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Foreword

This ETSI Standard (ES) has been produced by ETSI Technical Committee Access, Terminals, Transmission and Multiplexing (ATTM).

The present document is part 3, sub-part 2 of a multi-part deliverable. Full details of the entire series can be found in part 1 [i.1].

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).

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Executive summary

The present document proposes a series of KPIs to evaluate the operational impact on greenhouse gas emissions of ICT infrastructures in operation. The present document only deals with carbon intensity related to work done as defined in relevant standards ETSI EN 305 200-2-3 [2], ETSI EN 305 200-2-2 [1] and ETSI EN 305 200-3-1 [3]. It does not consider greenhouse gas related to other LCA phases (e.g. construction, decommissioning) nor other LCA considerations (e.g. raw materials, water) that will be dealt of in a future part of the series.

Introduction

Greenhouse gas emissions continue to rise, 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 operators implement effective general engineering of fixed and mobile broadband networks and sites provisioning, managing or using those networks (i.e. ICT sites) in order to respond to critical issues of greenhouse gas emissions while proposing essential solutions to broadband deployment. To guide this process, it is essential that metrics are defined, termed Global Key Performance Indicators (KPIs), that enable greenhouse gas usage to be managed more effectively.

The Global Key Performance Indicators specified in the ETSI EN 305 200 [i.2] series address operational infrastructures and do not consider design or operation of individual components comprising those infrastructures.

ETSI EN 305 200 [i.2] series of standards comprises:

- ETSI EN 305 200-1 [i.1] a generic requirements document addressing Global KPIs for operational infrastructures;
- a sub-series ETSI EN 305 200-2 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 EN 305 200-2-1 [i.11]: ICT sites;
  - ETSI EN 305 200-2-2 [1]: Fixed broadband access networks;

  NOTE: Excluding cable access networks.
- ETSI EN 305 200-2-3 [2]: Mobile broadband access networks.

The standards do not define weightings of Objective KPIs or targets or limits for Global KPIs but may contain information on values that have been used by certain organizations:

- a sub-series ETSI EN 305 200-3 including the present document that defines particular implementations of Global KPIs within ICT sites based on the requirements of ETSI EN 305 200-2-1 [i.11], and which may define levels of performance to simplify and provide clearer understanding of Global KPIs allowing the evaluation of performance of energy and carbon use management in ICT sites:
  - ETSI EN 305 200-3-1 [3]: Data processing and Communications Energy Management (DCEM);
  - ETSI EN 305 200-3-2: the present document;
- a sub-series ETSI EN 305 200-4 including ETSI EN 305 200-4-4 [i.7] that defines design assessments of 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).

These standards may be considered to be a contribution to the application of ISO 14001 [i.8] in relation to the development of policy for the continuous improvement of greenhouse gas management and will accelerate:

- the availability of operational infrastructure architectures and network implementations that reduce greenhouse gas emissions;
- the definition and attainment objectives for other environmental aspects of sustainability for operational broadband networks.

1 Scope

The present document specifies the requirements for a Global KPI for carbon management in operation (KPI_{DCCM}) and their underpinning Objective KPIs addressing the following objectives for the ICT sites of broadband deployment:

- Greenhouse gas emissions
- Effectiveness of energy generation over greenhouse gas emissions
- Avoided greenhouse gas emission
- Reused greenhouse gas emission

The management of energy efficiency is outside the scope of the present document.

Within the present document:

- clause 4.1 describes the energy parameters for ICT sites together with inclusions/exclusions of different energies contributions;
- clause 4.2 specifies the requirements for measurement, calculation, classification and reporting of KPI_{DCCM}.

The present document addresses CO_2 equivalent emissions (CO_2eq) resulting from energy consumption by *operational equipment* in ICT sites or groups of sites. It does not deal with other GHG gas emissions coming from cooling/heating (including heat recovery systems equipment leakages such as described in the Directive F-Gas EU-517-2014 [i.6] and emissions related to manufacturing, transportation and end of life.

The Global KPI alone is not designed for comparison of ICT sites or groups of sites. It does not define an ICT site as good or bad unless combined with other parameters considered relevant for a comparison, such as local climatic conditions, availability requirements or purpose of the ICT site.

The present document relies on energy measurement and task effectiveness principles defined in standards ETSI EN 305 200-3-1 [3] for data centres, ETSI EN 305 200-2-2 [1] for fixed networks and ETSI EN 305 200-2-3 [2] for mobile 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 EN 305 200-2-2: "Access, Terminals, Transmission and Multiplexing (ATTM); Energy management; Operational infrastructures; Global KPIs; Part 2: Specific requirements; Sub-part 2: Fixed broadband access networks".

[2] ETSI EN 305 200-2-3: "Access, Terminals, Transmission and Multiplexing (ATTM); Energy management; Operational infrastructures; Global KPIs; Part 2: Specific requirements; Sub-part 3: Mobile broadband access networks".

[3] ETSI EN 305 200-3-1: "Access, Terminals, Transmission and Multiplexing (ATTM); Energy management; Operational infrastructures; Global KPIs; Part 3: ICT Sites; Sub-part 1: DCEM".

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] ETSI EN 305 200-1: "Access, Terminals, Transmission and Multiplexing (ATTM); Energy management; Operational infrastructures; Global KPIs; Part 1: General requirements".

[i.2] ETSI EN 305 200 series: "Access, Terminals, Transmission and Multiplexing (ATTM); Energy management; Operational infrastructures; Global KPIs".

[i.3] ETSI ES 203 228: "Environmental Engineering (EE); Assessment of mobile network energy efficiency".

[i.4] Kyoto Protocol to the United Nations Framework Convention on Climate Change.

[i.5] Guidebook EUR 24360 EN (2010): "How to Develop a Sustainable Energy Action Plan (SEAP)".

NOTE: Available at https://publications.jrc.ec.europa.eu/repository/handle/JRC57789.

[i.6] Regulation (EU) No 517/2014 of the European Parliament and of the Council of 16 April 2014 on fluorinated greenhouse gases and repealing Regulation (EC) No 842/2006.

NOTE: Available at https://www.eea.europa.eu/policy-documents/regulation-eu-no-517-2014.

[i.7] ETSI EN 305 200-4-4: "Integrated broadband cable telecommunication networks (CABLE); Energy management; Operational infrastructures; Global KPIs; Part 4: Design assessments; Sub-part 4: Cable access networks".

[i.8] ISO 14001: "Environmental management systems".

[i.9] IPCC WG5 AR5 report annex: "Technology-specific Cost and Performance Parameters", Schlömer S., T. Bruckner, L. Fulton, E. Hertwich, A. McKinnon, D. Perczyk, J. Roy, R. Schaeffer, R. Sims, P. Smith, and R. Wiser, 2014: Annex III: "Technology-specific cost and performance parameters". In Climate Change 2014: Mitigation of Climate Change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, Edenhofer, O., R. Pichs-Madruga, Y. Sokona, E. Farahani, S. Kadner, K. Seyboth, A. Adler, I. Baum, S. Brunner, P. Eickemeier, B. Kriemann, J. Savolainen, S. Schlömer, C. von Stechow, T. Zwickel and J.C. Minx (eds.). Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

NOTE: Available at ipcc_wg3_ar5_annex-iii.pdf.

[i.10] "Emissions from Photovoltaic Life Cycles", Vasilis M. Fthenakis, Hyung Chul Kim and Erik Alsema. PV Environmental Research Center, Brookhaven National Laboratory, Upton, New York, Center for Life Cycle Analysis, Columbia University, New York, and Copernicus Institute of Sustainable Development, Utrecht University, Heidelberglaan 2, 3584 CS Utrecht, The Netherlands.

NOTE: Available at Emissions from Photovoltaic Life Cycles (acamedia.info).

[i.11] ETSI EN 305 200-2-1: "Access, Terminals, Transmission and Multiplexing (ATTM); Energy management; Operational infrastructures; Global KPIs; Part 2: Specific requirements; Sub-part 1: ICT Sites".

3 Definition of terms, symbols and abbreviations

3.1 Terms

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

carbon emission factor: kilograms of equivalent carbon dioxide emitted per kWh (kg of CO_2eq/kWh)

carbon intensity: quantity of CO_2 equivalent emission per unit of final energy consumption for an operational period of time

energy consumption: total consumption of energy by an operational infrastructure

final energy consumption: energy consumption as seen by the consumer of a power source

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

global KPI: compound KPI obtained by combination of objective KPIs in order to assess overall performance of carbon management

ICT equipment: equipment providing data storage, data processing and data transport services

ICT site: site containing structures or group of structures dedicated to the accommodation, interconnection and operation of ICT equipment together with all the facilities and infrastructures for power distribution and environmental control together with the necessary levels of resilience and security required to provide the desired service availability

objective KPI: KPI assessing one of the objectives of operational carbon emission which is subsequently used to define a Global KPI for Carbon management

operational infrastructure: combination of information technology equipment and/or network telecommunications equipment together with the power supply and environmental control systems necessary to ensure provision of service, including climatic conditions, security and safety installations

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

NOTE: In addition, for the purpose of the present document, the energy required for production is not higher than 10 % of the produced energy.

ton: non-SI unit of mass equal to 1 000 kilograms

3.2 Symbols

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

CEF_i	Carbon Emission Factor of source i
CEF_{REFi}	Carbon Emission Factor reference for source i
CE_{REC}	Carbon Emission Requirements avoided by reusing ICT site waste heat
$DC_{C.CLASS}$	Carbon emission Class part of KPI_{DCCM}
DC_{CE}	Carbon emission part of KPI_{DCCM}
DC_{CMP}	Carbon Management Performance
DC_G	Energy consumption gauge
EC_i	Total Energy consumption of source i
EC_{REF}	Reference Carbon Emission of an ICT site
KPI_{AE}	Objective KPI for "CO_2eq Avoided Emission"
KPI_{DCCM}	Global KPI for DCCM
KPI_{EC}	Objective KPI for "Energy Consumption"
KPI_{CE}	Objective KPI for "CO_2eq Emission"

KPI_{CEE}	Objective KPI for "Carbon Emission Effectiveness"
KPI_{REC}	Objective KPI for "CO_2eq RECycled emission"
KPI_{TE}	Objective KPI for "Task Effectiveness"
W_{AE}	Weighting factor for Avoided Emissions
W_{REC}	Weighting factor for RECycled emissions

3.3 Abbreviations

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

CEF	Carbon Emission Factor
CO_2eq	CO_2 equivalent
DCCM	Dataprocessing & Communications Carbon Management
DCEM	Dataprocessing and Communications Energy Management
EC	European Community
EU	European Union
GHG	GreenHouse Gas
GWP	Global Warming Potential
ICT	Information and Communication Technology
IPCC	Intergovernmental Panel on Climate Change
KPI	Key Performance Indicator
kWh	kiloWatt per hour
LCA	Life Cycle Assessment
MWh	MegaWatt per hour
OEU	Operational energy Efficiency for Users (ETSI Industry Specification Group)
PV	PhotoVoltaic
SEAP	Sustainable Energy Action Plan
SI	International System of Units

4 Definition of Key Performance Indicators

4.1 Objective KPIs for ICT sites operation

4.1.1 Carbon Emission of an ICT Site (KPI_{CE})

4.1.1.1 General

The operational Carbon emission of an ICT site is directly correlated to its energy consumption KPI_{EC} as defined in appropriate related standard (ETSI EN 305 200-2-2 [1], ETSI EN 305 200-2-3 [2] or ETSI EN 305 200-3-1 [3]).

All energy required to maintain an ICT site at its design level of service availability, including energy required by hosted ICT equipment and by technical equipment such as cooling, power distribution, surveillance systems, access control, flood and fire detection, fire extinguishing system and lighting are allocated to KPI_{EC}.

All other energy consumptions within the boundaries of an ICT site but not necessary to deliver the design level of service availability (such as office facilities) are out of the scope and are not included in any measurements of KPI_{EC}.

All energy consumptions shall be recorded by energy meters when possible. In other cases, final energy consumption by systems for producing and distributing other kinds of energy (e.g. cold loop network) shall be recorded.

Energy sources shall be clearly identified and translated into equivalent CO_2 emission (CO_2eq).

4.1.1.2 Scale

KPI_{CE} applies to all ICT sites of all sizes and includes ICT rooms located in buildings.

4.1.1.3 Evolution

KPI_{CE} applies to all states of ICT sites, from initial operation to end of life.

4.1.1.4 Formula

$$KPI_{CE} = \sum_{i=1}^{n} (EC_i \times CEF_i)$$

Where:

- EC_i: Yearly energy consumption by ICT site from power source *i* (e.g. local, heat/cold loops, grid) expressed as MWh.
- CEF_i: Yearly average Carbon Emission Factor of the source *i*.
- KPI_{CE} shall be expressed in Tons of CO_2eq.

NOTE: $\sum_{i=1}^{n} EC_i = KPI_{EC}$.

4.1.1.5 Measurement points and processes

Measurement points and processes related to energy consumptions EC_i are defined in appropriate related standard (ETSI EN 305 200-2-2 [1], ETSI EN 305 200-2-3 [2] or ETSI EN 305 200-3-1 [3]).

Emission Factors CEF_i applicable for each type of energy source at the time of writing as well as related general principles are listed in Annex A.

NOTE 1: If the country mix value for the considered period is not already known at the date of the assessment, the latest official known value will be used.

NOTE 2: Are considered only scope 1 and scope 2 emissions.

NOTE 3: Indirect GHG emissions due to refrigerant and GHG leakages are not considered.

4.1.2 Carbon Emission Effectiveness (KPI_{CEE})

4.1.2.1 General

KPI_{CEE} is the ratio of CO_2eq to actual work done in an ICT site over one year.

4.1.2.2 Scale

KPI_{CEE} applies to all ICT sites of all sizes and includes ICT rooms located in buildings.

4.1.2.3 Evolution

KPI_{CEE} applies to all states of ICT sites, from initial operation to end of life.

4.1.2.4 Formula

$$KPI_{CEE} = \frac{KPI_{CE} \times KPI_{TE}}{KPI_{EC}}$$

Where:

- KPI_{CE} is the Carbon emission KPI as defined in clause 4.1.1.
- KPI_{EC} is the total energy consumption as defined in appropriate related standard (ETSI EN 305 200-2-2 [1], ETSI EN 305 200-2-3 [2] or ETSI EN 305 200-3-1 [3]).

- KPI_{TE} is the task effectiveness as defined in appropriate related standard (ETSI EN 305 200-2-2 [1], ETSI EN 305 200-2-3 [2] or ETSI EN 305 200-3-1 [3]).
- KPI_{CEE} shall be expressed in kg of CO_2eq/MWh for ICT sites and kg of CO_2eq/data transmitted for mobile and fixed network as defined in relevant standards.

4.1.2.5 Measurement points and processes

Measurement points and processes related to energy consumption KPI_{CE} are defined in appropriate related standard (ETSI EN 305 200-2-2 [1], ETSI EN 305 200-2-3 [2] or ETSI EN 305 200-3-1 [3]).

NOTE 1: Measurements are done over a yearly period, so as to take into account the yearly climate changes.

NOTE 2: Carbon emission factors follow rules expressed in clause 4.1.1.

4.1.3 Avoided Emission (KPI_{AE})

4.1.3.1 General

KPI_{AE} is the ratio of the CO_2eq emission avoided due to the use of low carbon energy sources to the Reference Carbon Emission of the ICT site EC_{REF}.

Avoided emissions is the amount of CO_2eq that would have been emitted during one year if the grid had been used instead of the actual implemented power sources except when backup power had been used.

KPI_{AE} is a dimensionless number the maximum of which is 1, with the following meanings:

- 0: equivalent to the carbon intensity if all power was coming from the public grid
- 1: carbon free ICT site
- < 0: implemented solution has a worse carbon emission than if it had been connected to the grid

4.1.3.2 Scale

KPI_{AE} applies to all ICT sites of all sizes.

4.1.3.3 Evolution

KPI_{AE} applies to all states of ICT sites in operation, from initial operation to end of life.

4.1.3.4 Formula

$$KPI_{AE} = 1 - \frac{KPI_{CE}}{\sum_{i=1}^{N} EC_i \times CEF_{REFi}}$$

Where:

- KPI_{CE} is the Carbon emission (CO_2eq) KPI as defined in clause 4.1.1.
- EC_i is the yearly energy consumption of the source *i*.
- CEF_i is the yearly average Carbon Emission Factor (CEF) of source *i*.
- CEF_{REFi} is the yearly average Carbon Emission Factor (CEF) of the public grid for each energy source except for backup power sources. In this case the CEF value of the current backup power source shall be used. Reference Carbon emission for standard diesel generators shall be considered in future versions of the present document.

NOTE: $\sum_{i=1}^{N} EC_i \times CEF_{REFi} = KPI_{CEREF}$.

4.1.3.5 Measurement points and processes

Measurement points and processes related to energy consumption EC_i are defined in appropriate related standards (ETSI EN 305 200-2-2 [1], ETSI EN 305 200-2-3 [2] or ETSI EN 305 200-3-1 [3]).

4.1.4 Recycled Emission (KPI_{REC})

4.1.4.1 General

KPI_{REC} is the ratio of the CO_2eq emission avoided due to energy reuse for external uses to KPI_{CE}. Energy can be reused in different forms, liquid or gas (air). KPI_{REC} shall be measurable, quantifiable, and result reported in a dimensionless number.

Shall be considered as avoided emissions, the CO_2 equivalent emission linked to energy reused by existing usages which could not be reduced by other action and new usages which not have been created thank to the reuse of the output heat (e.g. heating of storage room or arboretum, etc.).

Emission avoided KPI_{REC} will be calculated taking into account the reference Energy source type which would have been used if the reused energy had not been available. The reference energy source shall be determined considering the public grid or available local energy sources.

4.1.4.2 Scale

KPI_{REC} applies to all ICT sites of all sizes and includes ICT rooms located in buildings.

4.1.4.3 Evolution

KPI_{REC} applies to all states of ICT sites in operation, from initial operation to end of life.

4.1.4.4 Formula

$$KPI_{REC} = \frac{CE_{REC}}{KPI_{CE}}$$

Where:

- KPI_{CE} is the Carbon emission (CO_2eq) KPI as defined in clause 4.1.1.
- CE_{REC} is the yearly CO_2 equivalent emission of the energy that would have been required if the reused heat had not been available. It is expressed in Tons of CO_2eq. For Operator sites and Operator data centres, CE_{REC} is based on the EC_{REUSE} as defined in ETSI EN 305 200-3-1 [3], converted to equivalent Carbon emission.

4.1.4.5 Measurement points and processes

Measurement points and processes related to energy reuse EC_{REUSE} are defined in ETSI EN 305 200-3-1 [3].

4.2 Definition of Global KPI KPI_{DCCM}

4.2.1 General

KPI_{DCCM} (Dataprocessing & Communications Carbon Management) determines in a simple way the conformance to a given "Carbon management" policy by a single ICT site or a group of ICT sites.

It is composed of two values, DC_{CE} and $DC_{C.Class}$, where:

- DC_{CE} is the CO_2eq emission by a single ICT site or a group of ICT Sites, expressed in Tons of CO_2eq over a year.
- $DC_{C.CLASS}$ is the CO_2eq emission performance class of a single ICT Site or a group of ICT sites, expressed as a letter.

The present document defines the principles for calculating CO_2 equivalent emission performance of ICT sites and provides a default number of classes and default gauges.

4.2.2 Global KPI KPI_{DCCM} for a single ICT site

4.2.2.1 General

For a single site, DC_{CE} and $DC_{C.CLASS}$ are calculated as follows:

- $DC_{CE} = KPI_{CE}$ as defined in clause 4.1.1.
- $DC_{C.CLASS}$ is a banded representation of Carbon Management Performance DC_{CMP} detailed in clause 4.2.2.3.

4.2.2.2 Definition of Energy Consumption Gauge (DC_G)

Within KPI_{DCCM}, DC_G is a banded representation of Objective KPI of energy consumption (KPI_{EC}) and is used to define the applicable weightings for W_{AE} and W_{REC} within the calculation of DC_{CMP} of clause 4.2.2.3.

Table 1: Default Gauges (DC_G)

KPI_{EC} range	DC_G
< 0,04 GWh	'XXS'
0,04 GWh ≥ KPI_{EC} < 0,2 GWh	'XS'
0,2 GWh ≥ KPI_{EC} < 1 GWh	'S'
1 GWh ≥ KPI_{EC} < 5 GWh	'M'
5 GWh ≥ KPI_{EC} < 25 GWh	'L'
25 GWh ≥ KPI_{EC} < 120 GWh	'XL'
≥ 120 GWh	'XXL'

The number of classes and ranges are at the hand of EC and Member States in order to define the minimum level to be reached for each DC_G.

4.2.2.3 Formula for Carbon Management Performance (DC_{CMP})

Formula: $DC_{CMP} = KPI_{CEE} \times (1 - W_{AE} \times KPI_{AE}) \times (1 - W_{REC} \times KPI_{REC})$ subject to a minimum value of 0.

Where:

- KPI_{CEE} is the Carbon emission effectiveness KPI as defined in clause 4.1.2.
- KPI_{AE} is the Avoided emissions KPI as defined in clause 4.1.3.
- KPI_{REC} is the Recycled emissions KPI as defined in clause 4.1.4.
- W_{AE} is a weighting factor ranging from 0 to 1.
- W_{REC} is a weighting factor ranging from 0 to 1.

- DC_{CMP} shall be expressed in kg of CO_2eq/MWh for ICT sites and kg of CO_2eq/data transmitted for mobile and fixed network as defined in relevant standards.

The weighting factors are at the hand of EC and Member States in order to define a policy for each DC_G.

The members of OEU consider factors value W_{AE} =1 and W_{REC} =1.

4.2.2.4 Definition of Carbon Management Performance class ($DC_{C.CLASS}$)

The Carbon Management performance class of an ICT site is determined by its DC_{CMP}. As explained in the scope, this KPI alone is not designed for comparison of ICT sites or group of sites. It does not define an ICT site as good or bad unless combined with other parameters considered relevant for a comparison, such as local climatic conditions, availability requirements or purpose of ICT site.

Table 2: Default Carbon Management Performance Classes for ICT sites

$DC_{C.Class}$	DC_{CMP} Range	
	≥	<
A		40
B	40	100
C	100	180
D	180	280
E	280	400
F	400	540
G	540	

4.2.3 Global KPI KPI_{DCCM} for a group of ICT sites

4.2.3.1 General

For a group of sites, DC_{CE} and $DC_{C.CLASS}$ are calculated as follows:

- DC_{CE} = Carbon Emission by a group of ICT sites
- $DC_{C.CLASS}$ = Carbon Management class for a group of ICT Sites

Network access ICT sites shall be considered in a different group than the rest of the ICT sites so as to keep a consistent view across industries that require diffuse networks (e.g. telecom and other mobility industries, smart cities) and those that do not. Use of standard ETSI ES 203 228 [i.3] may help to determine such groups.

4.2.3.2 Formula for Group CO_2 equivalent emission

$$DC_{CE} = \sum_{i=1}^{n} KPI_{CE}\,(i)$$

Where $KPI_{CE}(i)$ is the Carbon emission as defined in clause 4.1 by the i^{th} ICT site in a group of *n* ICT sites.

4.2.3.3 Formula for Group CO_2 equivalent emission performance Class

The class associated with a group of ICT sites is a weighted average of all ICT sites classes.

$$DC_{C.CLASS} = \frac{\sum_{i=1}^{n} DC_{C.CLASS}(i) \times KPI_{CE}(i)}{\sum_{i=1}^{n} KPI_{CE}(i)}$$

For this calculation, class letters are translated to their rank, i.e. A=1, B=2…; $DC_{C.CLASS}$ is expressed as a letter.

4.2.4 Scale

KPI_{DCCM} applies to all ICT sites, networks or groups of ICT sites of all sizes.

4.2.5 Evolution

KPI_{DCCM} applies to all states of ICT sites, networks or groups of ICT sites, from initial operation to end of life.

4.2.6 Measurement points and processes

Not relevant to this KPI.

Annex A (informative): Emission factors

A.1 Carbon emission factors of energy sources

GreenHouse Gases (GHGs) emissions are measured as CO_2eq. This universal unit allows the global warming potential of different GHGs to be compared. Values for CH_4 and N_2O are presented as CO_2eq using Global Warming Potential (GWP) factors, consistent with reporting under the Kyoto Protocol [i.4] and the second assessment report of the Intergovernmental Panel on Climate Change (IPCC) [i.9].

CO_2eq emissions can be either measured by continuously monitoring source emissions or estimated by multiplying activity data (e.g. litres of used fuel, consumption of natural gas) by relevant emissions factors. These factors convert activity data into Tons of CO_2eq.

Tables A.1 to A.3 correspond to tables 5, 6 and 7 extracted from Guidebook "How to Develop a Sustainable Energy Action Plan (SEAP)" [i.5]

A.2 National emission factors for consumed Electricity

Carbon Emission Factor for public Electricity Network is the average mix value for the considered period as published by the country's Energy regulation authority.

Table A.1

[t CO_2/MWh] Country	Standard emission factor	LCA emission factor
Austria	0,209	0,310
Belgium	0,285	0,402
Germany	0,624	0,706
Denmark	0,461	0,760
Spain	0,440	0,639
Finland	0,216	0,418
France	0,056	0,146
United Kingdom	0,543	0,658
Greece	1,149	1,167
Ireland	0,732	0,870
Italy	0,483	0,708
Netherlands	0,435	0,716
Portugal	0,369	0,750
Sweden	0,023	0,079
Bulgaria	0,819	0,906
Cyprus	0,874	1,019
Czech Republic	0,950	0,802
Estonia	0,908	1,593
Hungary	0,566	0,678
Lithuania	0,153	0,174
Latvia	0,109	0,563
Poland	1,191	1,185
Romania	0,701	1,084
Slovenia	0,557	0,602
Slovakia	0,252	0,353
EU-27 (EU-Wide mean) (see note)	0,460	0,578
NOTE: Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden and the United Kingdom.		

A.3 Emission factors for fuel combustion

Table A.2

[t CO_2/MWh] Fuel combustion	Standard emission factor	LCA emission factor
Motor Gasoline	0,249	0,299
Anthracite	0,267	0,305
Residual Fuel Oil	0,279	0,310
Anthracite	0,354	0,393
Other Bituminous Coal	0,341	0,380
Sub-Bituminous Coal	0,346	0,385
Lignite	0,364	0,375
Natural Gas	0,202	0,237
Municipal Wastes (non-biomass)	0,330	0,330
Sustainable wood	0,000	0,000
Unsustainable wood	0,402	0,405
Plant oil	0,000	0,182
Biodiesel	0,000	0,156
Bioethanol	0,000	0,206
Solar Thermal	0,000	0,000
Geothermal	0,000	0,000

Also consider the following table [i.9].

Table A.III.2 | Emissions of selected electricity supply technologies (gCO_2eq/kWh)[i]

Options	Direct emissions	Infrastructure & supply chain emissions	Biogenic CO_2 emissions and albedo effect	Methane emissions	Lifecycle emissions (incl. albedo effect)
	Min/Median/Max	Typical values			Min/Median/Max
Currently Commercially Available Technologies					
Coal—PC	670/760/870	*9.6*	*0*	*47*	**740/820/910**
Gas—Combined Cycle	350/370/490	*1.6*	*0*	*91*	**410/490/650**
Biomass—cofiring	n.a.[ii]	–	–	–	**620/740/890**[iii]
Biomass—dedicated	n.a.[ii]	*210*	*27*	*0*	**130/230/420**[iv]
Geothermal	0	*45*	*0*	*0*	**6.0/38/79**
Hydropower	0	*19*	*0*	*88*	**1.0/24/2200**
Nuclear	0	*18*	*0*	*0*	**3.7/12/110**
Concentrated Solar Power	0	*29*	*0*	*0*	**8.8/27/63**
Solar PV—rooftop	0	*42*	*0*	*0*	**26/41/60**
Solar PV—utility	0	*66*	*0*	*0*	**18/48/180**
Wind onshore	0	*15*	*0*	*0*	**7.0/11/56**
Wind offshore	0	*17*	*0*	*0*	**8.0/12/35**

A.4 Emission factors for local renewable electricity production

Table A.3

[t CO_2/MWh] Country	Standard emission factor	LCA emission factor
Solar PV	0,000	0,020 - 0,050 (see note 1)
WindPower	0,000	0,007 (see note 2)
HydroPower	0,000	0,024
NOTE 1: Source: Vasilis et al., 2008 [i.10].		
NOTE 2: Based on results from one plant, operated in coastal areas with good wind conditions.		

Annex B (informative): Change History

Date	Version	Information about changes
03/2021	0.0.0	Initial document

History

Document history		
V1.1.0	February 2022	Membership Approval Procedure MV 20220419: 2022-02-18 to 2022-04-19
V1.1.1	April 2022	Publication