3 Energy re-use

The present document does not provide a value for this KPI since in general, fixed access network sites are geographically scattered what limits the possibility for merging any heat generated at each site.

5.4 Renewable energy

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

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

A FAN may meet all its 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 1: This does not, as yet, take into consideration any proportion of utility supplies certified as "green" by nationally recognized 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 FANs at the same site. A site can be either indoors or outdoors (e.g. in a street cabinet).

NOTE 2: Depending on implementations, renewable energies may require increased use of batteries with their related sustainability issues.

6 Global operational KPIs

6.1 General

KPI_{EM} determines the performance of energy consumption management by a fixed network.

The present document defines the principles for calculating energy use management performance of fixed networks with default weighting factors, and provides a default number of classes and default gauges. The final user of KPI_{EM} may tailor those weighting factors, number of classes and gauges to its needs.

6.2 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 energy contribution from locally generated renewable sources (KPI_{REN}).

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

6.3 Evolution

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

- generally do not go from "zero" to full utilization 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 (e.g. change of network design, site relocation).

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

6.4 Formulae

6.4.1 KPI_{EM}

6.4.1.1 Formula

For the purpose of the present document, KPI_{EM} is defined mathematically as:

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

subject to a minimum value of 0.

This is shown schematically in Figure 4.

Default weighting factors are detailed in clause 6.4.

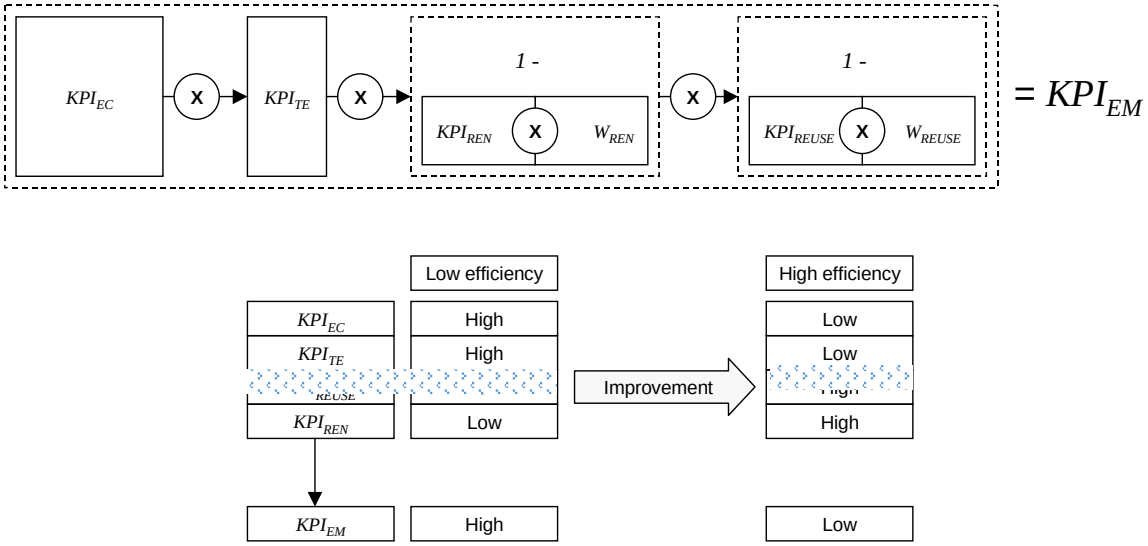


Figure 4: Schematic of fixed access network objective and global KPIs

6.4.1.2 Definitions of symbols

See clause 3.

6.4.1.3 Measurement procedures

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

6.4.1.4 Criteria

The default value of T_{KPI} as shown in Figure 5 shall be 365 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 weekend.

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 same weighting factor W_{REN} shall be used in each period.

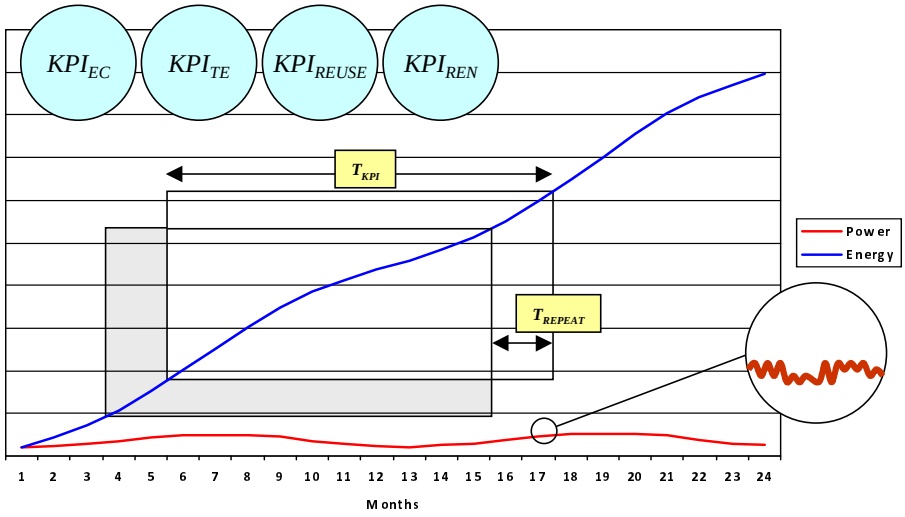


Figure 5: Schematic of KPI assessment periods

6.4.2 KPI_{EC}

6.4.2.1 Formula

For the purpose of the present document, KPI_{EC} for assessment period k is defined mathematically as:

$$KPI_{EC}^{(k)} = \sum_{n=1}^{N} C_n^{(k)}$$

6.4.2.2 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^{begin} and t_k^{end} as described in detail in ETSI ES 205 200-1 [1].

6.4.2.3 Measurement points

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

6.4.2.4 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^{begin} and t_k^{end} subject to the allowed variation (Δt) as shown in Figure 5 and described in more detail in ETSI ES 205 200-1 [1]).

6.4.2.5 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 $C_n^{(k)}$.

6.4.3 KPI_{TE}

6.4.3.1 Formula

For the purpose of the present document, KPI_{TE} for assessment period k is defined mathematically as a dimensionless number:

$$KPI_{TE}^{(k)} = \frac{\sum_{n=1}^{N} C_n^{(k)}}{\sum_{n=1}^{N} L_n^{(k)}}$$

Where:

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

6.4.3.2 Definitions of terms

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

j = NE load measurement point number.

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

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

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

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

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

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

6.4.3.3 Measurement points

See clause 6.4.2.3.

6.4.3.4 Measurement procedures

See clause 6.4.2.4.

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

6.4.3.5 Criteria

See clause 6.4.2.5.

6.4.4 KPI_{REN}

6.4.4.1 Formula

For the purpose of the present document, KPI_{REN} for assessment period k is defined mathematically as a dimensionless number:

$$KPI_{REN}^{(k)} = \frac{\sum_{n=1}^{N} REN_n^{(k)}}{\sum_{n=1}^{N} C_n^{(k)}}$$

6.4.4.2 Definitions of terms

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

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^{begin} and t_k^{end} as described in detail in ETSI ES 205 200-1 [1], see clause 6.4.2.2.

6.4.4.3 Measurement points

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

6.4.4.4 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^{begin} and t_k^{end} subject to the allowed variation (Δt) as shown in Figure 5 and described in more detail in ETSI ES 205 200-1 [1]).

6.4.4.5 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.

6.5 Weighting factors

6.5.1 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 effectiveness. 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 effectiveness within the infrastructures of broadband deployment.

The general application of this weighting factor requires $0 \leq W_{REN} \leq 1$.

The suggested value of W_{REN} is 0,8 based on a survey of existing sites by relevant organizations. Organizations that wish to apply the requirements of the present document may use different values of W_{REN} to fit their own objectives.

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 effectiveness" respectively.

By comparison, operators and other parties 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 effectiveness with more general objectives such as the re-use of waste heat and the use of renewable energy.

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 effectiveness of the operation for which that energy is consumed;
- while not wishing to encourage poor task effectiveness, 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 effectiveness, 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 from which a Global KPI is produced which reflects energy efficiency of operational systems - meeting the needs of operators and other parties 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 effectiveness, 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 reduce 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 value 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 effectiveness 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 effectiveness 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 effectiveness: a measure of the work done (as a result of design and/or operational procedures) for a given amount of energy consumed, where the work done depends on the operational infrastructure being measured;
- 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 effectiveness 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.

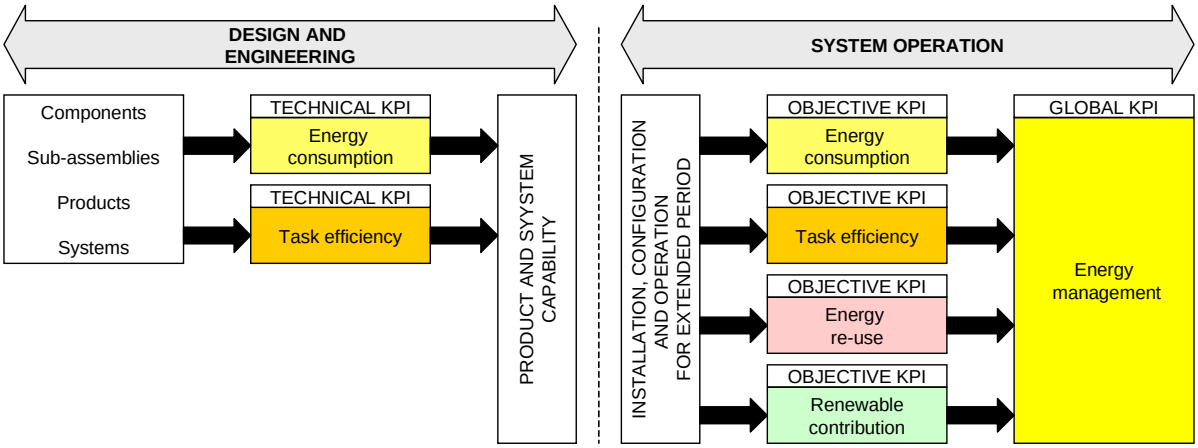


Figure A.1: The relationship of energy-related Technical, Objective and Global KPIs

The performance of products and systems, of proven Technical KPIs performance, may exhibit different energy consumption and task effectiveness 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 effectiveness 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 other parties.

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 effectiveness.

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
V1.1.0	March 2018	Membership Approval Procedure	MV 20180513: 2018-03-14 to 2018-05-14