Operational energy Efficiency for Users (OEU);
Carbon equivalent Intensity measurement;
Operational infrastructures;
Global KPIs;
Global KPIs for ICT Sites

Disclaimer

The present document has been produced and approved by the Operational energy Efficiency for Users (OEU) ETSI Industry Specification Group (ISG) and represents the views of those members who participated in this ISG. It does not necessarily represent the views of the entire ETSI membership.
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History
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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).

"must" and "must not" are NOT allowed in ETSI deliverables except when used in direct citation.

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 CO₂ emissions related to ICT equipment manufacturing, transportation and end of life.

The present document deals with CO₂ equivalent emissions (CO₂eq) 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 [1,7].

Energy consumption should not to be confused with power generation. Only CO₂eq 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.


- 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”.
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 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)".

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 CO₂eq/kWh)

**carbon intensity**: quantity of CO₂ 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:

\[\begin{align*}
CEF_i & \quad \text{Carbon Emission Factor of source } i \\
CEF_{REF} & \quad \text{Carbon Emission Factor reference for source } i \\
CE_{REQ} & \quad \text{Carbon Emission Requirements avoided by reusing ICT site waste heat} \\
DCC_{CLASS} & \quad \text{Carbon emission Class part of } DCl \\
DCE & \quad \text{Carbon emission part of } DCl \\
DCCI & \quad \text{Global KPI for Data processing & Communications Carbon Intensity} \\
DCIP & \quad \text{Carbon Intensity Performance} \\
DC_{CG} & \quad \text{Carbon emission gauge} \\
EC_i & \quad \text{Total Energy consumption of source } i \\
KPI_{AE} & \quad \text{Objective KPI for "CO}_2\text{eq avoided emission"} \\
KPI_{EC} & \quad \text{Objective KPI for "Energy Consumption"} \\
KPI_{CE} & \quad \text{Objective KPI for "CO}_2\text{eq Emission"} \\
KPI_{CEE} & \quad \text{Objective KPI for "Carbon emission effectiveness"} \\
KPI_{REC} & \quad \text{Objective KPI for "CO}_2\text{eq recycled emission"}
\end{align*}\]

3.3 Abbreviations

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

\[\begin{align*}
\text{CO}_2\text{eq} & \quad \text{CO}_2 \text{ equivalent} \\
\text{GHG} & \quad \text{GreenHouse Gas} \\
\text{GWP} & \quad \text{Global Warming Potential} \\
\text{IPCC} & \quad \text{Intergovernmental Panel on Climate Change} \\
\text{KPI} & \quad \text{Key Performance Indicator} \\
k\text{Wh} & \quad \text{kiloWatt per hour} \\
\text{MWh} & \quad \text{MegaWatt per hour} \\
\text{SEAP} & \quad \text{Sustainable Energy Action Plan} \\
\text{SI} & \quad \text{International System of Units}
\end{align*}\]
4 Definition of Key Performance Indicators

4.1 Objective KPIs for ICT sites operation

4.1.1 Carbon Emission of ICT Site \((\text{KPI}_{CE})\)

4.1.1.1 General

The Carbon emission of an ICT site is directly correlated to its energy consumption \(\text{KPI}_{EC}\) 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 \(\text{KPI}_{EC}\).

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 \(\text{KPI}_{EC}\).

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\(_2\)-eq).

4.1.1.2 Scale

\(\text{KPI}_{CE}\) applies to all ICT sites of all sizes and includes IT rooms located in buildings.

4.1.1.3 Evolution

\(\text{KPI}_{EC}\) applies to all states of ICT sites, from initial operation to end of life.

4.1.1.4 Formula

\[
\text{KPI}_{CE} = \sum_{i=1}^{n} \left( \text{EC}_i \times \text{CEF}_i \right)
\]

Where:

- \(\text{EC}_i\): Yearly energy consumption by ICT site from power source \(i\) (e.g. local, heat/cold loops, grid) expressed as MWh.
- \(\text{CEF}_i\): Yearly average Carbon Emission Factor of the source \(i\).
- \(\text{KPI}_{EC}\) shall be expressed in Tons of CO\(_2\)-eq.

NOTE: \[\sum_{i=1}^{n} \text{EC}_i = \text{KPI}_{EC}\]

Where:

\(\text{KPI}_{EC}\) 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 \(\text{EC}_i\) 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 \(\text{CEF}_i\) 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 CO₂eq 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

\[
KPI_{CEE} = \frac{KPI_{CE}}{KPI_{EC}}
\]

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 CO₂eq/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 CO₂eq 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 CO₂ 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

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

Where:

- $KPI_{CE}$ is the Carbon emission (CO$_2$eq) 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 of source $i$.
- $CEF_{REF_i}$ 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: $\sum_{i=1}^{N} (EC_i \times CEF_{REF_i}) = KPI_{CEREF}$.

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$_2$eq 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

\[ KPI_{REC} = \frac{CE_{REC}}{KPI_{CE}} \]

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\(_2\)eq. For Operator sites and Operator data centres, \( CE_{REC} \) is based on the \( EC\_\text{REUSE} \) 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 \( EC\_\text{REUSE} \) 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 \( DC_{C\_\text{CLASS}} \), where:

- \( DC_{CE} \) is the CO\(_2\)eq emission by a single ICT site or a group of ICT Sites, expressed in Tons of CO\(_2\)eq over a year.
- \( DC_{C\_\text{CLASS}} \) is the CO\(_2\)eq 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 \( DC_{C\_\text{CLASS}} \) are calculated as follows:

- \( DC_{CE} = KPI_{CE} \) as defined in clause 4.1.1.
- \( DC_{C\_\text{CLASS}} \) is a banded representation of Carbon Intensity Performance \( DC\_\text{P} \) 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 \(KPICE\) as defined in clause 4.1.1.

**Table 1: Default Gauges (\(DC_{CG}\))**

<table>
<thead>
<tr>
<th>(DC_{CG})</th>
<th>KPICE range</th>
</tr>
</thead>
<tbody>
<tr>
<td>XXS</td>
<td>(KPICE \leq 20)</td>
</tr>
<tr>
<td>XS</td>
<td>(20 &lt; KPICE \leq 100)</td>
</tr>
<tr>
<td>S</td>
<td>(100 &lt; KPICE \leq 500)</td>
</tr>
<tr>
<td>M</td>
<td>(500 &lt; KPICE \leq 2500)</td>
</tr>
<tr>
<td>L</td>
<td>(2500 &lt; KPICE \leq 12500)</td>
</tr>
<tr>
<td>XL</td>
<td>(12500 &lt; KPICE \leq 60000)</td>
</tr>
<tr>
<td>XXL</td>
<td>(KPICE &gt; 500000)</td>
</tr>
</tbody>
</table>

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: \(DC_{CIP} = KPICE_{CEF} \times (1 - W_{AE} \times KP_{ARE}) \times (1 - W_{REC} \times KP_{IREC})\) subject to a minimum value of 0.

Where:

- \(KPICE_{CEF}\) is the Carbon emission efficiency KPI as defined in clause 4.1.2.
- \(KP_{ARE}\) is the Avoided emissions KPI as defined in clause 4.1.3.
- \(KP_{IREC}\) 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**

<table>
<thead>
<tr>
<th>(DC_{C.Class})</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>(\geq 0)</td>
</tr>
<tr>
<td>B</td>
<td>40</td>
</tr>
<tr>
<td>C</td>
<td>100</td>
</tr>
<tr>
<td>D</td>
<td>180</td>
</tr>
<tr>
<td>E</td>
<td>280</td>
</tr>
<tr>
<td>F</td>
<td>400</td>
</tr>
<tr>
<td>G</td>
<td>540</td>
</tr>
</tbody>
</table>
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 $DC_{CLASS}$ are calculated as follows:

- $DC_{CE} =$ Carbon Intensity by a group of ICT sites
- $DC_{CLASS} =$ 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 $i^{th}$ 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.

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

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 CO₂eq. This universal unit allows the global warming potential of different GHGs to be compared. Values for CH₄ and N₂O are presented as CO₂eq 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).

CO₂eq 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 CO₂eq.

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>
<thead>
<tr>
<th>Country</th>
<th>Standard emission factor</th>
<th>LCA emission factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Austria</td>
<td>0.209</td>
<td>0.310</td>
</tr>
<tr>
<td>Belgium</td>
<td>0.285</td>
<td>0.402</td>
</tr>
<tr>
<td>Germany</td>
<td>0.624</td>
<td>0.706</td>
</tr>
<tr>
<td>Denmark</td>
<td>0.461</td>
<td>0.760</td>
</tr>
<tr>
<td>Spain</td>
<td>0.440</td>
<td>0.639</td>
</tr>
<tr>
<td>Finland</td>
<td>0.216</td>
<td>0.418</td>
</tr>
<tr>
<td>France</td>
<td>0.056</td>
<td>0.146</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>0.543</td>
<td>0.658</td>
</tr>
<tr>
<td>Greece</td>
<td>1.149</td>
<td>1.167</td>
</tr>
<tr>
<td>Ireland</td>
<td>0.732</td>
<td>0.870</td>
</tr>
<tr>
<td>Italy</td>
<td>0.483</td>
<td>0.708</td>
</tr>
<tr>
<td>Netherlands</td>
<td>0.435</td>
<td>0.716</td>
</tr>
<tr>
<td>Portugal</td>
<td>0.369</td>
<td>0.750</td>
</tr>
<tr>
<td>Sweden</td>
<td>0.023</td>
<td>0.079</td>
</tr>
<tr>
<td>Bulgaria</td>
<td>0.819</td>
<td>0.906</td>
</tr>
<tr>
<td>Cyprus</td>
<td>0.874</td>
<td>1.019</td>
</tr>
<tr>
<td>Czech Republic</td>
<td>0.950</td>
<td>0.802</td>
</tr>
<tr>
<td>Estonia</td>
<td>0.908</td>
<td>1.593</td>
</tr>
<tr>
<td>Hungary</td>
<td>0.566</td>
<td>0.678</td>
</tr>
<tr>
<td>Lithuania</td>
<td>0.153</td>
<td>0.174</td>
</tr>
<tr>
<td>Latvia</td>
<td>0.109</td>
<td>0.563</td>
</tr>
<tr>
<td>Poland</td>
<td>1.191</td>
<td>1.185</td>
</tr>
<tr>
<td>Romania</td>
<td>0.701</td>
<td>1.084</td>
</tr>
<tr>
<td>Slovenia</td>
<td>0.557</td>
<td>0.602</td>
</tr>
<tr>
<td>Slovakia</td>
<td>0.252</td>
<td>0.353</td>
</tr>
<tr>
<td>EU-27 (EU-Wide mean)</td>
<td>0.460</td>
<td>0.578</td>
</tr>
</tbody>
</table>
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**

<table>
<thead>
<tr>
<th>Fuel combustion</th>
<th>Standard emission factor</th>
<th>LCA emission factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motor Gasoline</td>
<td>0.249</td>
<td>0.299</td>
</tr>
<tr>
<td>Anthracite</td>
<td>0.267</td>
<td>0.305</td>
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<tr>
<td>Residual Fuel Oil</td>
<td>0.279</td>
<td>0.310</td>
</tr>
<tr>
<td>Anthracite</td>
<td>0.354</td>
<td>0.393</td>
</tr>
<tr>
<td>Other Bituminous Coal</td>
<td>0.341</td>
<td>0.380</td>
</tr>
<tr>
<td>Sub-Bituminous Coal</td>
<td>0.346</td>
<td>0.385</td>
</tr>
<tr>
<td>Lignite</td>
<td>0.364</td>
<td>0.375</td>
</tr>
<tr>
<td>Natural Gas</td>
<td>0.202</td>
<td>0.237</td>
</tr>
<tr>
<td>Municipal Wastes (non-biomass)</td>
<td>0.330</td>
<td>0.330</td>
</tr>
<tr>
<td>Substainable wood</td>
<td>0.000</td>
<td>0.000</td>
</tr>
<tr>
<td>Unsubstainable wood</td>
<td>0.402</td>
<td>0.405</td>
</tr>
<tr>
<td>Plant oil</td>
<td>0.000</td>
<td>0.182</td>
</tr>
<tr>
<td>Biodiesel</td>
<td>0.000</td>
<td>0.156</td>
</tr>
<tr>
<td>Bioethanol</td>
<td>0.000</td>
<td>0.206</td>
</tr>
<tr>
<td>Solar Thermal</td>
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</tr>
<tr>
<td>Geothermal</td>
<td>0.000</td>
<td>0.000</td>
</tr>
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### A.4 Emission factors for local renewable electricity production

**Table A.3**

<table>
<thead>
<tr>
<th>Country</th>
<th>Standard emission factor</th>
<th>LCA emission factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solar PV</td>
<td>0.000</td>
<td>0.020-0.050 ²</td>
</tr>
<tr>
<td>WindPower</td>
<td>0.000</td>
<td>0.007 ³</td>
</tr>
<tr>
<td>HydroPower</td>
<td>0.000</td>
<td>0.024</td>
</tr>
</tbody>
</table>

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:

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

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

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<td>adapt to ETSI EN 305 200 published standards</td>
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## History

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