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SERIES L: CONSTRUCTION, INSTALLATION AND
PROTECTION OF CABLES AND OTHER ELEMENTS
OF OUTSIDE PLANT

**Energy efficiency metrics and measurement for
power and cooling equipment for
telecommunications and data centres**

Recommendation ITU-T L.1320



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Energy efficiency metrics and measurement for power and cooling equipment for telecommunications and data centres

Summary

Recommendation ITU-T L.1320 contains the general definition of metrics, test procedures, methodologies and measurement profiles required to assess the energy efficiency of power and cooling equipment for telecommunications and data centres. More detailed measurement procedures and specifications can be developed in future related ITU-T Recommendations.

Metrics and measurement methods are defined for power equipment, alternating current (AC) power feeding equipment (such as AC uninterruptible power supply (UPS), direct current (DC/AC) inverters), DC power feeding equipment (such as AC/DC rectifiers, DC/DC converters), solar equipment, wind turbine equipment and fuel cell equipment.

In addition, metrics and measurement methods are defined for cooling equipment such as air conditioning equipment, outdoor air cooling equipment and heat exchanging cooling equipment.

History

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Energy efficiency, methodology, metrics.

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FOREWORD

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The World Telecommunication Standardization Assembly (WTSA), which meets every four years, establishes the topics for study by the ITU-T study groups which, in turn, produce Recommendations on these topics.

The approval of ITU-T Recommendations is covered by the procedure laid down in WTSA Resolution 1.

In some areas of information technology which fall within ITU-T's purview, the necessary standards are prepared on a collaborative basis with ISO and IEC.

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Introduction

Typically energy efficiency is defined as the ratio of work output to energy consumed, which in scientific terms can be expressed in the same functional units of joules. As applied to pieces of equipment, the energy efficiency term of work output has transformed to "useful work" or "useful output" to apply to specific items of interest. The energy consumed has also been transformed to units that reflect the primary form or unit of measure tracked to deliver that output, such as electricity or more specifically Watt-hours (Wh). While the measurement of the electricity consumed is generally straightforward, the definition of useful output is context driven and required to be explicit to the application to provide effective measures of monitoring and improvement. In fact, the use of energy efficiency metrics is expressly intended to monitor and drive programmes that gain the most useful output for the energy being consumed. Note that "useful-output" has finite bounds to the context of the application. These bounds may drive categorization methods towards groups such as applications, size, and/or conditions. To apply this concept for the targeted application or equipment, useful work or output must be defined in order to describe the energy efficiency for the subject entity.

For the purposes of this Recommendation, the energy efficiency of the power (delivery and conditioning) equipment will be expressed solely as the ratio of output energy (Watt-hours delivered) to input energy (Watt-hours consumed). This ratio may also be expressed in terms of power (i.e., Watts) if normalized under the condition of use (e.g., root mean square (RMS) over a reasonable application time period). The energy efficiency for air conditioning and air cooling equipment is designated as the ratio of cooling capacity to energy consumed. The cooling capacity is transformed from units of temperature and air/area properties to Watts. Thus for cooling purposes, the ratio is that of cooling capacity in Watts to energy consumed in Watts.

Recommendation ITU-T L.1320

Energy efficiency metrics and measurement for power and cooling equipment for telecommunications and data centres

1 Scope

This Recommendation specifies principles and concepts of energy efficiency metrics and measurement methods for power feeding equipment and cooling equipment in telecommunications rooms and data centres.

The methodologies defined in this Recommendation are applied at single equipment level. The efficiency of power conversion and cooling in the data centre or telecommunication facility is only partially attributed to the equipment. The architecture and organization of the space and equipment to deliver the power or cooling to the systems is as equal, if not a more significant factor in energy efficiency. Another general factor is the interoperability, management and response of these systems across the demand and operational range.

NOTE – Cooling equipment: In general, data centre level systems should be referred (or normalized) with respect to a full year, in order to take into account the yearly variability of environmental conditions and the consequent possible use of various cooling methods. The reference to a whole year helps to establish a power usage effectiveness (PUE) comparison, especially with respect to an individual data centre.

This Recommendation covers:

- Power feeding equipment:
 - AC power feeding equipment;
 - DC power feeding equipment;
 - Renewable energy equipment¹.
- Cooling equipment:
 - Air conditioner equipment;
 - Outdoor air cooling equipment;
 - Heat exchanging cooling equipment.

2 References

The following ITU-T Recommendations and other references contain provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published. The reference to a document within this Recommendation does not give it, as a stand-alone document, the status of a Recommendation.

[ATIS-0600015.04] ATIS-0600015.04 (2010), *Energy Efficiency for Telecommunication Equipment: Methodology for Measurement and Reporting DC Power Plant – Rectifier Requirements*.

¹ Renewable energy equipment implies the inclusion of either energy storage (e.g., battery and/or fuel cell) or power from/to the electrical grid. These sources and/or losses in the transmission are outside the scope of this Recommendation but should be taken into account for an overall efficiency assessment.

[IEC 61215]	IEC61215 Ed 2.0 (2005), <i>Crystalline silicon terrestrial photovoltaic (PV) modules – Design qualification and type approval.</i>
[IEC 61646]	IEC 61646 Ed.2.0 (2008), <i>Thin-film terrestrial photovoltaic modules – Design qualification and type approval.</i>
[IEC 62040-3]	IEC 62040-3 Ed.2.0 (2011), <i>Uninterruptible power systems (UPS) – Part 3: Method of specifying the performance and test requirements.</i>
[IEC 62108]	IEC 62108 Ed.1.0 (2007), <i>Concentrator photovoltaic (CPV) modules and assemblies – Design qualification and type approval.</i>

3 Definitions

3.1 Terms defined elsewhere

This Recommendation uses the following terms defined elsewhere:

3.1.1 energy [b-ISO 16818]: Capacity for doing work; having several forms that may be transformed from one to another, such as thermal (heat), mechanical (work), electrical or chemical and is expressed in Joules. For the purposes of this Recommendation, energy will be expressed in Watt-hours (Wh) or kilo Watt-hours (kWh).

3.1.2 power [b-ISO 16818]: Rate at which energy is transmitted.

NOTE 1 – Power is measured in units of Watts.

NOTE 2 – Though the rate of change can be observed as instantaneous values, use of power in these specifications imply normalization based on a reasonable representative period. Typically, energy is measured and a RMS power level is determined.

3.2 Terms defined in this Recommendation

This Recommendation defines the following terms:

3.2.1 alternating power (AC) power feeding equipment: AC power feeding equipment can be composed of an AC uninterruptible power supply (UPS), a direct current to alternating current (DC/AC) converter and an AC power distribution unit, if considered.

3.2.2 cooling capacity: It is the cooling power of air conditioners and refers to the rate that heat is removed from a space. It is most commonly measured as tons per hour or British thermal units (BTUs).

3.2.3 direct current (DC) power feeding equipment: DC power feeding equipment can be composed of a rectifier, a direct current to direct current (DC/DC) converter and DC power distribution units, if considered.

3.2.4 external static pressure: Static pressure at the air blower exit. High external static pressure is necessary for a cooling system with a raised floor or duct because of the high airflow resistance.

3.2.5 response time capability: The level of ability to respond to changes in the conditions in a certain time.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

AC	Alternating Current
BTU	British Thermal Unit
CF	Crest Factor