ETSI ES 203 475 V1.1.1 (2017-11)

ETSI STANDARD

Environmental Engineering (EE); Standardization terms and trends in energy efficiency

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Sous-Préfecture de Grasse (06) N° 7803/88

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Foreword

This ETSI Standard (ES) has been produced by ETSI Technical Committee Environmental Engineering (EE).

Modal verbs terminology

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Executive summary

The present document contains high level definition of energy efficiency, energy management requirement to increase the energy efficiency of ICT goods/networks/services.

Introduction

The present document was developed jointly by ETSI TC EE and ITU-T Study Group 5 and published respectively by ITU and ETSI as Recommendation ITU-T L.1315 [i.3] and ETSI Standard ETSI ES 203 475, which are technically equivalent.

1 Scope

The present document specifies terminology, principles and concepts for Energy efficiency and energy management.

The present document establishes common understanding on measurement methodology used to determine the energy efficiency of a good, service and network.

The present document is a framework for other ETSI standards and other Standard Development Organization SDO document for Energy efficiency thematic.

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.

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[i.1] Recommendation ITU-T L.1310 (08/2014): "Energy efficiency metrics and measurement methods for telecommunication equipment".

[i.2] ISO 14040 (07/2006): "Environmental management -- Life cycle assessment -- Principles and framework".

[i.3] Recommendation ITU-T L.1315 (05/2017): "Standardization terms and trends in energy efficiency".

3 Definitions, symbols and abbreviations

3.1 Definitions

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

active mode: For (small) networking equipment, this is the operational mode where all ports (WAN and LAN) are connected, with at least one Wi-Fi connection, if a Wi-Fi function is available. (As defined in Recommendation ITU-T L.1310 [i.1]).

energy: "The capacity for doing work". In the telecommunication systems, where the primary source of energy is electricity, energy is measured in Joules. (As defined in Recommendation ITU-T L.1310 [i.1]).

functional unit: (Based on ISO 14040 [i.2]). A performance representation of the system under analysis. For example, for transport equipment, the functional unit is the amount of Data transmitted, the distance over which it is transported and its rate in Gbit/s. Sometimes the term is used to represent useful output or work. (As defined in Recommendation ITU-T L.1310 [i.1]).

idle mode: For (small) networking equipment, this means the same as active mode, but with no user data traffic (it is not zero traffic, as service and protocol supporting traffic are present) being used, although it is ready to be used (U1 in routers part). (As defined in Recommendation ITU-T L.1310 [i.1]).

low power (sleep) mode: For small networking equipment, this means a state that happens after the device detects no user activity for a certain period of time and reduces energy consumption. For this state, no user-facing LAN ports are connected; the Wi-Fi is active but no clients are connected. The WAN port may be inactive. The device will reactivate on detecting a connection from a user port or device. (As defined in Recommendation ITU-T L.1310 [i.1]).

small networking device: A networking device with fixed hardware configuration, designed for home/domestic or small office use, with less than 12 wired ports. This device can have wireless functionality implemented. (As defined in Recommendation ITU-T L.1310 [i.1]).

3.2 Symbols

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

η Efficiency

3.3 Abbreviations

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

AC	Alternating Current
CRT	Cathode Ray Tube
EER	Energy Efficiency Rating
EUT	Equipment Under Test
ICT	Information and Communication Technology
LAN	Local Area Network
LCD	Liquid Cristal Display
LED	Light Emitting Diode
PUE	Power Usage Effectiveness (for datacentre)
SDO	Standard Development Organization
WAN	Wide Area Network

4 Energy Efficiency

4.1 General concept

Energy Efficiency is a widely used term with multiple meanings, one can hear "use stairs, be energy efficient" Energy efficient office or house or many others.

Since we are talking about electrical devices, efficiency definition could start from a generic definition for Energy Efficiency for energy converting devices:

$$\eta = Energy_{output} / Energy_{input} \qquad (1)$$

"Energy Efficiency" that applies to any device that uses energy to do work: "Percentage of total energy input to a machine or equipment that is consumed in useful work and not wasted as useless heat." This could be expressed as follows:

$$\eta = \frac{Energy\,for\,useful\,work}{Total\,used\,energy} \qquad (2)$$

By definition, "Energy Efficiency" is always in the range from 0 to 1, or 0 to 100 % (if expressed as a percentage).

The goal of increasing energy efficiency is to realize solutions that will give the same or better functionality using less energy.

For IT equipment output energy does not represent useful output energy therefore, Energy, Energy Efficiency for IT equipment shows how much energy used to perform a Functional Unit (which is specific for the device or solution). EE increase is one of ways of managing and restraining the growth in energy consumption. Devices is more energy efficient if it delivers more services for the same energy input, or the same services for less energy input. For example, when a LED/LCD Display uses less energy than a traditional display based on Cathode Ray Tube (CRT) to reproduce the video, the display is considered to be more energy efficient.

The goal of energy efficiency increase is to provide solutions that will give more functionality using less energy.

Trivial solution for the maximum energy saving can be achieved simply by switching off the device, but that will eliminate the service delivered by the device as well and EE will be zero as a result.

This is the major reason to consider for an equipment the energy efficiency and not only the energy consumption; Energy Efficiency is not an absolute metric, this implies that if it is necessary to do a comparison between equipment it is possible only for equipment of the same type and with similar functionality.

Energy efficiency increase is important at all stages of the energy chain from generation to final consumption. Eventually the benefits of energy efficiency increase will outweigh the costs, for instance those involved in renovations.

Energy efficiency is not equal to energy conservation. Energy conservation is reducing or going without a service to save energy.

The Power Usage Effectiveness (PUE) concept used for data centre follows this formulation.

When the energy efficiency concept it is applied to the ICT world, it is not possible to make reference to output to power or energy and it is important to introduce the concept of a proxy for useful work, changing formula 1.

In this case, the energy efficiency rating of functionality shall be expressed as the ratio between the expected result normally called a proxy for Useful work (similar to Functional Unit) and the energy used to realize the that functionality.

The new formula will be:

$$EER = \frac{useful\,work}{Total\,used\,energy} \qquad (3)$$

This formula in this case is not a ratio between two values with same units but between two different characteristics so the indicator of efficiency realized will be not a pure number but a ratio of useful work and energy the measurement unit will be different depending on the useful work selected for the service/EUT e.g. bit/J in the case that the useful work is a throughput, measured in bit/s

To have an easy way to measure the efficiency, in the case of equipment without a big variation of energy consumption, it is preferable to measure the power of an equipment instead of the energy. In this case the power will be not an instantaneous power but a power averaged in a time period to eliminate the fluctuation of the instantaneous power measurement.

In this last case the energy efficiency it is expressed with the same terminology but using total power and not total energy in the numerator of the formula.

The energy efficiency indicator (EER) is a device metric defined as a Functional Unit divided by the power. Various types of equipment have their own EER definitions.

4.2   Energy efficiency hierarchy

4.2.0   Energy efficiency general definition

An energy efficiency metric can be defined at different level:

- the network/solution level;

- the equipment/system level;

- the component level.

Normally in standardization, only metrics at network equipment/system level are considered, defined and used to test/evaluate the energy efficiency of equipment/system; metrics at the component level are given as suggestions only and could be used as a tool to improve the efficiency of an equipment.

Metrics at the network level are under study.

4.2.1   Energy efficiency at the network level

Network level metrics are used to evaluate the energy efficiency of an entire network or part of it (e.g. the access network of an operator). They are normally used to evaluate an internal network of an operator use and to satisfy an environmental goals. For the present document, the network level EE is considered a metric that will cover not only one single product but all equipment used to build telecommunication network, composed of different interworking equipment.

4.2.2   Energy efficiency at the equipment/system level

Equipment/system level metrics are mostly used to compare telecommunication equipment of the same functionality and place in a network. They evaluate the overall energy efficiency performance at the equipment/system level, which is considered as a "single box" or "single entity", from the measurement and reporting point of view.

4.2.3   Energy efficiency at the component level

Component-level metrics can be used in the design, development and manufacture of energy efficient equipment. They regard equipment as an "open box" and evaluate the energy efficiency performance of its individual components. Measuring and understanding the energy efficiency or energy consumption of each component within the equipment helps to identify the "hot spots" and key components in a system with regard to energy saving. It should be kept in mind that these kinds of metrics may lead to sub-optimizations unless considered in the context of the overall equipment's energy efficiency.

5   Useful work concept for ICT

Useful work is a general expression used to define the expected result that it is desired to be delivered by a device.

Considering that ICT devices are very complex, it is not simple to find a correct Functional Unit/proxy for Useful work. Using the output energy of devices is not possible, because the equipment it is not designed only to send energy at its output ports but to realize other type of activities such as data switching/routing, area coverage, and data computation.

These activities are different from different type of equipment and as some of examples, could be the data throughput of a port or system, the computational capacity, the area coverage, the transmitting distance or a combination of above, depending on the equipment usage/application considered.

In the wired technologies that include, router, switch, transport, fixed access equipment the following concept can be utilized:

- Utilization:

    - **Port Utilization:** Port throughput expressed as percentage of theoretical maximum.

    - **System Utilization:** System throughput expressed as percentage of Maximum Demonstrated Throughput.

- Throughput:

    - **Port Throughput:** Rate of traffic (in bps) passing through a port on sustained basis in either direction, including minimally needed line overhead.

    - **System Throughput:** Sum of throughput on all system ports in the egress direction (bps). *Example*: Maximum throughput for 1 Gigabit Ethernet port is 1Gbps (measured in a specified topology).

    - **Line rate:** Indicates the actual speed with which the bits are sent onto the wire (or via wireless connection).

In wireless technologies it is necessary consider also:

- **Coverage area:** this is the geographical area in which mobile radio stations provide the service.

- **Path length:** in radio technologies another important factor to be considered is the radio link length. E.g. distance between the two radios stations of the radio link.

For facility equipment other factor are considered like the cooling capacity, energy output.

In case of the future EER application to a network/solution than some useful work shall be:

- Number of user.

- Service per user.

- Level of oversubscription.

- Total traffic to outside of the network.

- Combinations of the above.

- Facilities used energy.