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Environmental Engineering (EE);
Best practice to assess energy performance of future Radio Access Network (RAN) deployment

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Foreword

This Technical Report (TR) has been produced by ETSI Technical Committee Environmental Engineering (EE).

Modal verbs terminology

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Introduction

Energy efficiency is one of the critical factors with substantial impact on environmental footprint and operational cost of the modern telecommunication systems. By 2016, **ICT** energy consumption is estimated to 7,8 % of Global Electricity and 4,4 % of Global total Energy Consumption. The **mobile systems** energy consumption is estimated to 1,8 % of the global electricity, equals 1 % of Global Total Energy Consumption. With introduction of new mobile system technologies to support the rapid traffic growth, while low efficiency legacy system still remains, the energy consumption may further increase. The increased energy consumption is a threat to the environment as well as the profitability of the industry as operator revenues may remain flat. The mobile industry is working hard to increase efficiency and reduce energy consumption of current and future RAN with focus on strategies to modernize RAN with new RAT's while reduce the total energy consumption of the RAN. Operators and vendors are running parallel studies on energy consumption of the future RAN, elaborating on different energy saving strategies. However, results are very different with low accuracy as methods are quite diverse with limited standard support for metrics and methods.

The aim of the present document is to collect best practices on future RAN energy performance assessment, list KPI's from available standards and define additional KPI's needed for a relevant assessment of future RAN deployment.

As RAN consumes 80 % of mobile systems energy consumption, the present document is focusing on RAN site and equipment, including Backhaul. Depending on technology, it is often referred to as BTS, NodeB, eNodeB, etc. and in the present document denoted as BS. Core and service networks are not considered. The power consumption of Radio Network Control nodes (RNC or BSC) are covered in ETSI ES 201 554 [i.35].

The measurements in testing laboratories of the efficiency of the Base Stations is the topic treated in ETSI ES 202 706 [i.18]. Field measurement energy performance is defined in ETSI ES 203 228 [i.19]. Energy metrics of those standards are preferred.

1 Scope

The aim of the present document is to find and describe methods and best practice to assess energy performance (Energy Consumption and Energy Efficiency) of a future RAN deployment. The results documented will include a summary of previous work, a collection of important preconditions as traffic aspects (growth, new traffic classes, potential disruption), collection of energy efficiency/saving solutions and strategies and energy issues in current networks. Network energy performance assessment method examples based on set of scenarios including different solutions. The assessment period is at least until 2020, optionally also including 5G impact. Energy consumption and efficiency definitions from ETSI ES 202 706 [i.18] and ETSI ES 203 228 [i.19] are preferred.

2 References

2.1 Normative references

Normative references are not applicable in the present document.

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.

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3 Abbreviations

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

AC	Alternating Current
AirCon	Air Condition
BS	Base Station
CA	Carrier Aggregation
cf	cooling factor
CC	Common Channels
COP	Coefficient Of Performance.

NOTE: Efficiency KPI for climate equipment.

DBS	Distributed Base Station
DC	Direct Current
DL	DownLink
EC	Energy Consumption
EU	European Union
FD-MIMO	Full Dimension MIMO
FP7	UE Frame Program 7
GHG	Green House Gas
GSM	Global System for Mobile communication

GWATT® Global What

NOTE: If Analyser of network energy consumption.

ICT Information and Communication Technology
IoT Internet of Things

NOTE: Including M2M, D2D, V2X, etc.

IP Internet Protocol
ITU-T International Telecommunication Union - Telecommunication Standardization Sector
KPI Key Performance Indicator
KTH Royal Institute of Technology, Stockholm

NOTE: In Swedish: Kungliga Tekniska Högskolan.

LAA Large Antenna Arrays
LiU Linköping University
LSA Large Scale Antennas
LuU Lund University
METIS EU FP7 cofunded research project on telecommunication at 2020 and beyond.
MIMO Massive Input Massive Output
NB Narrow Band
PA Power Amplifier
PC Personal Computers
QoS Quality of Service
RAN Radio Access Network
RAT Radio Access Technology

NOTE: E.g. GSM, 3G, 4G, 5G.

RATS Radio Access Technologies
SC Small Cell
SE Spectral Efficiency
SEE Site Energy Efficiency
sf site factor

NOTE: I.e. total site energy consumption/BS equipment energy consumption.

sps shelter power share

NOTE: I.e. the dissipation in shelter versus DC energy consumption.

TBC To Be Confirmed
TCO Total Cost of Ownership
URL Uniform Resource Locator

NOTE: I.e. web address.

VNI Visual Networking Index

NOTE: CISCO® tool providing ICT traffic data.

WI Work Item
RNC Radio Network Control

4 Assessment of Energy Performance of future RAN

4.1 Assessment steps

The basic steps for the analysis are: