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SERIES L: ENVIRONMENT AND ICTS, CLIMATE CHANGE, E-WASTE, ENERGY EFFICIENCY; CONSTRUCTION, INSTALLATION AND PROTECTION OF CABLES AND OTHER ELEMENTS OF OUTSIDE PLANT

Energy efficiency measurement methodology for base station sites

Recommendation ITU-T L.1351

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ITU-T L-SERIES RECOMMENDATIONS

ENVIRONMENT AND ICTS, CLIMATE CHANGE, E-WASTE, ENERGY EFFICIENCY; CONSTRUCTION, INSTALLATION AND PROTECTION OF CABLES AND OTHER ELEMENTS OF OUTSIDE PLANT

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Recommendation ITU-T L.1351

Energy efficiency measurement methodology for base station sites

Summary

Recommendation ITU-T L.1351 describes and establishes requirements for energy efficiency measurements applicable to base station sites.

This Recommendation describes:

– Measurement points definitions
– Conditions of measurement
– Instrumentation requirement
– Reporting requirement
– Use of a monitoring system.

This Recommendation can be used as a conformity assessment standard for Recommendation ITU-T L.1350.

History

Edition	Recommendation	Approval	Study Group	Unique ID*
1.0	ITU-T L.1351	2018-08-22	5	11.1002/1000/13580

Keywords

Conformity assessment, metric measurement, radio site facilities, site energy efficiency.

* To access the Recommendation, type the URL http://handle.itu.int/ in the address field of your web browser, followed by the Recommendation's unique ID. For example, http://handle.itu.int/11.1002/1000/11830-en.

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.

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In this Recommendation, the expression "Administration" is used for conciseness to indicate both a telecommunication administration and a recognized operating agency.

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Recommendation ITU-T L.1351

Energy efficiency measurement methodology for base station sites

1 Scope

This Recommendation is applicable to base station site energy efficiency parameter measurement in line with the metric established by [ITU-T L.1350].

This Recommendation describes how to realize measurement of parameters establishing requirements on:

– measurement points,

– measurement conditions, and

– instrumentation.

This Recommendation also considers continuous monitoring of the site energy efficiency parameters. It does not specify metrics, but refers to the metric defined in [ITU-T L.1350].

The concepts of energy efficiency are covered by [ITU-T L.1315].

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..

[ITU-T L.1315] Recommendation ITU-T L.1315 (2017), *Standardization terms and trends in energy efficiency*.

[ITU-T L.1350] Recommendation ITU-T L.1350 (2016), *Energy efficiency metrics of a base station site.*

[ISO/IEC 17025] ISO/IEC 17025:2017, *General requirements for the competence of testing and calibration laboratories.*

[IEC 62053-21] IEC 62053-21:2003, *Electricity metering equipment (a.c.) –Particular requirements – Part 21: Static meters for active energy (classes 1 and 2).*

3 Definitions

3.1 Terms defined elsewhere

This Recommendation uses the following terms defined elsewhere:

3.1.1 base station (BS) [b-ITU-T L.1330]: A generic term used for a network component which serves one or more cells and interfaces the user terminal (through air interface) and a radio access network infrastructure.

3.1.2 energy [b-ITU-T L.1330]: Capacity for doing work; having several forms that may be transformed from one to another, such as thermal (heat), mechanical (work), electrical or chemical, expressed in Joules. For the purpose of this Recommendation, energy will be expressed in Watt-hours (Wh) or kilowatt-hours (kWh).

3.1.3 power [b-ITU-T L.1330]: The rate at which energy is transmitted. Power is measured in units of Watts.

3.1.4 infrastructure (facility) [ITU-T L.1350]: Equipment that supports the ICT equipment functionality providing energy, cooling and site ancillary activity, e.g., power delivery components and cooling system components.

3.2 Terms defined in this Recommendation

None.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

ICT Information and Communication Technology

KPI Key Performance Indicator

SEE Site Energy Efficiency

TEC Thermoelectric Cooler

5 Conventions

This Recommendation uses the following conventions:

E_{CT} Base station telecommunication equipment energy consumption

E_{FE} Electrical energy locally generated

E_{GE} Electrical energy from a public grid

E_{TS} Total site electrical energy consumption

E_{RE} Electrical energy locally generated on the site by renewable energy system (solar, etc.)

6 Measurement point definitions

[ITU-T L.1350] defines site energy efficiency (SEE) as the ratio between the total energy consumption of telecommunication equipment and the total energy consumption of a site:

$$\mathrm{SEE} = \frac{\mathrm{E_{CT}}}{\mathrm{E_{TS}}} \times 100\%$$

To calculate the SEE metric it is necessary to have the two quantities E_{CT} and E_{TS}.

E_{CT} is the energy consumption of telecommunication equipment present in the base station site under consideration during the measurement time period.

E_{CT} shall be measured at the input of the equipment, as close as possible to it, see Figure 1. For DC powered equipment the reference point should be the interface A defined in [b-ETSI EN 300 132-2].

E_{TS} is the sum of the different input energy sources that could be present at a site:

– public grid (E_{GE});

– diesel generator present at the site or from a different type of local generator (E_{FE});

– renewable energy source (E_{RE}), etc.

E_{GE} shall be measured at the base station site grid input or, if there are no other AC load or generators, at the input of the power feeding equipment.

E_{FE} shall be measured at the generator output or, if there are no other generators, at the input of the power feeding equipment.

E_{RE} shall be measured at the renewable energy source output (e.g., the photovoltaic array system) or, if there is no other renewable energy source, at the input of the power feeding equipment.

In the case, as shown in Figure 1, in which the renewable generator directly produces DC energy in the site, E_{FE} should always be measured at the output of the generator.

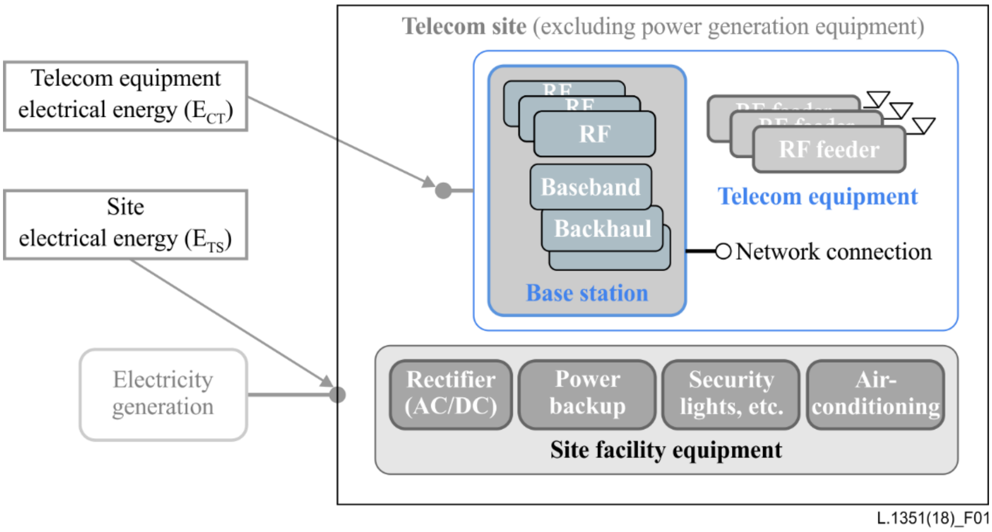

Figure 1 – Measurement points location

7 Measurement conditions

As reported in [ITU-T L.1350], the measurement conditions can change during the measurement period. Considering that the SEE metric is defined for a real site, the measurement will be a field measurement and not a laboratory measurement, so measurement conditions including climatic, load and power grid variations should be uncontrolled.

The metric considers that the measurement recording period should be one of the following:

– 1 day
– 1 week
– 1 month
– 1 year

All necessary data, including E_{CT} and E_{TS}, shall be read in the same measurement time period.

The measurement period for recording the parameters necessary for SEE calculation needs to be at least every 15 minutes.

8 Instrumentation requirement

To measure the quantity necessary to calculate SEE, calibrated AC energy meters and DC energy meters shall be used.

General requirements for voltage and current measurement equipment are contained in [ITU-T L.1315].

Energy meters used in the field shall be in line with Class 1 requirements defined by [IEC 62053-21].

9 Reporting requirement

Measurement reports shall be in line with the general requirements of [ISO/IEC 17025].

The test report shall include the following information:

– Site identification
– Equipment present in the site
– List of sensors/instrumentation used

The test set-up should be fully described, including topology, the choice of offered load structures and test actions within a range of possible choices.

10 Continuous monitoring

Continuous monitoring shall be implemented using sensors integrated in the information and communication technology (ICT) equipment able to report the energy consumption or, alternatively, the voltage and current at the input of ICT equipment to establish the value of E_{CT}.

To determine the value of E_{TS} the monitoring shall be implemented in a way that any infrastructure equipment shall give information on the energy consumption at this input.

If the load ICT equipment was not being monitored as energy consumption, it is possible to use as a value of E_{CT} the value of the energy at the output of power feeding equipment.

Using this data, the monitoring system can register and control the SEE of a site implementing a "preventive maintenance" operation based on the anomaly variation of SEE.

Figure 2 shows an example of SEE monitoring. For example, it is possible to set a key performance indicator (KPI) at a certain value to automatically show a site anomaly

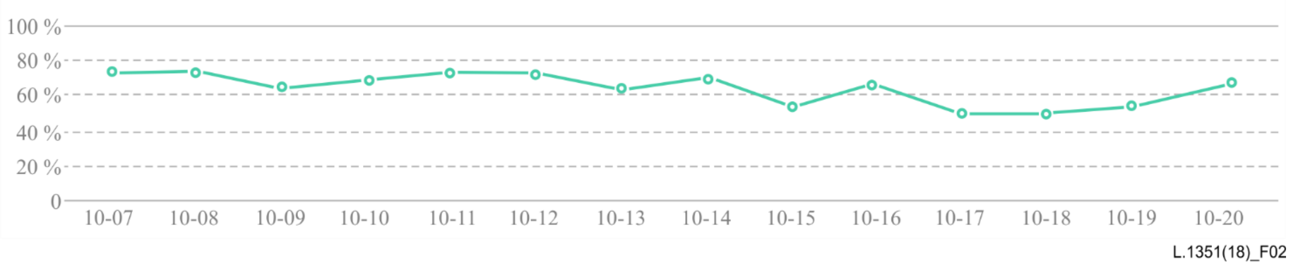

Figure 2 – Example of SEE monitoring

Appendix I

Laboratory measurement

(This appendix does not form an integral part of this Recommendation.)

This appendix describes how SEE can be used to evaluate different infrastructure/facility solutions in a laboratory before implementation on site to find the right solution for a site depending on power consumption and climate zone.

The SEE shall also be used to validate site infrastructure solutions before their field implementation so the user can select the most suitable solution for a specific site based on SEE measurement results.

I.1 Test set-up

In this case the load shall be simulated using some equipment as a load simulator or resistive load.

The energy consumption of the solutions e.g., an outdoor power feeding equipment able to contain ICT equipment, shall be monitored with an energy meter with the instrument requirements described in clause 8.

The ambient temperature during the test shall be registered.

I.2 Test results evaluation

As shown in Table I.1, the test can provide an evaluation for a SEE solution as a function of temperature. For a typical solution composed of a power feeding equipment comprising an ICT load and with two different types of cooling system: one cooling system for the electronic part and a thermoelectric cooler (TEC) for the battery space. This solution structure is shown in Figure I.1.

Looking at the results in Table I.1:

Measure the SEE values at the following temperatures: −25℃, −15℃, −5℃, 5℃, 15℃, 25℃, 35℃, 45℃.

Each temperature point test needs at least 2 hours, the first hour is to ensure that the temperature is stable. Only collect the data of the second hour.

It can be seen that the maximum SEE of 90% or above is available only in a temperature range from −20°C to 25°C.

So, if the site under consideration for development experiences climate conditions that are within that range, the solution could be implemented. If this is not the case, then it may be necessary look more carefully at climate data to check the amount of time during which the site will experience temperatures outside of that range, to have an idea of the percentage of time during which the SEE will be lower. If the percentage of time during which the SEE will be lower, then other solutions may have to be considered. The percentage of time considered depends on each solution (e.g., 50% of the time as a first approach is a good indication). The evaluation depends on the savings that can be obtained using a higher SSE and, on relevant business cases, a comparison between savings and the implementation of the solution.

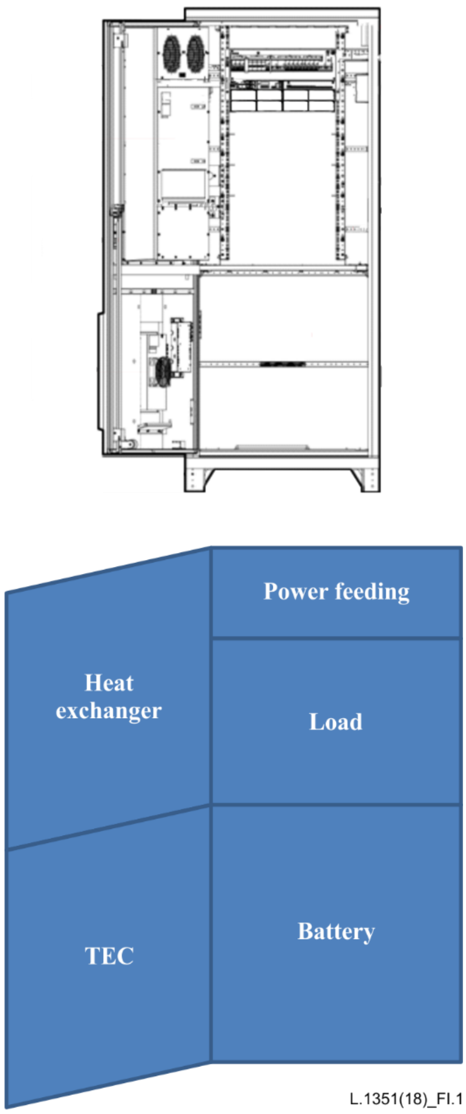

Figure I.1 – An example of an outdoor power feeding equipment

Table I.1 – Examples of SEE values

Ambient temperature	AC input consumption	Main equipment (Loads) consumption	Equipment cooling unit consumption	TEC consumption	SEE
45	3250	2800	40	289	86.15%
35	3256	2790	27	298	85.69%
25	3140	2810	19	207	89.49%
15	3000	2850	13.8	41	95.00%
5	3020	2900	12.049	40	96.03%
−5	3047.2	2930	8.7	48	96.15%
−15	3162	2910	9.4	84	92.03%
−25	3304	2890	8.5	244	87.47%
NOTE – A SEE data temperature test at −35°C and 50°C may also be required depending on real site conditions.					

Bibliography

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