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Foreword

This Group Specification (GS) has been produced by ETSI Industry Specification Group (ISG) Operational energy Efficiency for Users (OEU).

The present document is based on the Objective KPIs defined in standard ETSI EN 305 200-2-2 [2] for fixed networks, ETSI EN 305 200-2-3 [3] for mobile networks, ETSI EN 305 200-2-1 [1] for ICT Sites, their related implementation standards ETSI TS 105 200-2-2 [i.1], ETSI TS 105 200-2-3 [i.2], ETSI TS 105 200-3-1 [i.3] and uses them to define Global Key Performance Indicators (KPIs) allowing the evaluation of carbon equivalent intensity in ICT sites.

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

This group specification proposes a series of KPIs to evaluate the operational impact on greenhouse gas emissions by ICT sites.

Introduction

Information and Communication Technology (ICT) sites constitute one of the most important areas of the worldwide growing energy consumption. They are responsible for at least 2 % of the worldwide greenhouse gas emissions, still growing.

Greenhouse gas emissions of ICT sites are an important matter. It is now essential if not vital to implement commitments in order to reduce the greenhouse gas emission of ICT sites.

Further to the 1997 Kyoto protocol [i.5], the European Commission has issued, and will issue, Directives in order to improve energy management of networks, sites included, of whole industry sectors.

Therefore suppliers and users of ICT equipment are required to implement "Green" tools (indicators, recognized Green levels) to monitor the efficiency of their greener ICT sites.

Consequently, the first target of ETSI ATTM has been the development of the present document with support of ISG OEU members (ICT world Users) in order to define those tools.

The KPIs presented in the present document is an answer to requirements by end users and European Community to justify an environmental sustainability level for ICT sites. On the side of the ICT site owner, it assesses performance carbon intensity level; on the EC side, it allows a follow-up for the global adjustment of policy for sustainability of ICT industry.

1 Scope

The present document defines field implementation of a so-called Global Key Performance Indicator (Global KPI) enabling the monitoring of Carbon Intensity in all ICT sites including, but not limited to, data centres and operator sites.

The present document addresses Carbon usage performance due to energy usage by *operational infrastructures* in ICT sites. The present document does not deal with other CO_2 emissions related to ICT equipment manufacturing, transportation and end of life.

The present document deals with CO_2 equivalent emissions (CO_2eq) resulting from final energy consumption by ICT sites or group of sites. It does not deal with other GHG gas emissions coming from equipment leakages such as described in the Directive F-Gas EU-517-2014 [i.7].

Energy consumption should not to be confused with power generation. Only CO_2eq emission coming from energy actually consumed by the ICT site is considered. Use of excess locally generated power is out of the scope of the present document.

The Global 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.

The present document addresses in a simple way the equivalent carbon of following objectives defined in ETSI EN 305 200-2-1 [1] for data centres, ETSI EN 305 200-2-2 [2] for fixed networks and ETSI EN 305 200-2-3 [3] for mobile networks using four objective KPIs:

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

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

[2] 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".

[3] 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".

[4]   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.

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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 TS 105 200-2-2: "Access, Terminals, Transmission and Multiplexing (ATTM); Energy management; Operational infrastructures; Implementation of Global KPIs; Part 2: Specific requirements; Sub-part 2: Fixed broadband access networks".

[i.2]   ETSI TS 105 200-2-3: "Access, Terminals, Transmission and Multiplexing (ATTM); Energy management; Operational infrastructures; Implementation of Global KPIs; Part 2: Specific requirements; Sub-part 3: Mobile broadband access networks".

[i.3]   ETSI TS 105 200-3-1: "Access, Terminals, Transmission and Multiplexing (ATTM); Energy management; Operational infrastructures; Implementation of Global KPIs; Part 3: ICT Sites; Sub-part 1: DCEM".

[i.4]   ETSI ES 203 228: "Environmental Engineering (EE); Assessment of mobile network energy efficiency".

[i.5]   Kyoto Protocol to the United Nations Framework Convention on Climate Change.

[i.6]   Guidebook EUR 24360 EN (2010): "How to Develop a Sustainable Energy Action Plan (SEAP)".

[i.7]   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.

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 use

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.

fossil energy: any energy not classified as renewable energy

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

ICT equipment: equipment providing data storage, processing and 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 intensity

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 no 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_{REQ}	Carbon Emission Requirements avoided by reusing ICT site waste heat
$DC_{C.CLASS}$	Carbon emission Class part of DC_{CI}
DC_{CE}	Carbon emission part of DC_{CI}
DC_{CI}	Global KPI for Data processing & Communications Carbon Intensity
DC_{CIP}	Carbon Intensity Performance
DC_{CG}	Carbon emission gauge
EC_i	Total Energy consumption of source i
KPI_{AE}	Objective KPI for "C0$_2$eq avoided emission"
KPI_{EC}	Objective KPI for "Energy Consumption"
KPI_{CE}	Objective KPI for "C0$_2$eq Emission"
$KPIC_{EE}$	Objective KPI for "Carbon emission effectiveness"
$KPIR_{EC}$	Objective KPI for "C0$_2$eq recycled emission"

3.3 Abbreviations

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

CO$_2$eq	CO$_2$ equivalent
GHG	GreenHouse Gas
GWP	Global Warming Potential
IPCC	Intergovernmental Panel on Climate Change
KPI	Key Performance Indicator
kWh	kiloWatt per hour
MWh	MegaWatt per hour
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 ICT Site (KPI_{CE})

4.1.1.1   General

The 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 [2], ETSI EN 305 200-2-3 [3] or ETSI EN 305 200-3-1 [4]).

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 in Equivalent CO_2 emission (CO_2eq).

4.1.1.2   Scale

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

4.1.1.3   Evolution

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

Where:

KPI_{EC} is defined in appropriate related standard (ETSI EN 305 200-2-2 [2], ETSI EN 305 200-2-3 [3] or ETSI EN 305 200-3-1 [4]).

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 [2], ETSI EN 305 200-2-3 [3] or ETSI EN 305 200-3-1 [4]).

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:

- 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.

- Are considered only scope 1 and scope 2 emissions.

- Indirect GHG emission 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 energy consumption by an ICT site over one year.

4.1.2.2   Scale

KPI_{CEE} applies to all ICT sites of all sizes and includes IT 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

$$KPI_{CEE} = KPI_{CE}/KPI_{EC}$$

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 [2], ETSI EN 305 200-2-3 [3] or ETSI EN 305 200-3-1 [4]).

- KPI_{CEE} shall be expressed in kg of CO_2eq/MWh.

4.1.2.5   Measurement points and processes

Measurement points and processes related to energy consumption EC are defined in appropriate related standard (ETSI EN 305 200-2-2 [2], ETSI EN 305 200-2-3 [3] or ETSI EN 305 200-3-1 [4]).

NOTE:

- Measurement are done over a yearly period, so as to take into account the yearly climate changes.

- 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_2 that would have been emitted during one year if 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 that if it were 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.

- ECi is the yearly energy consumption of the source i.

- CEF_i is the yearly average Carbon Emission Factor of source i.

- CEF_{REFi} is the yearly average Carbon Emission Factor of the public grid for each energy sources 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 generator 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 are defined in appropriate related standard (ETSI EN 305 200-2-2 [2], ETSI EN 305 200-2-3 [3] or ETSI EN 305 200-3-1 [4]).

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_{AE} shall be measurable and quantifiable and results 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_{AE} will be calculated taking into account the reference Energy source type which would had been used if the reused energy had not been available.

4.1.4.2 Scale

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

4.1.4.3 Evolution

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

4.1.4.4 Formula

$$KPI_{REC} = CE_{REC} / KPI_{CE}$$

Where:

- KPI_{CE} is the Carbon emission (CO_2 eq) 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 [4], converted in 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 [4].

4.2 Definition of Global KPI DC_{CI}

4.2.1 General

KPI DC_{CI} (Data processing & Communications Carbon Intensity) determines in a simple way the conformance to a given "Carbon intensity" 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 DC_{CI} 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 Intensity Performance $DC_{CI\,P}$ detailed in clause 4.2.2.3.

4.2.2.2 Definition of Carbon Emission gauge (DC_{CG})

DC_{CG} is an intermediate KPI defining the carbon emission gauge based on the KPI_{CE} as defined in clause 4.1.1.

Table 1: Default Gauges (DC_{CG})

DC_{CG}	KPI_{CE} range
XXS	$KPI_{CE} \leq 20$
XS	$20 < KPI_{CE} \leq 100$
S	$100 < KPI_{CE} \leq 500$
M	$500 < KPI_{CE} \leq 2\ 500$
L	$2\ 500 < KPI_{CE} \leq 12\ 500$
XL	$12\ 500 < KPI_{CE} \leq 60\ 000$
XXL	$KPI_{CE} > 500\ 000$

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 Definition of Carbon Intensity performance (DC_{CIP})

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

Where:

- KPI_{CEE} is the Carbon emission efficiency 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.

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 Intensity performance class ($DC_{C.CLASS}$)

The Carbon Intensity performance class of an ICT site is determined by its DC_{CIP}. 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 Intensity Performance Classes

$DC_{C.Class}$	Range	
	$\geq$	$<$
A	0	40
B	40	100
C	100	180
D	180	280
E	280	400
F	400	540
G	540	$+\infty$

4.2.3 Global KPI DC_{CI} for a group of ICT sites

4.2.3.1 General

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

- DC_{CE} = Carbon Intensity by a group of ICT sites

- $DC_{C.CLASS}$ = Carbon Intensity class for a group of ICT Sites

Network access ICT sites shall be considered in a different group that of the rest of 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.4] 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 ith 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_{CLASS} is expressed as a letter.

4.2.4 Scale

KPI DC_{CI} applies to all sites or groups of ICT sites of all sizes.

4.2.5 Evolution

KPI DC_{EM} applies to all states of ICT sites or group 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 and the second assessment report of the Intergovernmental Panel on Climate Change (IPCC).

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.

The emission factors in the following tables come from Guidebook "How to Develop a Sustainable Energy Action Plan (SEAP)" [i.6].

Tables A.1 to A.3 correspond tables 5, 6 and 7 extracted from Guidebook "How to Develop a Sustainable Energy Action Plan (SEAP)" [i.6] © European Union, 2010. Reproduction is authorized provided the source is acknowledged.

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 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[1] (EU-Wide mean)	0.460	0.578

NOTE: [1] 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
Substainable wood	0.000	0,000
Unsubstainable 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

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 [2]
WindPower	0.000	0.007 [3]
HydroPower	0.000	0.024

NOTE: [2] Source: Vasilis et al., 2008
              [3] Based on results from one plant, operated in coastal areas with good wind conditions.

Annex B (informative):
Possible evolutions to KPI_{CEE}

In order to compare carbon intensity to actual work done (i.e. data volume for both fixed and mobile network, and energy consumption by ICT equipment for ICT sites), a future version of the present document could define Carbon efficiency as follows:

$$KPI_{CEE} = KPI_{CEE} \times KPI_{TE}/KPI_{EC}$$

Where:

- KPI_{TE} and KPI_{EC} are defined in appropriate related standard (ETSI EN 305 200-2-2 [2], ETSI EN 305 200-2-3 [3] or ETSI EN 305 200-3-1 [4]).

Annex C (informative):
Change History

Date	Version	Information about changes
January 2019	0.0.4	adapt to ETSI EN 305 200 published standards

History

Document history		
V1.1.1	March 2020	Publication