PRODUCT CATEGORY RULES (PCR)
DATE 2019-09-06

HOME AND SOHO GATEWAYS

PRODUCT CATEGORY CLASSIFICATION: UN CPC 47223

VERSION 2.11 2019-09-06

VALID UNTIL: 2021-02-28

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1 INTRODUCTION

This document constitutes Product Category Rules (PCR) developed in the framework of the International EPD® System: a programme for type III environmental declarations[1] according to ISO 14025:2006. Environmental Product Declarations (EPD) are voluntary documents for a company or organisation to present transparent information about the life cycle environmental impact for their goods or services.

The rules for the overall administration and operation of the programme are the General Programme Instructions, publicly available at www.environdec.com. A PCR complements the General Programme Instructions and the standards by providing specific rules, requirements and guidelines for developing an EPD for one or more specific product categories (see Figure 1). A PCR should enable different practitioners using the PCR to generate consistent results when assessing products of the same product category.

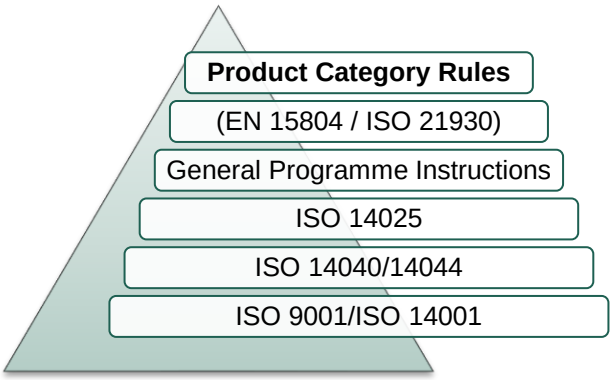

Figure 1 Illustration PCR in relation to the hierarchy of standards and other documents.

Within the present PCR, the following terminology is adopted:

- The term “shall” is used to indicate what is obligatory.
- The term “should” is used to indicate a recommendation, rather than a requirement.
- The term “may” or “can” is used to indicate an option that is permissible

For the definition of terms used in the document, see the normative standards.

A PCR is valid for a pre-determined period of time to ensure that it is updated at regular intervals. The latest version of the PCR is available via www.environdec.com. Stakeholder feedback on PCRs is very much encouraged. Any comments on this PCR document may be given via the PCR Forum at www.environdec.com or sent directly to the PCR moderator during its development or during the period of validity.

Any references to this document should include the PCR registration number, name and version.

The programme operator maintains the copyright of the document to ensure that it is possible to publish, update when necessary, and available to all organisations to develop and register EPDs. Stakeholders participating in PCR development should be acknowledged in the final document and on the website.

[1] Type III environmental declarations in the International EPD® System are referred to as EPD, Environmental Product Declarations.

2 GENERAL INFORMATION

2.1 ADMINISTRATIVE INFORMATION

Name:	Home and SOHO gateways *SOHO = Small Office, Home office*
Registration number and version:	2013:02, version 2.11
Programme:	The International EPD® System
Programme operator:	EPD International AB, Box 210 60, SE-100 31 Stockholm, Sweden. Website: www.environdec.com E-mail: info@environdec.com
PCR moderator:	Luca Giacomello, Telecom Italia SpA, Home Network & Wireline Devices (Italy) luca.giacomello@telecomitalia.it
PCR Committee:	Telecom Italia SpA, Home Network & Wireline Devices (Italy) Politecnico di Torino , Department of Applied Science and Technology (Italy)
Date of publication and last revision:	2019-09-06 (Version 2.11) Version 1.0 was published 2013-07-17. A version history is available in Section 7.
Valid until:	2021-02-28
Schedule for renewal:	A PCR is valid for a pre-determined period of time to ensure that it is updated at regular intervals. When the PCR is about to expire the PCR moderator shall initiate a discussion with the Secretariat how to proceed with updating the document and renewing its validity. A PCR document may be revised during its period of validity provided significant and well-justified proposals for changes or amendments are presented. See www.environdec.com for up-to-date information and the latest version.
Standards conformance:	▪ General Programme Instructions of the International EPD® System, version 3.0, based on ISO 14025 and ISO 14040/14044 ▪ PCR Basic Module, CPC Division 47 Radio, television and communication equipment, version 3.01, dated 2018-11-06
PCR language(s):	This PCR was developed and is available in English. In case of translated versions the English version takes precedence in case of any discrepancies.

2.2 SCOPE OF PCR

2.2.1 PRODUCT CATEGORY DEFINITION AND DESCRIPTION

This document provides Product Category Rules (PCR) for the assessment of the environmental performance of Home and SOHO (Small Office, Home Office) Gateways and the declaration of this performance by an EPD. The product category corresponds to UN CPC 4747223 (with specific regard for modems, home routers/home gateways or other transmission data/voice digital home equipment).

The full definition of the CPC 47223 subclass is 'Other telephone sets and apparatus for transmission or reception of voice, images or other data, including apparatus for communication in a wired or wireless network (such as a local or wide area network)'; this subclass also includes switching and routing apparatus for transmission of data, such as modems [2].

Hierarchy of CPC 47223:

- Section: 4 - Metal products, machinery and equipment
  - Division: 47 - Radio, television and communication equipment and apparatus
    - Group: 472 - Television and radio transmitters; television, video and digital cameras; telephone sets
      - Class: 4722 - Telephone sets, including telephones for cellular networks or for other wireless networks; other apparatus for the transmission or reception of voice, images or other data, including apparatus for communication in a wired or wireless network (such as a local or wide area network)
        - **Subclass: 47223 - Other telephone sets and apparatus for transmission or reception of voice, images or other data, including apparatus for communication in a wired or wireless network (such as a local or wide area network).**

The main components of Home and SOHO Gateways are the following:

- External case;
- Input/output Interfaces;
- Printed Circuit Board(s);
- Electronic Components;
- Network cable, phone cable, phone plug, etc.;
- DSL filter, if applicable;
- Packaging.

Home Gateways may also include the following:

- External antennas;
- External power supply/ battery;
- Display;
- Others: CD/DVD, user manual, instruction book.

The term "Home and SOHO Gateway" denotes both the home and small/home office gateways and gateway products. Home/SOHO Gateways are devices capable of supporting a full suite of data, voice, video communication. video live streaming, video on demand, and smart home/Internet of Things (IoT) services. Home/SOHO Gateways are equipped with the functions of routers and cable/xDSL modems, and can connect the home environment with at least a broadband network, either fixed or mobile, or both, ensuring interoperability with the access and core telecommunication networks and the accessibility of the Internet and devoted application servers.

In this group the following products could be included:

- DSL (ADSL, ADSL2, ADSL2+, VDSL2, e-VDSL) and G.Fast Network terminations (NT) and CPEs;

[2] http://unstats.un.org/unsd/cr/registry/regcs.asp?Cl=25&Lg=1&Co=47223

- Cable modems and CPEs (DOCSIS 2.0 and 3.0);
- Optical network terminations (ONT) (PON and PtP);
- Ethernet/wireless routers;
- LTE and in general mobile CPEs.

In this group: enterprise routers, Wi-Fi extenders, home network infrastructure devices (e.g., Ethernet to power-line bridge, Ethernet to home PNA bridge, etc.) *should not* be included. In any case the Home Gateway and SOHO Gateway functionalities set shall be clearly declared in the LCA study and in the EPD document.

The following specific product information shall be given:

- Product description (dimensions, weight, operating voltage, power dissipation, environmental working conditions, etc.) with possible reference to international standards;
- Main application/services supported;
- Main market sector (small/home office or residential) where the product is sold;
- Main geographical areas where the product is sold;
- Main hardware/basic software functions (e.g., Wi-Fi, LAN ports, USB interfaces, DECT[3], smart home radio interfaces, VoIP ports, etc.).

Main characteristics (e.g., Home Gateway power requirement at different operational states, power supply unit efficiency at different loads, etc.); Reference standards are the following:

- Home Gateway Technical Requirements and implementation guidelines[4].
- EU's Code of Conduct on Energy Consumption of Broadband Equipment Version 5[5].

Further information that can be taken into account are:

- DLNA - Digital Living Network Alliance[6].
- PCR 2013:10 - Product Category Rules (PCR) Home and SOHO Gateways – date 2013-07-17

This PCR complies with the General Programme Instruction of the International EPD® System, version 3.0 dated 2017-12-11. It is based on the requirements and guidelines given in "PCR Basic Module, CPC Division 47: "Radio, television and communication equipment and apparatus", version 3.01, dated 2018-11-06 and refers to The Methodology for Environmental Life Cycle Assessment (LCA) of ICT goods, networks and services, known as ITU-T L.1410 in ITU-T and ES 203 199 in ETSI.

2.2.2 GEOGRAPHICAL REGION

This PCR is applicable to be used globally.

2.2.3 EPD VALIDITY

An EPD based on this PCR shall be valid from its registration and publication at www.environdec.com and for a five year period starting from the date of the verification report ("approval date"), or until the EPD has been de-registered from the International EPD® System.

An EPD shall be updated and re-verified during its validity if changes in technology or other circumstances have led to:

[3] Digital Enhanced Cordless Telecommunications.

[4]Various documents on http://www.homegatewayinitiative.org/ and www.broadbandforum.org

[5]http://iet.jrc.ec.europa.eu/energyefficiency/ict-codes-conduct/energy-consumption-broadband-communication-equipment

[6]http://www.dlna.org/

- an increase of 10% or more of any of the indicators listed in Section 5.4.5.1,
- errors in the declared information, or
- significant changes to the declared product information, content declaration, or additional environmental information.

If such changes have occurred, but the EPD is not updated, the EPD owner shall contact the Secretariat to de-register the EPD.

3 PCR REVIEW AND BACKGROUND INFORMATION

This PCR was developed in accordance with the process described in the General Programme Instructions of the International EPD® System, including PCR review and open consultation.

3.1 PCR REVIEW

3.1.1 VERSION 1.0

Version 1.0 of this PCR was reviewed by the Technical Committee of the International EPD® System.

3.1.2 VERSION 2.0

PCR review panel:	The Technical Committee of the International EPD® System. A full list of members available on www.environdec.com. The review panel may be contacted via info@environdec.com. Members of the Technical Committee were requested to state any potential conflict of interest with the PCR moderator or PCR committee, and were excused from the review.
Chair of the PCR review:	Maurizio Fieschi
Review dates:	From 2016-06-20 to 2016-08-20

3.2 OPEN CONSULTATION

3.2.1 VERSION 1.0

Version 1.0 of this PCR was available for open consultation at www.environdec.com from 2013-03-22 until 2013-05-03.

3.2.2 VERSION 2.0

This PCR was available for open consultation from 2016-06-01 until 2016-08-20, during which any stakeholder was able to provide comments by posting on the PCR forum on www.environdec.com or by contacting the PCR moderator.

A total of 8 stakeholders were invited via e-mail or other means to take part in the open consultation, and were encouraged to forward the invitation to other relevant stakeholders. No comments during were provided the open consultation,

3.3 EXISTING PCRS FOR THE PRODUCT CATEGORY

As part of the development of this PCR, existing PCRs were considered in order to avoid overlaps in scope. The existence of such documents was checked in the public PCR listings of the following programmes based on ISO 14025 or similar:

- International EPD® System. www.environdec.com.

No existing PCRs with overlapping scope were identified.

3.4 REASONING FOR DEVELOPMENT OF PCR

The main motivation for developing this PCR arose in 2013, as Telecom Italia SpA, Politecnico di Torino and ZyXEL decided to collaborate for the submission of a PCR devoted to Home and Small Office/Home Office Gateways. A first document prepared by

ZyXEL for the Taiwanese EPD system was developed in 2010. The authors decided to update the document to provide the International EPD® System with a more comprehensive PCR, aligned with the General Programme Instructions.

3.5 UNDERLYING STUDIES

The methodological choices made during the development of this PCR (functional unit/declared unit, system boundary, allocation methods, impact categories, data quality rules, etc.) in this PCR were primarily based on the following underlying studies:

- Cucchietti et al. (2011) presented environmental results in terms of Global Warming Potential and Gross Energy Requirement for universal mobile chargers. The authors focused mainly on the manufacturing phase and the use phase, considering 400 working cycles during a lifetime of 2 years.
- Giacomello et al. (2013) used the structure of the first version of the PCR to analyse the Telecom Italia “Modem ADSL2 Wi-Fi N”, in which two scenarios were considered concerning the use phase: home use and small office use.
- De Benedetti et al (2013) relied on the PCR to compare two generations of home gateways, by means of the Life Cycle Assessment methodology.
- ETSI ES 203 199 V1.3.0 (2014) “Environmental Engineering (EE); Methodology for environmental Life Cycle Assessment (LCA) of Information and Communication Technology (ICT) goods, networks and services” was considered during the development of this document (see Appendix C).

4 GOAL AND SCOPE, LIFE CYCLE INVENTORY AND LIFE CYCLE IMPACT ASSESSMENT

The goal of this section is to provide specific rules, requirements and guidelines for developing an EPD for the product category as defined in Section 2.2.1.

4.1 FUNCTIONAL UNIT/DECLARED UNIT

The declared unit (DU) is defined as one unit of Home/SOHO Gateway (including power supply, accessories and packaging), as Home/SOHO Gateways are marketed and sold in such units, taking into account the total ICT equipment use per lifetime of Home/SOHO Gateway.

The declared unit shall be specified in the EPD. The environmental impact shall be given per declared unit.

Due to the need to harmonize very different product functions, consumer procurement different needs, use-phase different behaviours, interwork with other equipment, and market strategies changes, an alternative functional unit may be investigated. As an example, the environmental information reported in the EPD document may be normalised to the functional unit conceived according to one of the following nominal parameters:

- Maximal/measured download speed from WAN side;
- Maximal/measured bit rate from LAN side in the case of wired connection (all Ethernet interfaces);
- Maximal/measured bit rate from LAN side in the case of wireless connection (sum of all Wi-Fi radio interfaces).
- Maximal/measured bit rate from LAN side in the case of wired and wireless connections combined (all Ethernet and Wi-Fi interfaces)

A simple numerical example is provided hereinafter to explain the normalisation process. The maximal/measured download speed from WAN side is considered as the key parameter.

The performances of a VDSL modem can be often described making reference to the aggregate throughput managed on WAN side, in downstream and upstream directions (e.g. 0,25 Gbit per second maximum aggregate throughput as typical value for the VDSL modems of a number of European operators, measured for example according to the Broadband Forum TR-143 procedures).

If a single unit of VDSL Home/SOHO Gateway is associated to a lifecycle global warming potential of 10 kg of CO_2 equivalents, the product lifecycle is of 5 years (means 5*8 760 hours) and the level of usage (i.e. when the device is managing traffic) is of 4 hours per day (around 17% of the lifecycle, see “ON State” definition in section 4.3.4), we can calculate (1 hour = 3 600 sec.):

- Overall amount of time devoted to traffic management: L= 5*8 760*0,17*3 600 = $26,81*10^6$ sec
- Maximum amount of traffic managed: T = L*0,25 = $6,7*10^6$ Gbits
- Global warming potential per Gbit managed (either transmitted or received) = 10 kg CO_2 eq/T = $1,49*10^{-7}$ kg CO_2 eq/Gbit

The declared unit shall be stated in the EPD. The environmental impact shall be given per declared unit. A description of the function of the product considered for this alternative definition of the DU shall be included in the EPD®, in order to avoid ambiguities; any comparisons between EPDs shall be made with care and by taking that functionality description into account.

4.2 REFERENCE SERVICE LIFE (RSL)

Not applicable for this product category.

4.3 SYSTEM BOUNDARY

The International EPD® System uses an approach where all attributional processes from “cradle to grave” should be included using the principle of “limited loss of information at the final product”. This is especially important in the case of business-to-consumer communication.

The scope of this PCR and EPDs based on it is cradle-to-grave.

4.3.1 LIFE CYCLE STAGES

For the purpose of different data quality rules and for the presentation of results, the life cycle of products is divided into three different life cycle stages:

- Upstream processes (from cradle-to-gate);
- Core processes (from gate-to-gate)
- Downstream processes (from gate-to-grave)

In the EPD, the environmental performance associated with each of the three life-cycle stages above shall be reported separately. The processes included in the scope of the PCR and belonging to each life cycle stage are described in Sections 4.3.1.1–4.3.1.3.

4.3.1.1. Upstream processes

The following attributional processes are part of the product system and classified as upstream processes:

- Extraction and production of raw material for all main parts and components. Main parts, intermediate components (e.g., electronic components, etc.), auxiliaries, accessories and support equipment (e.g., cables, DSL filters, etc.) produced by subcontractors are classified as upstream processes.
- Impacts due to the production of electricity and fuels used in the upstream module
- Production of auxiliary products used such as detergents for cleaning, etc.
- Production of semiproducts used in the core process. In this particular case, a number of semiproducts and components are included in the overall production process (not exhaustive list):
  - Main printed circuit board
  - Electronic components
  - Plastic connectors
  - Antennas and small copper wires
- Manufacturing of primary and secondary packaging

Upstream processes not listed may also be included. All elementary flows at resource extraction shall be included, except for the flows that fall under the general cut-off rule in Section 4.5.

4.3.1.2. Core processes

The following attributional processes are part of the product system and classified as core processes:

- External transportation to the core processes
- Manufacturing process for main parts and components
- Preparation of the final product
- Internal transports within the manufacturing plant
- Assembly of the final product (Home/SOHO Gateway assembly) and /or testing in own establishment, if applicable
- Maintenance (e.g. of the machines)
- Waste treatment of waste generated during manufacturing;
- Impacts due to the production of electricity and fuels used in the core module

Manufacturing processes not listed may also be included. The production of the raw materials used for production of all product parts shall be included. A minimum of 99% of the total weight of the declared product including packaging shall be included.

The technical system shall not include:

- Manufacturing of production equipment, buildings and other capital goods.
- Business travel of personnel.

- Travel to and from work by personnel.
- Research and development activities.

4.3.1.3. Downstream processes

The following attributional processes are part of the product system and classified as downstream processes:

- Transportation from preparation to an average retailer/distribution platform
- Lifetime operation of the product including power losses and emissions
- Maintenance, replacements of parts, during life time
- End-of-life processes of any wasted part of the product
- End-of-life processes of packaging waste

4.3.2 OTHER BOUNDARY SETTING

4.3.2.1. Boundary towards nature

Boundaries to nature are defined as flows of material and energy resources from nature into the system. Emissions to air, water and soil cross the system boundary when they are emitted from or leaving the product system.

4.3.2.2. Boundaries in the life cycle

See Section 4.3.1. The EPD may present the information divided into additional sub-divisions.

4.3.2.3. Boundaries towards other technical systems

See Section 4.6.2.

4.4 SYSTEM DIAGRAM

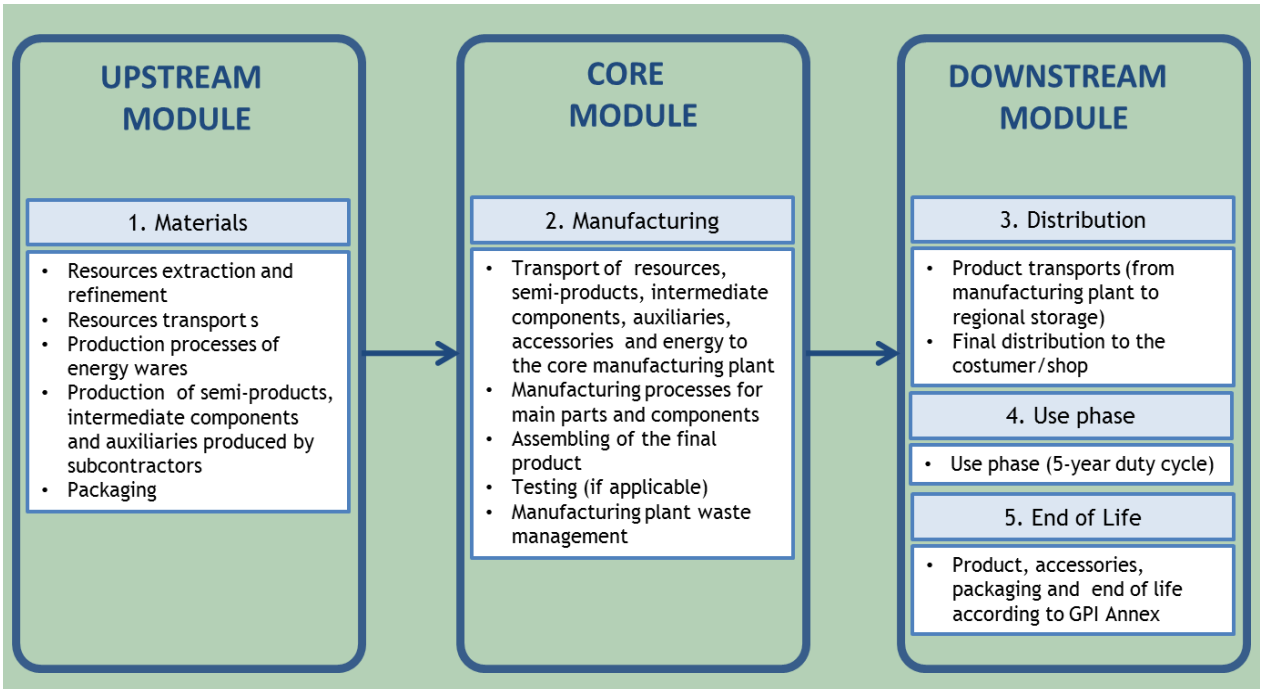

Figure 2 Presentation of Core Module (core process) and upstream and downstream processes related to the production of one Home/SOHO Gateway unit.

4.5 CUT-OFF RULES

Data for elementary flows to and from the product system contributing to a minimum of 99% of the declared environmental impacts shall be included (not including processes that are explicitly outside the system boundary as described in Section 4.3).

The check for cut-off rules in a satisfactory way is through the combination of expert judgment based on experience of similar product systems and a sensitivity analysis in which it is possible to understand how the un-investigated input or output could affect the final results.

4.6 ALLOCATION RULES

4.6.1 CO-PRODUCT ALLOCATION

The following step-wise procedure shall be applied for multifunctional products and multiproduct processes:

1. Allocation shall be avoided, if possible, by dividing the unit process into two or more sub-processes and collecting the environmental data related to these sub-processes.
2. If allocation cannot be avoided, the inputs and outputs of the system shall be partitioned between its different products or functions in a way that reflects the underlying physical relationships between them; i.e. they should reflect the way in which the inputs and outputs are changed by quantitative changes in the products or functions delivered by the system.
3. If not possible, allocation problems shall be solved by economic allocation. In this case, a sensitivity analysis shall be performed in the LCA report.

4.6.2 REUSE, RECYCLING, AND RECOVERY

In the framework of the International EPD® System, the methodological choices for allocation for reuse, recycling and recovery have been set according to the polluter pays principle (PPP). This means that the generator of the waste shall carry the full environmental impact until the point in the product's life cycle at which the waste is transported to a scrapyard or the gate of a waste processing

plant (collection site). The subsequent user of the waste shall carry the environmental impact from the processing and refinement of the waste but not the environmental impact caused in the “earlier” life cycles. See General Programme Instruction for further information and examples.

4.7 DATA QUALITY REQUIREMENTS

An LCA calculation requires two different kinds of information:

- data related to the **environmental aspects** of the considered system (such materials or energy flows that enter the production system). These data usually come from the company that is performing the LCA calculation.
- data related to the **life cycle impacts** of the material or energy flows that enter the production system. These data usually come from databases.

Data on environmental aspects shall be as specific as possible and shall be representative of the studied process.

Data on the life cycle of materials or energy inputs are classified into three categories – specific data, selected generic data, and proxy data, defined as follows:

- **specific data** (also referred to as “primary data” or “site-specific data”) – data gathered from the actual manufacturing plant where product-specific processes are carried out, and data from other parts of the life cycle traced to the specific product system under study, e.g. materials or electricity provided by a contracted supplier that is able to provide data for the actual delivered services, transportation that takes place based on actual fuel consumption, and related emissions, etc.,
- **generic data** (sometimes referred to as “secondary data”), divided into**:**
  - **selected generic data** – data from commonly available data sources (e.g. commercial databases and free databases) that fulfil prescribed data quality characteristics for precision, completeness, and,
  - **proxy data** – data from commonly available data sources (e.g. commercial databases and free databases) that do not fulfil all of the data quality characteristics of “selected generic data”.

As a general rule, specific data shall always be used, if available, after performing a data quality assessment. It is mandatory to use specific data for the core processes as defined above. For the upstream processes, downstream processes, and infrastructure, generic data may also be used if specific data are not available.

Any data used should preferably represent average values for a specific reference year. However, the way these data are generated could vary, e.g. over time, and in such cases they should have the form of a representative annual average value for a specified reference period. Such deviations should be declared.

4.7.1 RULES FOR USING GENERIC DATA

The attributional LCA approach in the International EPD® System forms the basic prerequisites for selecting generic data. To allow the classification of generic data as “selected generic data”, they shall fulfil selected prescribed characteristics for precision, completeness, and representativeness (temporal, geographical, and technological), such as:

- the reference year must be as current as possible and preferably assessed to be representative for at least the validity period of the EPD,
- the cut-off criteria to be met on the level of the modelled product system are the qualitative coverage of at least 99% of energy, mass, and overall environmental relevance of the flows,
- completeness in which the inventory data set should, in principle, cover all elementary flows that contribute to a relevant degree of the impact categories, and
- the representativeness of the resulting inventory in the given temporal, technological, and geographical reference should, as a general principle, be better than ±5% of the environmental impact of fully representative data.

Section 4.8 provides a list of recommended databases/data sets to be used for generic data.

If selected generic data that meets the requirements of the International EPD® System are not available as the necessary input data, proxy data may be used and documented. The environmental impacts associated with proxy data shall not exceed 10% of the overall environmental impact from the product system.

The EPD may include a data quality declaration to demonstrate the share of specific data, selected generic data and proxy data for the environmental impacts.

4.8 RECOMMENDED DATABASES FOR GENERIC DATA

No specific databases are recommended for generic data.

4.9 IMPACT CATEGORIES AND IMPACT ASSESSMENT

The EPD shall declare the default impact categories as described in the General Programme Instructions. The characterisation models and factors to use for the default impact categories are available on www.environdec.com and shall be updated on a regular basis based on the latest developments in LCA methodology and ensuring the market stability of EPDs. The source and version of the characterisation models and the factors used shall be reported in the EPD. Alternative regional life cycle impact assessment methods and characterisation factors are allowed to be calculated and displayed in addition to the default list. If so, the EPD shall contain an explanation of the difference between the different sets of indicators, as they may appear to the reader to display duplicate information.

4.10 OTHER CALCULATION RULES AND SCENARIOS

4.10.1 UPSTREAM PROCESSES

The following requirements apply to the upstream processes:

- Data referring to processes and activities upstream in a supply chain over which an organisation has direct management control shall be specific and collected on site.
- Data referring to contractors that supply main parts, packaging, or main auxiliaries should be requested from the contractor as specific data, as well as infrastructure, where relevant.
- The transport of main parts and components along the supply chain to a distribution point (e.g. a stockroom or warehouse) where the final delivery to the manufacturer can take place based on the actual transportation mode, distance from the supplier, and vehicle load.
- In case specific data is lacking, selected generic data may be used. If this is also lacking, proxy data may be used.
- For the electricity used in the upstream processes, electricity production impacts shall be accounted for in this priority when specific data are used in the upstream processes:

    1. Specific electricity mix as generated, or purchased, from an electricity supplier, demonstrated by a Guarantee of Origin (or similar, where reliability, traceability, and the avoidance of double-counting are ensured) as provided by the electricity supplier. If no specific mix is purchased, the residual electricity mix from the electricity supplier shall be used.[7]
    2. National residual electricity mix or residual electricity mix on the market
    3. National electricity production mix or electricity mix on the market.

    The mix of electricity used in upstream processes shall be documented in the EPD, where relevant.

- Packaging: specific data shall be used for the consumer packaging production if it is under the direct control of the organization or if the environmental impact related to the consumer packaging production is more than 10% of the total product environmental indicators. In other cases, generic data may be used. When consumer packaging shows the organization's logo, the LCA report should report the exerted/non exerted direct control on the production of consumer packaging by the organization.

4.10.2 CORE PROCESSES

The following requirements apply to the core processes:

[7] The residual electricity mix is the mix when all contract-specific electricity that has been sold to other customers has been subtracted from the total production mix of the electricity supplier.

- Specific data shall be used for the assembly of the product and for the manufacture of main parts as well as for on-site generation of steam, heat, electricity, etc., where relevant.
- For the electricity used in the core processes, electricity production impacts shall be accounted for in this priority:
    1. Specific electricity mix as generated, or purchased, from an electricity supplier, demonstrated by a Guarantee of Origin (or similar, where reliability, traceability, and the avoidance of double-counting are ensured) as provided by the electricity supplier. If no specific mix is purchased, the residual electricity mix from the electricity supplier shall be used.[8]
    2. National residual electricity mix or residual electricity mix on the market
    3. National electricity production mix or electricity mix on the market.

    The mix of electricity used in the core processes shall be documented in the EPD, where relevant.
- Transport from the final delivery point of raw materials, chemicals, main parts, and components (see above regarding upstream processes) to the manufacturing plant/place of service provision should be based on the actual transportation mode, distance from the supplier, and vehicle load, if available.
- Waste treatment processes of manufacturing waste should be based on specific data, if available.

Main parts can be: external casing, mother board, network core processor, additional processors for traffic management or LAN interfaces support, insert-type transformer, insert type electrolyte capacitors, external power supply (if included), network cable, phone cable, optical CD (if included in the package), and any other electronic component each time that it is not supplied by subcontractors.

4.10.3 DOWNSTREAM PROCESSES

The following requirements apply to the downstream processes:

- Data for the use stage are usually based on scenarios, but specific data should be used when available and relevant.
- Data on the pollutant emissions from the use stage should be based on documented tests, verified studies in conjunction with average or typical product use, or recommendations concerning suitable product use. Whenever applicable, test methods shall be internationally recognised.
- The use of the energy mix in the region/country where the product is sold and then used shall be approximated with OECD electricity mix statistics. For non-OECD countries, in order to adopt a suitable region- or country-specific electricity mix (reflecting approximately the region(s)/countries' share) a similar precision will be required. The mix used shall be documented in the EPD, if significant. Use phase scenarios are defined in Section 4.10.4.
- The transport of the product to the customer shall be described in the reference PCR, which should reflect the actual situation to the best extent possible. The following priority should be used:
    1. Actual transportation distances and types.
    2. Calculated as the average distance of a product of that product type transported by different means of transport modes.
    3. Calculated as a fixed long transport, such as 1 000 km transport by lorry or 10 000 km by airplane, according to product type.
- Scenarios for the end-of-life stage shall be technically and economically practicable and compliant with current regulations in the relevant geographical region based on the geographical scope of the EPD. Key assumptions regarding the end-of-life stage scenario shall be documented.
- Key assumptions regarding the end-of-life stage shall be documented in the EPD.

4.10.4 . USE PHASE SCENARIO

The use of the energy mix in the region/country where the product is sold and then used shall be approximated as the OECD electricity mix. For non-OECD countries, in order to adopt a suitable region- or country-specific electricity mix (reflecting approximately the region(s)/countries' share) a similar precision will be required. The mix shall be documented.

[8] The residual electricity mix is the mix when all contract-specific electricity that has been sold to other customers has been subtracted from the total production mix of the electricity supplier.

The device mode of operation is composed by a mix of “energy states” throughout its useful life, which is typically of 5 years. These energy states are usually categorized as Off State, Idle State and On State, according to the definitions reported below, and are corresponding to the activation of different functionalities and related different energy consumption levels.

The actual mix of the energy states cannot be defined “a priori” as it depends on the single way of utilization of the device, linked to the broadband services provided to the final user. However, it is possible to define a “standard” mix in terms of number of hours corresponding to a specific energy state, as described later in this section.

The EPD shall declare the electricity consumption during Off State, Idle State and On State; the electricity consumption measurement shall be conducted with the test method stipulated for use at the product exported region, such as EN 50564:2011. Based on the Code of Conduct on Energy Consumption of Broadband Equipment Version 4, the product’s energy consumption states are defined as follows:

Off State: In the off-state the device is not providing any functionality. This state is defined by the Commission Regulation (EC) No 1275/2008.

Note: EC Commission Regulation (EC) No 1275/2008 states:

“off mode” means a condition in which the equipment is connected to the mains power source and is not providing any function; the following shall also be considered as off mode:

- Conditions providing only an indication of off mode condition;
- Conditions providing only functionalities intended to ensure electromagnetic compatibility pursuant to Directive 2004/108/EC of the European Parliament and of the Council”.

Idle State: the device is idle, with all the components being in their individual idle states. In this state the device is not processing or transmitting a significant amount of traffic, but is ready to detect activity.

Transitions between the idle-state and on-state must occur without manual reconfiguration of the device, i.e. they must happen automatically.

The Idle State of a home gateway is defined as all the components of the home gateway being in their idle-state.

On State: all the components of the home gateway being in their on-state.
Based on the types of interfaces, the Idle State and On State of the Home/SOHO Gateway can be further defined as in Table 1.

INTERFACE/COMPONENT	**IDLE STATE**	**ON STATE**
Central functions (processor and memory routing, firewall, OAM (e.g. TR-069), user interface)	Not processing user traffic	Processing the user traffic present on the WAN and LAN interfaces
WAN interface	Single WAN: Idle (link established, but no user traffic transmission). More details on the physical layer configuration of certain interfaces can be found in the On-state definitions. The idle state configuration can be different than in On-state if this does not require a manual reconfiguration by the end user (e.g. in case of DOCSIS 3.0, the CPE could transition to a 1x1 configuration or in case of ADSL2plus to the L2 mode).	Single WAN: Active (link established and passing user traffic) In case of dual WAN interface, for backup or alternative purposes, only one of the two ports will be in the above described state, while the second will be disconnected or not active, but able to be manually or automatically activated in case of need. In case of dual WAN interface for simultaneous operation, both ports will be in the above described state.
LAN Ethernet ports	Port not connected (or no Ethernet connection), but tested with the Ethernet port connected.	LAN Fast Ethernet ports: All ports active, link established at 100 Mbit/s, cable length=5m and passing user traffic: concurrent 10 Mbit/s downstream and 10 Mbit/s upstream per port LAN Gigabit Ethernet Ports: All ports active, link established at 1000

		Mbit/s, cable length=5m and passing user traffic: concurrent 20 Mbit/s downstream and 20 Mbit/s upstream per port
Wi-Fi	Wireless network beacon on, but no data traffic, no client associated	Wi-Fi 802.11g or 11a: Beacon on, 1 Wi-Fi client associated and 1-5m away from AP in the same room, avoid interference in the same band, with user traffic: concurrent 5 Mbit/s downstream and 5 Mbit/s upstream (where simultaneous dual-band operation is supported, this traffic is used on each of the band) Wi-Fi 802.11n: Beacon on, 1 Wi-Fi 802.11n client associated and 1-5m away from AP in the same room, avoid interference in the same band, with user traffic: concurrent 10 Mbit/s downstream and 10 Mbit/s upstream (where simultaneous dual-band operation is supported, this traffic is used on each of the band)

Table 1 Definition of Low Power state and Full Power state for Home Gateways

As Home/SOHO Gateway only serves to transmit data between the home network infrastructure devices, its actual energy consumption will depend on the usage scenarios of the connected equipment and is less relevant to the types of home gateways. In order to provide a uniform basis for calculation of home gateways' energy consumption during the use phase, the following calculation equation for home gateway use phase annual electricity consumption was developed based on EU's ErP[9] Implementing measures Lot 26 working document as well as preparatory studies of ENER Lot 26: Networked standby losses[10].

The product use phase has to be analysed considering a life span of a 5-year period of time and a working time of 8760 hours per year. Different scenarios have to be justified.

The modem device can be intended for being used as Home Gateway or as SOHO Gateway or as both of them. According to the type of use, the energy consumption calculation shall be assessed accordingly (see "calculation equations"). If the modem is used for both aims, then a weighted average shall be calculated according to the available information (e.g., market statistics).

Steps for the calculation of the energy consumption during use phase scenario are hereafter detailed.

Home Gateway calculation equations:

Assuming a Home Gateway is connected to main power all year long and the user's working "behaviour" is divided into "work days" and "vacation days". During work days, home gateway is operated at 2 hour/day On State, and 22 hour/day Idle State; during vacation days, the home gateway is 4 hour/day On State, and 20 hour/day Idle State.

- Annual work days: 5day/week * 4 week/month * 12 month/year = 240 day/year;
- Annual vacation days: 365 day/year – 240 day/year= 125 day/year.

$$Energy\ On\ State\ [kWh/year] = \frac{Power\ On\ State\ [W] \times \left[\left(2\frac{h}{day} \times 240\frac{day}{year}\right) + \left(4\frac{h}{day} \times 125\frac{day}{year}\right)\right]}{1000\ [W/kW]}$$

[9] http://www.eup-network.de/product-groups/drafts-regulations/

[10] http://www.eup-network.de/product-groups/drafts-regulations/

$$Energy\ Idle\ State\ [kWh/year] = \frac{Power\ Idle\ State\ [W] \times \left[\left(22\frac{h}{day} \times 240\frac{day}{year}\right) + \left(20\frac{h}{day} \times 125\frac{day}{year}\right)\right]}{1000\ [W/kW]}$$

$$Total\ Energy\ [kWh] = (Energy\ On\ State\ [kWh/year] + Energy\ Idle\ State[kWh/year]) \times 5\ [year]$$

SOHO Gateway calculation equations:

Assuming a SOHO Gateway is connected to main power all year long and the user's working "behaviour" is divided into "work days" and "vacation days". During work days, home gateway is operated at 8 hour/day On State, and 16 hour/day Idle State; during vacation days, the home gateway is 2 hour/day On State, and 22 hour/day Idle State.

- Annual work days: 5 day/week * 4 week/month * 12 month/year = 240 day/year;
- Annual vacation days: 365 day/year – 240 day/year = 125 day/year.

$$Energy\ On\ State\ [kWh/year] = \frac{Power\ On\ State\ [W] \times \left[\left(8\frac{h}{day} \times 240\frac{day}{year}\right) + \left(2\frac{h}{day} \times 125\frac{day}{year}\right)\right]}{1000\ [W/kW]}$$

$$Energy\ Idle\ State\ [kWh/year] = \frac{Power\ Idle\ State\ [W] \times \left[\left(16\frac{h}{day} \times 240\frac{day}{year}\right) + \left(22\frac{h}{day} \times 125\frac{day}{year}\right)\right]}{1000\ [W/kW]}$$

$$Total\ Energy\ [kWh] = (Energy\ On\ State\ [kWh/year] + Energy\ Idle\ State[kWh/year]) \times 5\ [year]$$

The reporting of information on maintenance during use phase is optional.

5 CONTENT AND FORMAT OF EPD

EPDs based on this PCR shall contain the information described in this section. Flexibility is allowed in the formatting and layout provided that the EPD still includes the prescribed information. A generic template for EPDs is available via www.environdec.com

As a general rule the EPD content:

- shall be in line with the requirements and guidelines in ISO 14020 (Environmental labels and declarations - General principles),
- shall be verifiable, accurate, relevant and not misleading, and
- shall not include rating, judgements or direct comparison with other products.

An EPD should be made with a reasonable number of pages for the intended audience and use.

5.1 EPD LANGUAGES

EPDs should be published in English, but may also be published in additional languages. If the EPD is not available in English, it shall contain an executive summary in English including the main content of the EPD. This summary is part of the EPD and thus subject to the same verification procedure.

5.2 UNITS AND QUANTITIES

The following requirements apply for units and quantities:

- The International System of Units (SI units) shall be used, e.g., kilograms (kg), Joules (J) and metres (m). Reasonable multiples of SI units may be decided in the PCR to improve readability, e.g., grams (g) or megajoules (MJ). The following exceptions apply:
  - Resources used for energy input (primary energy) should be expressed as kilowatt-hours (kWh) or megajoules (MJ), including renewable energy sources, e.g., hydropower, wind power and geothermal power.
  - Water use should be expressed in cubic metres (m^3)
  - Temperature should be expressed in degrees Celsius (°C),
  - Time should be expressed in the units most practical, e.g., seconds, minutes, hours, days or years.
- Three significant figures[11] should be adopted for all results, The number of significant digits shall be appropriate and consistent.
- The thousand separator and decimal mark in the EPD shall follow one of the following styles (a number with six significant figures shown for illustration):
  - SI style (French version): 1 234,56
  - SI style (English version): 1 234.56

  In case of potential confusion or intended use of the EPD in markets where different symbols are used, the EPD shall state what symbols are used for thousand separator and decimal mark.
- Dates and times presented in the EPD should follow the format in ISO 8601. For years, the prescribed format is YYYY-MM-DD, e.g., 2017-03-26 for March 26th, 2017.
- The result tables shall:
  - Only contain values or the letters “INA” (Indicator Not Assessed). It is not possible to specify INA for mandatory indicators. INA shall only be used for voluntary parameters that are not quantified because no data is available.[12]
  - Contain no blank cells, hyphens, less than or greater than signs or letters (except “INA”).

[11] Significant figures are those digits that carry meaning contributing to its precision. For example with two significant digits, the result of 123.45 shall be displayed as 120, and 0.12345 shall be displayed as 0.12. In scientific notation, these two examples would be displayed as $1.2*10^2$ and $1.2*10^{-2}$.

[12] This requirement does not intend to give guidance on what indicators are mandated (“shall”) or voluntary.

- Use the value 0 only for parameters that have been calculated to be zero.
- Footnotes shall be used to explain any limitation to the result value.

5.3 USE OF IMAGES IN EPD

Images used in the EPD, especially pictures featured on the cover page, may in themselves be interpreted as an environmental claim. Images such as trees, mountains, wildlife that are not related to the declared product should therefore be used with caution and in compliance with national legislation and best available practices in the markets in which the EPD is intended to be used.

5.4 EPD REPORTING FORMAT

The reporting format of the EPD shall include the following sections:

- Cover page (see Section 5.4.1)
- Programme information (see Section 5.4.2)
- Product information (see Section 5.4.3)
- Content declaration (see Section 5.4.4)
- Environmental performance (see Section 5.4.5)
- Additional environmental information (see Section 5.4.6)
- References (see Section 5.4.9)

The following information shall be included, when applicable:

- Information related to Sector EPDs (see Section 5.4.7)
- Differences versus previous versions (see Section 5.4.8)
- Executive summary in English (see Section 5.4.10)

5.4.1 COVER PAGE

The cover page shall include:

- Product name and image,
- Name and logotype of EPD owner,
- The text “Environmental Product Declaration” and/or “EPD”
- *Programme: The International EPD® System, www.environdec.com,*
- *Programme operator: EPD International AB*
- Logotype of the International EPD® System,
- EPD registration number as issued by the programme operator[13],
- *Date of publication (issue): 20XX-YY-ZZ,*
- *Date of revision: 20XX-YY-ZZ*, when applicable,
- *Date of validity; 20XX-YY-ZZ*
- A note that “*An EPD should provide current information, and may be updated if conditions change. The stated validity is therefore subject to the continued registration and publication at www.environdec.com*.”

[13] The EPD shall not include a “registration number” if such is provided by the certification body, as this may be confused with the registration number issued by the programme operator.

- A statement of conformity with ISO 14025,

5.4.2 PROGRAMME INFORMATION

The programme information section of the EPD shall include:

- Address of programme operator: *EPD International AB, Box 210 60, SE-100 31 Stockholm, Sweden, E-mail: info@environdec.com*
- The following mandatory statement from ISO 14025: "*EPDs within the same product category but from different programmes may not be comparable*."
- A statement that the EPD owner has the sole ownership, liability and responsibility of the EPD
- Information about verification[14] and reference PCR in a table with the following format and contents:

Product category rules (PCR): PCR 2013:02 Home and SOHO Gateway, version 2.1. UN CPC 47233.
PCR review was conducted by: *The Technical Committee of the International EPD® System. Chair: Maurizio Fieschi Contact via info@environdec.com.*
Independent third-party verification of the declaration and data, according to ISO 14025:2006: ☐ EPD process certification ☐ EPD verification
Third party verifier: *<name, organisation and signature of the third party verifier>* *In case of certification bodies:* Accredited by: *<name of the accreditation body and accreditation number, if applicable>.* *In case of individual verifiers:* Approved by: The International EPD® System Technical Committee, supported by the Secretariat
Procedure for follow-up of data during EPD validity involves third party verifier: ☐ Yes ☐ No

5.4.3 PRODUCT INFORMATION

The product information section of the EPD shall include:

- Address and contact information to EPD owner,
- Description of the organisation. This may include information on products- or management system-related certifications (e.g. ISO 14024 Type I environmental labels, ISO 9001- and 14001-certificates and EMAS-registrations) and other relevant work the organisation wants to communicate (e.g. SA 8000, supply-chain management and social responsibility),
- Name and location of production site,
- Product identification by name, and an unambiguous identification of the product by standards, concessions or other means,
- Identification of the product according to the UN CPC scheme system. Other relevant codes for product classification may also be included, e.g.
  - Common Procurement Vocabulary (CPV),
  - United Nations Standard Products and Services Code® (UNSPSC),

[14] If the EPD has been verified by an approved individual verifier who has received contractual assistance from a certification body that is not accredited, this certification body shall not be included in this table.

- Classification of Products by Activity (NACE/CPA) or
- Australian and New Zealand Standard Industrial Classification (ANZSIC),

- Description of the product, its application/intended use and technical functions, e.g. expected service life time,
- Geographical scope of the EPD, i.e., for which geographical location(s) of use and end-of-life the product's performance has been calculated,
- Functional unit or declared unit,
- Reference service life (RSL), if applicable,
- Declaration of the year(s) covered by the data used for the LCA calculation and other relevant reference years,
- Reference to the main database(s) for generic data and LCA software used, if relevant,
- System diagram of the processes included in the LCA, divided into the life cycle stages,
- Description if the EPD system boundary is "cradle-to-gate", "cradle-to-gate with options" or "cradle-to-grave",
- Information on which life cycle stages are not considered (if any), with a justification of the omission,
- Relevant websites for more information or explanatory materials.

This section may also include:

- Name and contact information of organisation carrying out the underlying LCA study,
- Additional information about the underlying LCA-based information, such as assumptions, cut-off rules, data quality and allocation.

5.4.4 CONTENT DECLARATION

The content declaration shall have the form of a list of materials and chemical substances including information on their environmental and hazardous properties. The gross weight of material shall be declared in the EPD at a minimum of 99 % of one unit of product.

Information on the hazardous properties of materials and chemical substances should follow the requirements given in the latest revision of the Globally Harmonized System of Classification and Labelling of Chemicals (GHS)[15], issued by United Nations or national or regional applications of the GHS.

As an example, the following regulations should be used for EPDs intended to be used in the European Union:

- Regulation (EC) No 1907/2006 of the European parliament and of the council of 18 December 2006 concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH)
- Regulation (EC) No 1272/2008 of the European Parliament and of the Council of 16 December 2008 on classification, labelling and packaging of substances and mixtures

5.4.4.1. Information about recycled materials

When a product is made in whole or in part with recycled materials, the provenience of the materials (pre-consumer or post-consumer) shall be presented in the EPD as part of the content declaration.

To avoid any misunderstanding about which material may be considered "recycled material", the guidance given in ISO 14021 shall be taken into account. In brief, the standard states that:

- only pre-consumer or post-consumer materials (scraps) shall be considered in the accounting of the recycled materials, and
- materials coming from scrap reutilisation (such as rework, regrind, or scrap generated in a process and capable of being reclaimed within the same process that generated it) shall not be considered as recycled content.

[15] The GHS document is available on www.unece.org.

5.4.4.2. Information about packaging

As packaging is strongly connected with the product, the producer shall provide information about packaging in the EPD, when applicable. Packaging may be classified as:

- Distribution Packaging: packaging designed to contain one or more articles or packages, or bulk materials, for the purposes of transport, handling and/or distribution (ISO 21067-1:2016, Par. 2.2.6)
- Consumer Packaging: packaging constituting, with its content, a sales unit for the final user or consumer at the point of retail (ISO 21067-1:2016, Par. 2.2.7).

Consumer packaging is generally the outcome of eco-design processes, or other activities, under direct control of the organisation. Many critical categories with strict legal requirements belong to consumer packaging category like food contact packaging and pharmaceutical packaging.

The type and function of packaging shall be reported in the EPD.

A statement of the source of the materials (pre-consumer or post-consumer) shall be presented in the EPD when the packaging is made in whole or in part by recycled materials.

5.4.5 ENVIRONMENTAL PERFORMANCE

5.4.5.1. Environmental impacts

The indicators related to potential environmental impact listed in Table 2 shall be declared per functional unit or declared unit, and per life cycle stage.

PARAMETER		UNIT	UPSTREAM	CORE	DOWNSTREAM	TOTAL
Global warming potential (GWP)	Fossil	kg CO_2 eq.				
	Biogenic	kg CO_2 eq.				
	Land use and land transformation	kg CO_2 eq.				
	TOTAL	kg CO_2 eq.				
Acidification potential (AP)		kg SO_2 eq.				
Eutrophication potential (EP)		kg PO_4^{3-} eq.				
Formation potential of tropospheric ozone (POCP)		kg C_2H_4 eq.				
Abiotic depletion potential – Elements		kg Sb eq.				
Abiotic depletion potential – Fossil fuels		MJ, net calorific value				
Water scarcity potential		m^3 eq.				

Table 2 Indicators describing potential environmental impacts[16].

Notes:

- Abiotic depletion potential is calculated and displayed as two separate indicators. ADP-fossil fuels include all fossil resources, while ADP-elements include all non-renewable material resources.

The following potential environmental impacts may be voluntary calculated and reported in the EPD®:

- Emission of ozone-depleting gases (expressed as the sum of ozone-depleting potential in mass of CFC 11-equivalents, 20 years, according to the CML2001 Ozone Layer Depletion Potential - ODP steady state);

[16] Please check www.environdec.com for the latest list of default impact categories, units and characterisation factors as they may have been updated compared to this table.

- Abiotic resource depletion (expressed as kg Sb-Equiv., according to the CML2001 Abiotic Depletion - ADP elements).

5.4.5.2. Specifications for GWP calculations

This section is adopted from the General Programme Instructions (GPI) v3.0 2017-12-11, Section A.9.

GHG EMISSIONS AND REMOVALS TO BE INCLUDED IN THE CARBON FOOTPRINT

The carbon footprint shall include emissions and removals of greenhouse gases arising from fossil sources, biogenic sources, and direct land use change. The reporting shall be done in separate sub-indicators for the different sources, unless other guidance is provided in the reference PCR.

Where a secondary material with a stored carbon content enters the system boundary, the quantity of stored carbon within it should be accounted in the same way as if it were a primary material. Thus accounting for the total quantity of carbon that the new product will contain and continue to store.

CARBON SEQUESTRATION AND STORED CARBON

Where some or all removed carbon will not be emitted to the atmosphere within the 100-year assessment period, the portion of carbon not emitted to the atmosphere during that period shall be treated as stored carbon. Following issues shall be taken into account:

- carbon storage might arise where biogenic carbon forms part or all of a product (e.g. wood fibre in a table), or where atmospheric carbon is taken up by a product over its life cycle (e.g. cement),
- While land and forest management activities might result in additional carbon storage in soil or managed forests through the retention of soil carbon or forest biomass, the linking of this potential source of carbon storage to the product level is not included in the scope of the International EPD® System.

OFFSETTING

Greenhouse gas emissions offset mechanisms shall not be used in the assessment of the carbon footprint indicators. The EPD owner may declare their participation in offsetting programmes or purchase of carbon neutral products separately in the additional information section of the EPD, where these effects also may be qualified.

5.4.5.3. Use of resources

The indicators for resource use based on the life cycle inventory (LCI) listed in Table 3 shall be declared per functional unit or declared unit, and per life cycle stage.

PARAMETER		UNIT	UPSTREAM	CORE	DOWNSTREAM	TOTAL
Primary energy resources – Renewable	Use as energy carrier	MJ, net calorific value				
	Used as raw materials	MJ, net calorific value				
	TOTAL	MJ, net calorific value				
Primary energy resources – Non-renewable	Use as energy carrier	MJ, net calorific value				
	Used as raw materials	MJ, net calorific value				
	TOTAL	MJ, net calorific value				
Secondary material		kg				
Renewable secondary fuels		MJ, net calorific value				

Non-renewable secondary fuels	MJ, net calorific value				
Net use of fresh water	m^3				

Table 3 Indicators describing use of primary and secondary resources.

Notes:

- In order to identify the primary energy used as an energy carrier (and not used as raw materials), the parameter may be calculated as the difference between the total input of primary energy and the input of energy resources used as raw materials.
- Energy content of biomass used for feed or food purposes shall not be considered.
- The net use of fresh water does not constitute a “water footprint” as potential environmental impacts due to the water use in different geographical locations is not captured. For this indicator:
  - Evaporation, transpiration, product integration, release into different drainage basins or the sea, displacement of water from one water resource type to another water resource type within a drainage basin (e.g. from groundwater to surface water) is included.
  - In-stream water use is not included.
  - For water used in closed loop processes (such as cooling system) and in power generation only the net water consumption (such as reintegration of water losses) should be considered.
  - Seawater shall not be included
  - Tap water or treated water (e.g. from a water treatment plant), or wastewater that is not directly released in the environment (e.g. sent to a wastewater treatment plant) are not elementary water flows, but intermediate flows from a process within the technosphere.
  - Additional transparency in terms of geographical location, type of water resource (e.g. groundwater, surface water), water quality and temporal aspects may be included as additional information.

5.4.5.4. Waste production and output flows

Waste generated along the whole life cycle production chains shall be treated following the technical specifications described in the General Programme Instructions. When the amount of waste or the output flows is from the life cycle inventory (LCI) are declared, the indicators in Table 4 and Table 5 shall be reported per functional unit or declared unit, and per life cycle stage.

PARAMETER	UNIT	UPSTREAM	CORE	DOWNSTREAM	TOTAL
Hazardous waste disposed	kg				
Non-hazardous waste disposed	kg				
Radioactive waste disposed	kg				

Table 4 Indicators describing waste production.

PARAMETER	UNIT	UPSTREAM	CORE	DOWNSTREAM	TOTAL
Components for reuse	kg				
Material for recycling	kg				
Materials for energy recovery	kg				
Exported energy, electricity	MJ				
Exported energy, thermal	MJ				

Table 5 Indicators describing output flows.

Notes:

- The parameters are calculated on the gross amounts leaving the system boundary of the product system in the LCI. If e.g. there is no gross amount of “exported energy, electricity” leaving the system boundary, this indicator is set to zero,
- The parameter “Materials for energy recovery” does not include materials for waste incineration. Waste incineration is a method of waste processing, when R1<60% (European Guideline on R1 energy interpretation), and is allocated within the system boundary.
- In case there are never any flows of these types leaving the system boundary for a product category, the indicators may be removed by the PCR.

5.4.5.5. Other environmental indicators’

The following indicators per declared unit shall be reported in the EPD, divided into core, upstream and downstream module:

- Toxic emissions, measured as Human Toxicity Potential (CML2011, HTP inf.), [kg DCB-Equiv.];
- Material subject for recycling, [kg].

5.4.6 ADDITIONAL INFORMATION

The contents of the following materials and chemical substances in the product may be declared:

- flame retardants;
- lead content in solder;
- lead and flame retardant content in solder masking agent.

The EPD may declare the content of materials and chemical substances regulated by:

- RoHS (2002/95/EC) and by RoHS 2 Directive (2011/65/EU);
- REACH Regulation EC No1907/2006, Annex XIV and XVII would be priority to be concerned;
- Regulation (EC) No 850/2004 with its amendments on Persistent organic pollutants (POPs) requirements;
- Regulation (EC) No 1272/2008 of the European Parliament and of the Council of 16 December 2008 on classification, labelling and packaging of substances and mixtures.

In any case, all materials/substances submitted to legal requirements shall be listed. Content of regulated substances within the geographical regions for which the EPD is valid shall be declared as well as the geographical validity of the EPD.

The declaration of halogen-free flame retardants, lead-free solders and no RoHS-regulated substances may only be made when appropriate evidences are available (for example, test reports from accredited laboratories/testing facilities) EN50581:2012 also can be as a reference to comply with EU market.

For definitions of testing methodology and confirmations of regulated hazardous substances based on the accredited laboratories’ product testing methods, refer to latest IEC62321 series Standard.

In order to ensure the comprehensiveness of the LCA study, the inclusion of information on recycling of B2C (Business to Consumer) product is mandatory. The recycling information shall include information such as disassembly instructions, which parts/components are suitable for recycling or not suitable for recycling in the light of IEC 62635:2012.

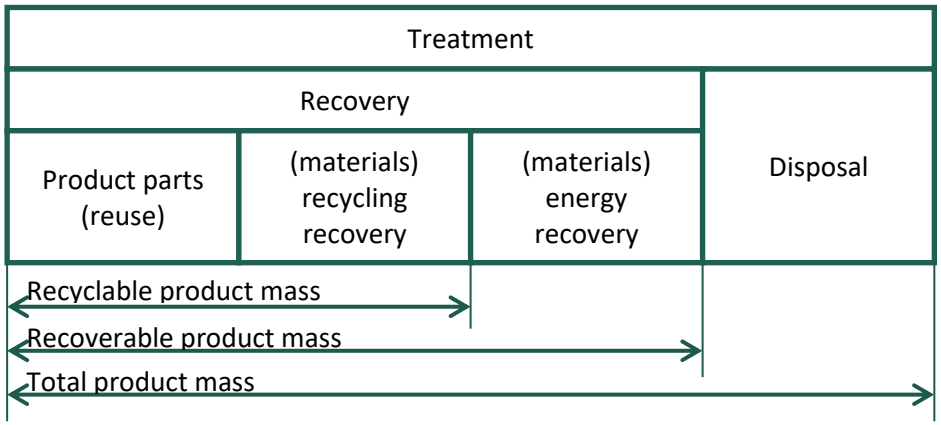

Figure 3: Schematic description of key terms covering End of Life treatment.

The recyclability and recoverability rates[17] of the Home and SOHO gateway product refer to the mass of product at the End of Life phase and shall be calculated in accordance with the IEC 62635:2012 standard. Both values shall be declared in the EPD.

Recyclability rate formula:

$$R_{cyc} = \frac{\sum recyclable\ masses\ of\ each\ parts}{Total\ product\ mass} \cdot 100\%$$

Recoverability rate formula:

$$R_{cov} = \frac{\sum recoverbale\ masses\ of\ each\ parts}{Total\ product\ mass} \cdot 100\%$$

The product end of life shall be classified according to European Waste Catalogue (EWC). In particular, regarding product disposal, the EPD must include classification of product according to the WEEE European framework (2012/19/EU) and subsequent modifications and integrations as well as the reference of series standard of ISO 1043 and ISO 11469 on plastic parts identification in order for treatment facilities classification. Batteries incorporated into products shall be managed in compliance with Directive 2006/66/EC with its amendments (if applicable).

If the product is usually addressed to a global market, this makes possible different end of life scenarios. Therefore the EPD will qualitatively individuate environmental impacts for each possible end of life scenario that is technically and economically feasible and compliant with current regulations regarding waste management.

5.4.7 INFORMATION RELATED TO SECTOR EPDS

For sector EPDs, the following information shall also be included:

- a list of the contributing manufacturers that the Sector EPD covers,
- a description of how the selection of the sites/products has been done and how the average has been determined, and
- a statement that the document covers average values for an entire or partial product category (specifying the percentage of representativeness) and, hence, the declared product is an average that is not available for purchase on the market.

5.4.8 DIFFERENCES VERSUS PREVIOUS VERSIONS

For EPDs that have been updated, the following information shall also be included:

[17]See Appendix for definitions.

- a description of the differences versus previously published versions, e.g. a description of the percentage change in results and the main reason for the change;
- a revision date on the cover page

5.4.9 REFERENCES

This section shall include a list of references, including the General Programme Instructions (including version number), standards and PCR (registration number, name and version). The source and version of the characterisation models and the factors used shall be reported in the EPD.

- The underlying LCA
- The name, CPC code and version number of the PCR used
- Other documents that verify and complement the EPD®
- Instruction for recycling, if relevant
- The General Programme instructions of the International EPD® System

5.4.10 EXECUTIVE SUMMARY IN ENGLISH

For EPDs published in another language than English, an executive summary in English shall be included.

The executive summary should contain relevant summarised information related to the programme, product, environmental performance, additional information, information related to sector EPDs, references and differences versus previous versions.

6 GLOSSARY

ACL	Access Control List
ADSL	Asymmetric Digital Subscriber Line
AP	Access Point
CD	Compact Disk
CFC	Chlorofluorocarbon
CPC	Central Product Classification (United Nation Statistics Division - Classification Registry)
CPE	Costumer Premises Equipment
CO_2	Carbon dioxide
DECT	Digital Enhanced Cordless Telecommunications
DHCP	Dynamic Host Configuration Protocol
DU	Declared Unit
DVD	Digital Versatile Disk
EAA	European Aluminium Association
EC	European Commission
EIME	Environmental Information and Management Explorer
ELCD	European reference Life Cycle Database
EMAS	Eco-Management and Audit Scheme
EPD	Environmental Product Declaration
ErP	Energy Related Product
ETSI	European Telecommunications Standards Institute
EU	European Union
FXS	Foreign Exchange Subscriber
GPI	General Programme Instructions
GWP	Global Warming Potential
HG	Home Gateway
HGI	Home Gateway Initiative
ICT	Information and Communication Technology
IEC	International Electrotechnical Commission
IISI	International Iron and Steel Institute
IP	Internet Protocol
ISO	International Organization for Standardization
JRC	Joint Research Centre
kg	kilogram
LAN	Local Area Network
LCA	Life Cycle Assessment
NA(P)T	Network Address (Port) Translation
NREL	National Renewable Energy Laboratory
NT	Network Termination
OAM	Operations Administration and Maintenance
ONT	Optical Network Termination
PC	Personal Computer

PCR	Product Category rules
PDA	Personal Digital Assistant
PON	Passive Optical Network
POP	Persistent organic pollutants
PP	Polluter-pays
PPP	Point to Point Protocol
PtP	Point to Point
QoS	Quality of Service
REACH	Registration, Evaluation, Authorisation and Restriction of Chemicals
RoHS	Restriction of Hazardous Substances
SI	The International System of Units
SO_2	Sulphur dioxide
SOHO	Small Office - Home Office
TR	Technical Report
TS	Technical Specification
TV	Television
UN	United Nations
UPnP	Universal Plug&Play
USB	Universal Serial Bus
VDSL	Very-high-bit-rate Digital Subscriber Line
VoIP	Voice Over Internet Protocol
WAN	Wide Area Network
WEP	Wired Equivalent Privacy
WHAN	Wireless Home Area Networks
WPA	Wireless Protected Access
CPC	Central product classification

7 REFERENCES

CEN (2013), EN 15804:2012+A1:2013, Sustainability of construction works – Environmental product declarations – Core rules for the product category of construction products.

Cucchietti F., Giacomello L., Griffa G., Vaccarone P., Tecchio P., Bolla R., Bruschi R, D'Agostino L. (2011) Environmental benefits of a universal mobile charger and energy-aware survey on current products.

De Benedetti B., Tecchio P., Rollino S., Giacomello L. (2013) Quantified innovation in ICT: Life Cycle Assessment approach applied to two generations of home gateways.

ETSI ES 203 199: environmental engineering (EE); Methodology for environmental life cycle assessment (LCA) of information and communication technology (ICT) goods, networks and services.

Giacomello L, De Benedetti B., Tecchio P., Rollino S., (2013) Life Cycle Assessment of sustainable Home Gateways and Product Category Rules definition for environmental labelling.

EPD International (2017) General Programme Instructions for the International EPD® System. Version 3.0, dated 2017-12-11. www.environdec.com

ISO (2000), ISO 14020:2000, Environmental labels and declarations – General principles

ISO (2004), ISO 8601:2004 Data elements and interchange formats – Information interchange – Representation of dates and times

ISO (2006a), ISO 14025:2006, Environmental labels and declarations – Type III environmental declarations – Principles and procedures

ISO (2006b), ISO 14040:2006, Environmental management – Life cycle assessment – Principles and framework

ISO (2006c), ISO 14044: 2006, Environmental management – Life cycle assessment – Requirements and guidelines

ISO (2007), ISO 21930:2007, Sustainability in building construction -- Environmental declaration of building products

ISO (2013), ISO/TS 14067:2013, Greenhouse gases – Carbon footprint of products – Requirements and guidelines for quantification and communication

ISO (2014), ISO 14046:2014, Environmental management – Water footprint – Principles, requirements and guidelines

ISO (2017), ISO 21930:2017, Sustainability in buildings and civil engineering works -- Core rules for environmental product declarations of construction products and services

Broadband Forum TR-143 - Enabling Network Throughput Performance Tests and Statistical Monitoring – Amendment 1 Corrigendum 1 - Aug 2015

8 VERSION HISTORY OF PCR

VERSION 1.0, 2013-07-17

Original version of the PCR with registration No. 2013:10. Valid until 2016-07-17

VERSION 2.0, 2017-02-28

- Compliance with GPI 2.5
- Use of the latest PCR template
- Use of the PCR Basic Module CPC 47 Radio television and communication equipment v2.5
- Section 1: revision of references to ETSI documents on LCA
- Section 2.2: small changes in the product definition (hardware components, services support) and references to BBF and EU Commission documents
- Section 3: addition of alternatives and calculation example for the functional unit definition
- Section 8: abbreviations updated
- Section 9: literature review updated
- Appendix A: small changes in the product definition (hardware interfaces, service support) and references to HGI documents

VERSION 2.1, 2018-12-12

Updated in accordance with GPI 3.0 and new PCR basic module.

VERSION 2.11, 2019-09-06

- Clarified terms of use
- Editorial changes

APPENDIX A: HOME AND SOHO GATEWAY DESCRIPTION

The Home/SOHO Gateway is the main entrance to the digital home: broadband Residential Gateway devices are capable of supporting a full suite of data, voice, video-communication, video live streaming, video on demand, and smart home/Internet of Things (IoT) services (e.g. home automation, energy management, etc.).. A Home/Residential Gateway implementing the general requirements of the Broadband Forum TR-124 will incorporate at least one embedded WAN interface, routing, bridging, a basic or enhanced firewall, one or multiple LAN interfaces and home networking functionality that can be deployed as a consumer self-installable device.

This document specifies a baseline of Home/Residential Gateway device and application functions needed to support service delivery in routed and bridged broadband network architectures. Devices can be specified that will operate on any of the different types of Broadband Forum defined network architectures. This allows service providers to configure a Residential Gateway device supporting specified TR-124 modular requirements locally via TR-064 and Web Graphical User Interface or remotely via TR-069.

As main entrance to the digital home, the home gateway ensures continuity between the home network and the external networking world. With growing demands for networking services the home gateway becomes a central technology of the future.

Based on the definition adopted by EU's Code of Conduct Broadband Equipment, home gateway's architectural concept can be presented in below Figure 4.

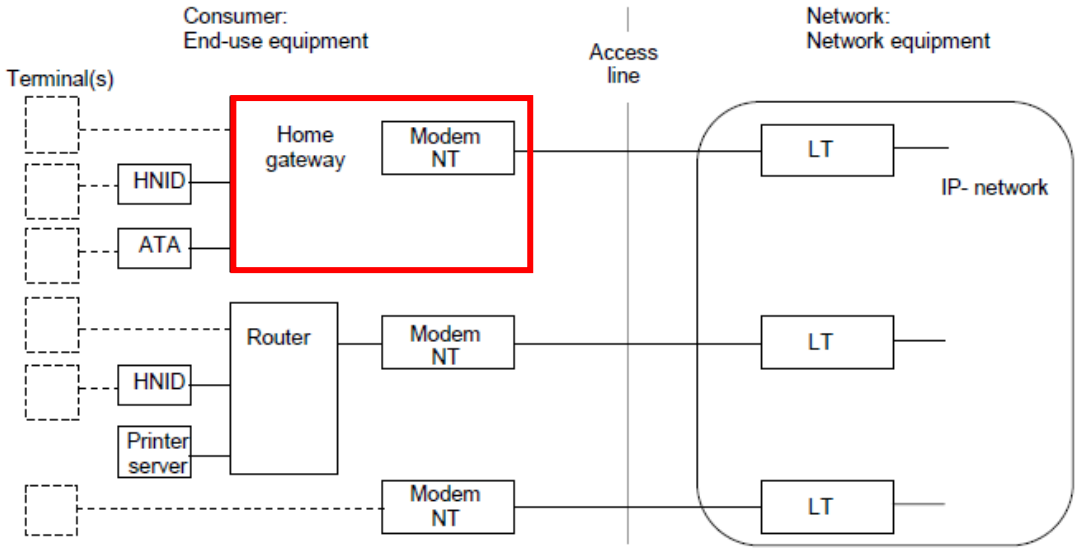

Figure 4: Home Gateway Architectural concept.

Based on the TR-124 Functional Requirements for Broadband Residential Gateway Devices published by the Broadband Forum, the home gateways can be divided into three types:

1. **Internet information home gateways:**
   Devices connecting residential information network equipment, such as PC, notebook computer, PDA and communication equipment (such as Telephon0065 & IP Phone). This type of home gateway are using in the form of SOHO routers.
2. **Entertainment home gateways:**
   Devices connecting home entertainment equipment, such as TV, DVD, and PC. This type of home gateways are usually in the form of STB products.
3. **Controller home gateways:**
   Devices controlling the network connection of smart appliances. This type of home gateways are usually in the form of controller home gateways or build-in device inside smart appliances.

The home gateway is composed of several components, namely a processor plus memory, a WAN interface and several LAN interfaces. Depending on the purpose of a given home gateway different components may be included.

The power consumption targets for each type of home gateway are calculated by summing the values of its individual components. The home gateway as a whole has to meet the summed targets for its various modes of operation and activity. Component power consumption values are used to compute the overall home gateway target for a given configuration and mode of operation, but are

not themselves normative. The home gateway must meet the power targets for low-power-state and for on-state. Depending on the actual state of the individual components, several intermediate power consumption levels for the home gateway exist.

The HG architecture is defined as a set of functionalities each of which is a task or a set of tasks to be performed through a software program and/or a hardware device/interface/component. In Figure 5 it is possible to appreciate the set of functional blocks specified by the HGI release 2 – RD001, now to be integrated with additional capabilities and Wireless Home Area Network (WHAN) interfaces for managing smart home services and IoT scenarios (home automation, energy management, etc.)[18]..

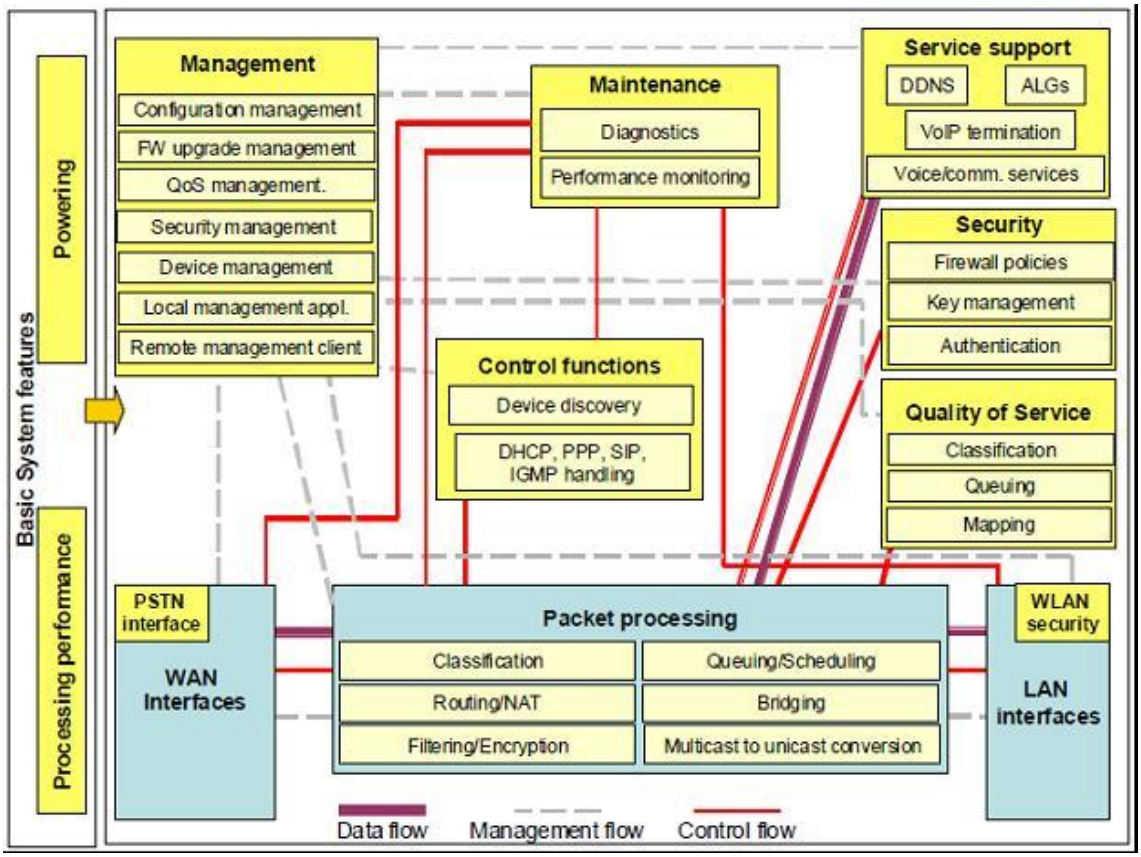

Figure 5: Definition of the Technical Description of Home Gateway.

The blocks cover a number of functions related to the data plane, the control plane and the management plane. The “Packet Processing” block only acts on the header of IP packets, not the payload. This process is done on the basis of rules and policies contained in the “Quality of Service” and “Security” blocks and is supported by the “Control functions” block for any issue related to addressing and device discovery, as well as management or specific protocols such as SIP and IGMP.

The product technical description part of the EPD shall at least include the following information:

- Equipment dimension and weight
- Connected devices and terminal device
- Types, number and transmission rate of interfaces.
- Configuration of equipment and supported protocol
- Upgradeability of firmware
- Expected/design product life
- Power consumption

[18] See RD039 Wireless Home Area Network (WHAN) Home Gateway Requirements, www.homegateway.org

- Other supported functions and their definitions, such as firewall, Quality of Service (QoS), network diagnosis, performance monitoring, power management.

The technical description for the interfaces shall at least include the following information:

(1) WAN interface
(2) LAN (Wired and Wireless) and WHAN interfaces
(3) Packet processing
(4) Control functions
(5) Security
(6) Quality of Service
(7) Service Support
(8) Management
(9) Maintenance
(10) Basic system features

According to HGI standard, the definitions of network interface technology are the following:

(1) WAN interface:
This block describes the physical interface towards the access network and the functionalities related to the WAN interface at layers 1 and 2. Different types of WAN interface are possible, but only one interface is supported at a time.

(2) Wired/Wireless LAN interfaces:
This block describes the physical interfaces towards the home network and the related functionalities at layer 1 and 2. A number of different interfaces I1…In, are included. A distinction should be made between the interfaces corresponding to a different LAN technologies (Ethernet, Wi-Fi, USB, …) and service specific interfaces (DECT, FXS port for VoIP, etc.). The LAN technologies are handled at the lower layers, while any service specific functions are described in the service support block. Wi-Fi security (WEP/WPA keys and ACL management) is included here.
Additional wireless interfaces are to be considered for supporting Wireless Home Area Network (WHAN) connectivity, such as Zigbee, Z-Wave, Bluetooth, etc.

(3) Packet processing:
This block describes the interconnection functions at layer 2 and/or layer 3 for LAN-WAN, WAN-LAN and LAN-LAN traffic. This means relaying, forwarding, bridging, and also NA(P)T functions if appropriate. The internal connection functions also include the routing of IP-traffic which is meant for, or coming from, the HG itself (local HG traffic). The block also includes the classification and queuing functions related to QoS management and the filtering and encryption functions related to security, as well as specific service-related functions. These tasks are performed only on the basis of information contained on the Ethernet or IP header; this block does not perform any functions involving an analysis of the packet payload.

(4) Control functions:
This block consists of the control communication stacks and the control handling. It covers all the functionality needed to control connection addressing and user authentication (via DHCP and/or PPP and signaling protocols) and device discovery inside the home (using DHCP itself or the UPnP protocol). For credentials, it has a relationship with the security block.

(5) Security:
All functionalities defining policies related to security are contained in this block. It covers protection for the user from unauthorized attacks and intrusions and for the operators from malicious use of the broadband link. Thus, fire-walling rules, authentication handling functions, key management for encryption are all defined here.

(6) Quality of Service (QoS):
This block implements the policies for QoS management in the Home Gateway and the home network, as well as any mapping between the LAN side and WAN side. It contains the rules to perform classification and queuing, and priority field mappings.

(7) Service support:
This block contains a very limited set of application layer related functions, which allows the support of some terminals which lack the necessary capabilities to provide a service. For HGI release 1, this support is limited to voice/communication services; also, in this block some specific features to ensure the support of specific applications and to manage remote access to the home network are considered.

(8) Management:
This block consists of the management communication stacks and the management handling. It contains all the functionality needed to manage the HG itself (configuration, firmware upgrade, QoS and security management etc.), the HG services (provisioning, troubleshooting) and also devices (device configuration) and services (service configuration)

reachable through the HG. The Web interface is also covered by this block, since it is considered as a basic management tool.

(9) Maintenance:
This block contains the processes related to performance control and general diagnostics.

(10) Basic system features:
This part contains the powering and the processing performance blocks. These two blocks describe the basic hardware HG resources to be shared between the various functional blocks with specific reference to available power (and related issues such as dissipation, reliability etc.) and general capability of the main processor(s) to process traffic flows (both from a data and a control plane point of view) with a defined level of performance.

APPENDIX B: HOME AND SOHO GATEWAY APPLICATIONS

Possible Home/SOHO Gateways applications are presented in Figure 6.

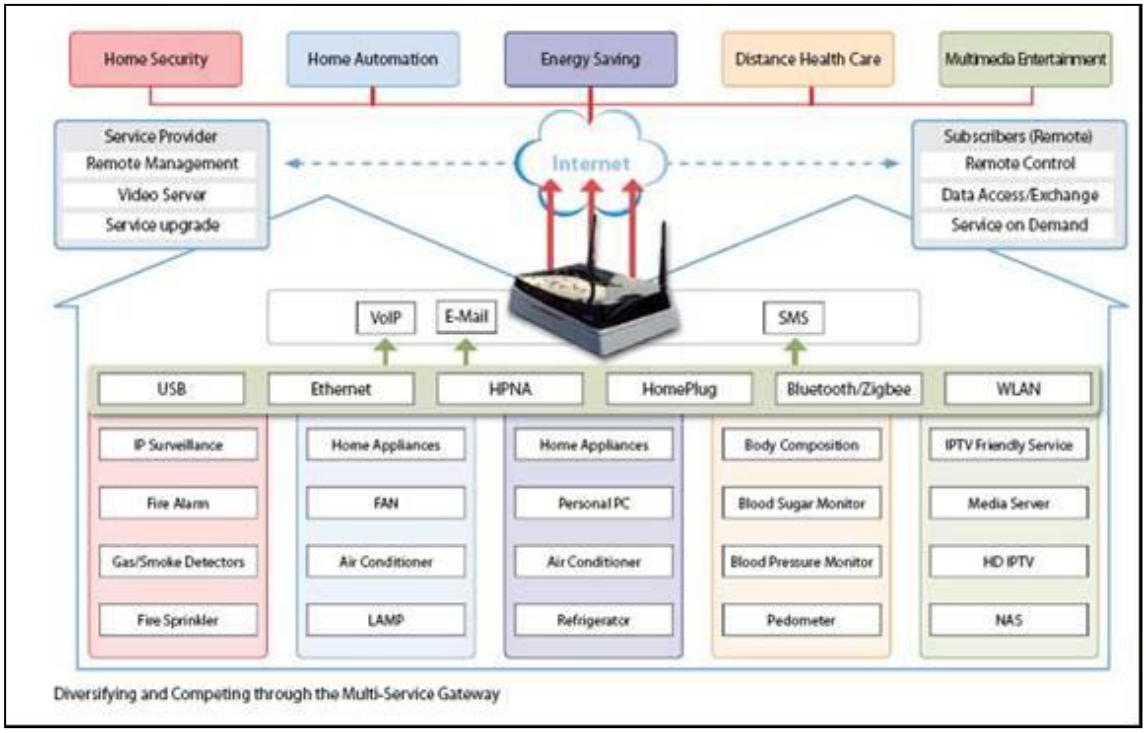

Figure 6: General Application Scenarios for Integrated Home/SOHO Gateways.

APPENDIX C: SCOPE DEFINITION WITH REFERENCE TO ETSI ES 203 199

ETSI ES 203 199 product system for LCA of ICT goods			**GPI and PCR (International EPD® System) Home/SOHO Gateway**
TAG	**Life cycle stage**	**Mandatory/Optional**	**Upstream/Core/Downstream processes**
A	**Equipment Raw Material Acquisition**		
A1	Raw material extraction	Mandatory	UPSTREAM PROCESS
A2	Raw material processing	Mandatory	UPSTREAM PROCESS
B	**Production**		
B1	**ICT goods production**		
B1.1	Parts production	Mandatory	CORE PROCESS
B1.2	Assembly	Mandatory	CORE PROCESS
B1.3	ICT manufacturer support activities	*Recommended*	*Not included*
B2	**Support goods production**		
B2.1	Support goods manufacturing	Mandatory if Support goods are included in the studied product system	UPSTREAM PROCESS (when manufactured by subcontractors)
B3	**ICT specific Site construction**		
B3.1	Construction of ICT specific Site	Recommended if Support goods are included in the studied product system	*Not included*
C	**Use**		
C1	ICT good use	Mandatory	DOWNSTREAM PROCESS
C2	Support goods use	Mandatory if Support Equipment is included in the studied product system	DOWNSTREAM PROCESS
C3	Operator support activities	Optional	*Not included*
C4	Service provider support activities	Not applicable	*Not included*
D	**Equipment End of Life Treatment**		
D1	Preparation of ICT goods for Re-use	Mandatory	DOWNSTREAM PROCESS[19]
D2	**ICT specific EoLT**		
D2.1	Storage/Disassembly/Dismantling/Shredding	Mandatory	DOWNSTREAM PROCESS
D2.2	Recycling	Mandatory	DOWNSTREAM PROCESS
D3	Other EoLT	Mandatory	DOWNSTREAM PROCESS

[19] According to GPI v3.0.

