

Product-Category Rules (PCR)
for Preparing an Environmental Product
Declaration (EPD) for
Power/Distribution Transformer
PCR 2015:1.0

FORTUNE ELECTRIC CO., LTD.

Version 1.0
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This document complies with the relevant requirements of the International EPD® SYSTEM, as well as the management requirements of the Environment and Development Foundation (www.edf.org.tw)

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1. General Information

This document is to be used as the product category rules (PCR) for the manufacturing of power/distribution transformers (“product”) globally. This PCR covers products with the following Harmonized System (HS) Codes: 8504.21-8504.23 and 8504.31-8504.34. The requirements specified in this PCR are intended to be used for EPDs certified in accordance with the ISO 14025 standard. This document shall be valid until November 30, 2018.

This PCR was first drafted by the FORTUNE ELECTRIC CO., LTD. Representatives from major Taiwanese manufacturers of similar products and stakeholders were invited by the Taiwan Electrical and Electronic Manufacturers’ Association (TEEMA) to the open consultation meeting held on October 23, 2015, to participate in the discussion and review of this PCR. The Environment and Development Foundation (EDF) subsequently reviewed and approved this PCR.

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2. Company and product description

The EPD shall include information about the manufacturing company/organization. The information may include manufacturing process related information, and environmental related information, such as the environmental management system information. The information may also include special issues which the company/organization would like to emphasize, such as the products meeting certain environmental criteria, or environmental safety and health related information.

This PCR covers the whole life stages of the product, and is applicable to both Business-to-Business (B2B) and Business-to-Consumer/Customer (B2C) communications. During the inventory of product related environmental impacts, the scope of inventory shall cover both the product and its packaging and accessories.

2.1 Product group function

The power/distribution transformers are used to convert the electrical voltage and current from the source into electrical voltage and current suitable for use by the users. The transformers are used in industrial, commercial and domestic front-end (excluding home use) applications, where there is a need to convert the source voltage or current into voltage and current more appropriate for users’ needs. Thus, the transformers play an important role of functional device in converting electrical voltage and current for the power grid.

2.2 Product components/compositions

The product’s components include but not limited to the following major and secondary components:

Major components:

- Core assembly (silicon steel belt/AMDT parts): flux conversion.
- Winding assembly: provide input and output voltage, e.g., copper or aluminum coil.
- Outer steel casing: stationary/fixed load bearing device.
- Insulation or cooling medium: provide cooling and insulation of windings, e.g. insulation oil, sulfur hexafluoride, insulation paper, cardboard, crepe paper, glass fiber materials and resin.
- Clamps: Hold transformer core body in place.

Auxiliary/secondary components:

- Support frame: Hold transformer's internal leads in place.
- Radiator (fan): Increase the transformer's heat dissipation area and cooling efficiency.
- Cable: Connect the power grid and the transformer.
- Switch: Make adjustment to fixed load voltage.
- Accessories: Transformer's protective device with the function of monitoring equipment conditions, e.g., breather or pressure relief devices.
- Packing: moisture-proof plate, stop washers, valve, screw, etc.
- Other: e.g., iron material.

Packaging materials: e.g., pallets, plastic film, wooden boxes.

2.3 Product technical description

The product technical description part of the EPD may include but not limited to the following information:

- Number of phases: single-phase or three-phase.
- Frequency: 50Hz or 60Hz.
- Primary voltage: may change according to customers' needs.
- Secondary voltage: may change according to customers' needs.
- Insulation level: tolerance of insulation to stress/pressure.
- Insulation thermal withstand level): different insulation materials have differences thermal withstand temperature.



Figure 1 Schematic Diagram of a Power/Distribution Transformer

3. List of materials and chemical substances

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

- All materials of the product with weight ratio (material weight/product weight) $\geq 0.5\%$;
- All substances/materials in the product restricted/regulated by legal and customer requirements; and
- The following materials in the main components: polychlorinated biphenyls (PCBs) in insulation fluid and lead content in solder.

The declaration of polychlorinated biphenyls (PCBs) in insulation fluid and lead content in solders, may only be made when appropriate evidences are available (for example, MSDSs or test reports from accredited laboratories/testing facilities). The following organizations may provide accreditation for testing facilities: Taiwan Accreditation Foundation (TAF), (Asia Pacific Laboratory Accreditation Cooperation (APLAC), International Laboratory Accreditation Cooperation (ILAC) or ILAC Mutual Recognition Arrangement (ILAC MRA). For definitions of testing methodology and confirmations of regulated hazardous substances based on the accredited laboratories' product testing methods, please refer to IEC 62321 Standard.

4. Declared unit

The declared unit is one (1) unit of power/distribution transformer, with the indication of number of phases, frequency, input and output voltage, and capacity. The reason for adopting this unit is that the product is sold and marketed in this unit.

5. System boundaries

The main system boundaries for the declared product system are presented as follows:

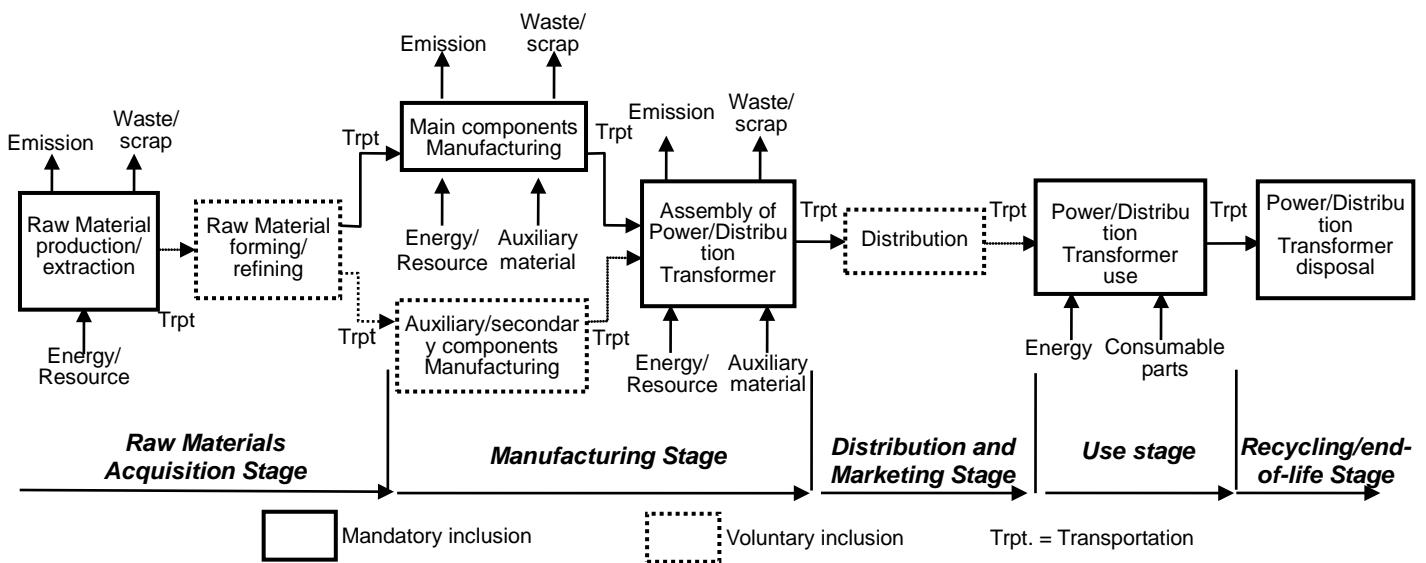


Figure 2 System boundary of the product system

As noted in Figure 2 above, the life cycle of a power/distribution transformer covers five life cycle stages: raw material acquisition, product manufacturing, distribution and marketing, product use and recycling/end-of-life. The reporting of recycling information is voluntary (optional) (see Section 11).

Raw Materials Acquisition Stage

Environmental impacts information for product components shall be obtained through inventory of upstream suppliers' operations. The inventory process shall cover:

- Composition and weight of each component, including auxiliary material and packaging material;
- Energy and resources consumption during manufacturing of components, e.g., electricity and water consumption and amount of coolant added;
- Information related to transportation to finished components to the product assembly plant, e.g., transportation vehicle, distances traveled and number of trips;
- Information related to waste generation and disposal during component manufacturing;
- Information on appropriate allocation rules based on component characteristics, such as production, area, volume, etc.;
- Information related to material and weight of packaging materials.

The data quality requirements for the main components and other components are described in Section 9 on calculation rules and data quality requirements. Data related to the packaging materials or other components shall also be included in the EPD, but their data quality requirements are different from those of the main components.

Manufacturing Stage

The inventory process for this stage shall include the processes related to the assembly, testing, packaging and warehousing of the product, and shall cover the following:

- Manufacturing of main components and the generation of process waste;
- Assembly of product and generation of process waste; and
- Transportation of main components to the product assembly plant;
- Transportation of process waste from main component manufacturing and product assembly to the waste treatment facilities.

The inclusion in the LCA the information on the input/output of packaging materials during main components manufacturing process, and the manufacturing of minor/secondary components is optional (voluntary).

The data quality requirements for the main components are described in Section 9 on calculation rules and data quality requirements. Data related to the minor/secondary components shall also be included in the EPD/CFP, but their data quality requirements are different from those of the main components.

Distribution and Marketing Stage

The LCA shall include information for the following unit processes:

- Transportation of products to the distribution sites or customer designated locations;
- Inventory and reporting of distributors' operations and transportation from sales/distribution sites to users is optional (voluntary).

Use Stage

If the product is used for the customer/user side, information related to the electricity consumption during the on-load and no-load modes shall be provided, and verified through testing method recognized by the competent authority of the countries/regions where the product is located. Examples of such testing methods include *IEEE C57.12, IEC 60076, CNS 599-C3003 and CNS 13390-C4468*.

In accordance with *CNS598-C4010 and CNS599-C3003* standards, the energy losses of the transformer can be losses calculated as follows:

$$\text{Transformer losses (kWh)} = (\text{No-load loss (W)} + \text{Load Loss (W)} \times \text{load factor}^2) \times \text{use time (hr)} / 1000$$

Where the no-load losses are fixed losses, which do not vary with load changes; while the load losses are variable losses which change with the fluctuations of loads.

Recycling/end-of-life Stage

- Reporting of recycling information (such as recycling and dis-assembly report or information on recycling channels) is mandatory in the EPD; the environmental impact shall be calculated based on the declared recycling rate;
- Inventory and reporting of transportation of end-of-life products to recycler or waste management sites is optional (voluntary);
- If there are potential recycling benefits associated with the recycler's recycling technologies or recycling approach, information related to such benefits shall be provided in the EPD.

5.1 Specification of different boundary settings

Boundary in time

The validity period for the LCA results presented in the LCA report shall be defined.

Boundary towards nature

If the manufacturing processes are located within Taiwan, the solid waste categories as defined in Taiwan's Waste Disposal Act shall be adopted. If the processes are located in other countries, equivalent legal requirements shall be considered.

The natural boundary of the system shall describe the boundary where the materials and energy resources flow from nature into the system, and where the water and air emissions and waste are released out of the system.

Only the quantity of the disposed waste needs to be considered; landfilling process does not need to be considered. If the waste is generated through wastewater treatment or incineration process, such waste should be included into the wastewater treatment or incineration process.

Boundaries in the life cycle

The boundaries in the product life cycle are described in Figure 1. The construction of the site and infrastructure, as well as the production of manufacturing equipment and activities of site operators do not need to be included.

Boundaries towards other technical systems

Boundaries towards other technical systems describe the inputs of material and other components towards other systems, as well as outputs of materials towards other systems. For the inputs of recycled materials and energy towards the product manufacturing stage, the transportation between the recycling process and use of recycled materials shall be included in the data set. For the production of recyclable products during the manufacturing stage, the transportation towards the recycling process shall be included.

(Note: Further explanations are provided in Section 7 on open-loop recycling.)

Boundaries regarding geographical coverage

The manufacturing stage may cover manufacturing processes located on any sites around the world. For processes located in a specific region, the data used should be representative of the region. The data for the main constituents shall be the specific regional data for the region where the process takes place (see Section 9). For ease of comparison, no matter where the emissions are generated, the same environmental impact parameters should be used for life cycle impact assessment (see Section 10).

6. Cut-off rules

For any impact category, if the sum of various impacts from a specific process/activity is less than 1% of the impact equivalent in that category, such a process/activity may be neglected during the inventory analysis. Nonetheless, the accumulated impact of neglected process/activity may not exceed 5%. That is, at least 95% of the potential life cycle emissions shall be evaluated. Components and materials omitted from the LCA shall be documented.

(Note: This judgment for this “1% Rule” is based on the environment relevance assessment of material input to the system, and does not consider special and exceptional environmental impacts.)

7. Allocation rules

The main allocation rules shall be valid for the entire product system. For other secondary processes, other allocation rules may be defined; however, the use of these rules should be

justified. Product-specific information should be preferentially collected in order to avoid the need for allocation. While selecting allocation rules, the following principles are recommended.

- **Multi-output:** The allocations are based on the changes in the resource consumption and pollutant emissions (for example, adopted quantity allocation for some main component, or surface allocation for some components), following the changes in the studied system's output product or function or economical relationship.
- **Multi-input:** The allocation is based on actual relationship. For example, the manufacturing process's emissions may be affected by the change in waste flow input.
- **Open loop recycling:** For the input of recycled materials or energy during the manufacturing stage of the product system, the transportation between the recycling process and the recycling to material use shall be included in the dataset. For the product which shall be recycled during the manufacturing stage, the transportation towards the recycling process shall be included.

Notes:- Allocation may be avoided through avoidance of dividing processes, for example as described in Section 6.3 of ISO/TR 14049; or through expansion of system boundary (for example as described in Section 6.4), so that the amended system shares the same product exchanges as the original system.

8. Units

The base units and derived units of the International System of Units (SI, *Système International d'unités*) shall be used preferentially.

Power & energy units:

- power unit: W
- energy unit: J

Specification units:

- length unit: m
- capacity unit: m³
- area unit: m²
- weight unit: kg

If necessary, prefixes may be used before the SI units:

10⁹ = giga, symbol "G"

10⁶ = mega, symbol "M"

10^3 = kilo, symbol “k”

10^{-2} = centi, symbol “c”

10^{-3} = milli, symbol “m”

10^{-6} = micro, symbol “ μ ”

10^{-9} = nano, symbol “n”

9. Calculation rules and data quality requirements

Data quality requirements for the raw material acquisition stage and manufacturing stage

- Site specific data (for example, specific data for manufacturing plant or transportation) shall be used for the manufacturing and assembly of major components. If other types of information are used, description of the information and rationale for using the information shall be provided. For site specific data of main component manufacturing plants, specific data from a plant representative of such a site may be used.
- Generic data may be used for the manufacturing of other components for the products, and based the calculation on actual consumption. Please refer to Appendix I for the common sources of generic data.
- When generic data are used, the equivalence between the chemical and/or physical process of referred systems shall be considered. Moreover, it is also recommended to consider the date or geographic aspects of the data quality when feasible.
- Generic data may also be used when suppliers refuse to provide specific data, or when even if generic data are used in place of specific data, there is only minor impact to the results. The general rule is that if generic data are used in place of specific data, their combined contribution for all life cycle stages shall not be greater than 20% of total impacts for each impact category. However, there may be certain exception to specific products, and such exceptions shall be explained.
- The data shall be representative for the average of a specific year. If the average data for a specific time period of less than one year is used, the reason for using such data shall be provided.
- The electricity mix for the manufacturing stage should be site specific data. If site specific data cannot be obtained, the official electricity mix for the country where the site is located may be used as approximate value. The electricity mix should be documented.
- For the definition of hazardous waste, the definition as defined in Taiwan’s Waste Disposal Act shall be used for sites located in Taiwan. For sites located outside Taiwan, legal requirements for the host country shall be observed.
- For the transportation of main components to the manufacturing plant, the actual transportation modes used and distance traveled shall be considered.

Data quality requirements for the distribution and marketing stage

- For transportation of products to the downstream distributors, the actual mode of

transportation and distance traveled shall be considered.

Date quality requirements for the use stage

- The energy consumption during the use stage scenario shall be included.
- The energy consumption of the product shall be determined based on testing methodology stipulated in applicable international, national or industrial standards of the countries/regions the product is marketed.
- For the electricity mix for the use stage, the official electricity mix for the country where the product is exported may be used as approximate value or generic data. Please refer to Appendix I for the common sources of generic data. . The year of the data cannot be older than 1990.

Date quality requirements for the recycling/end-of-life stage

- For transportation of end-of-life product as post-consumer waste for delivery to processors or recyclers, the data from national or industry sources or consumer behavior surveys can be used. When such data cannot be obtained, evaluation based on assumed scenario can be made, and the assumptions for such a scenario shall be reported in the EPD.
- Generic data may be used during the recycling/end-of-life stage, if for specific reason the site specific data for the recycling/waste disposal system cannot be obtained. Then generic data and recycling rate may be used to calculate environmental impact. Please refer to Appendix I for the common sources of generic data.

10. Parameters to be declared in the EPD

The following parameters shall be declared in the EPD:

Resource use

- non-renewable resources
 - materials resources
 - energy resources (used for energy conversion purposes)
- renewable resources
 - material resources
 - energy resources (used for energy conversion purposes)
- secondary resources
 - material resources (pre-consumer or post-consumer recycling and reuse)
 - energy resources (used for energy conversion purposes)
- recovered energy flows (such as thermal energy) expressed in MJ
- water use divided into:

- total amount of water (consider make-up water for in-plant recycling and reuse)
- direct amount of water used by the core process

The following requirements on the resource declaration also apply:

- all parameters for resource consumption shall be expressed in mass, with the exception of renewable energy; resources used for the generation of hydroelectric, wind electricity and solar energy, which shall be expressed in MJ;
- all parameters shall not be aggregated but reported separately. Resources which contribute for less than 5% in each category shall be included in the resources list as “other”;
- nuclear power shall be reported among the non-renewable energy resources as kg of uranium calculated by converting the thermal energy (MJ) considering a reactor of III generation with an efficiency of 33%;
- the PCR can define other resources (for example rare materials originating from the LCI data) which may be listed and detailed in the EPD for each specific product category;
- the energy content into some products (such as paper or plastic based products) is useful information for the end of life management. For this reason, the “energy content of product” shall be declared in MJ: its estimation shall be made considering the gross calorific value of the product. Only the energy that is suitable for an eventual energy recovery at the end of life shall be considered (energy content of steel due to its carbon content for example shall not be considered since it is not practically recoverable);
- energy content of biomass used for feed or food purposes shall not be considered.

Impact equivalents expressed as potential environmental impacts

The potential environmental impacts associated with the various types of use of resources and pollutant emissions shall be reported into the following impact categories:

- Emission of greenhouse gases (expressed as the sum of global warming potential, GWP, 100 years, in CO₂ equivalents).
- Emission of acidifying gases (expressed as the sum of acidifying potential in sulphur dioxide (SO₂) equivalents).
- Emission of gases that contribute to the creation of ground-level ozone (expressed as the sum of ozone-creating potential, ethene-equivalents).
- Emission of substances to water contributing to oxygen depletion (expressed as phosphate (PO₄) equivalents).

Impact categories for optional declaration

- Emission of ozone-depleting gases (expressed as the sum of ozone-depleting potential in mass of CFC 11-equivalents, 20 years).

Waste

- hazardous waste (as defined in Taiwan’s Waste Disposal Act, or follow host countries’ laws for sites outside Taiwan).
- non-hazardous waste

Note: For characterization factors of each impact category, please refer to *General Programme Instructions For The International EPD System, Version 2.01 (2013-09-18)*.

11. Recycling information

In order to ensure the completeness of the LCA, inclusion of recycling information for B2C product shall be mandatory. The recycling information shall include information such as dis-assembly instructions, which parts/components are suitable for recycling (such as metal cases) or not suitable for recycling. The information provided by end product manufacturer may also be included in the declaration information for products.

If practical, information for the parts which cannot be recycled and therefore should be disposed of properly during the end-of-life stage may also be included.

12. Other environmental information (Optional)

The EPD may cover information including technology adopted, site of product manufacturing and assembly, as well as information on other working environment, health and risk-related aspects.

The following information may also be included: information with high consumer interest and readily available for manufacturer, e.g., risk-related issues and their reduction during product use and maintenance; how to reduce environmental impact during product use; and information related to environmental information system (e.g., ecolabelling).

Information on most common emissions during use should be included. Information related to odor should be included, as customers will often inquire about odor issue prior to purchasing.

If this PCR is to be used for product carbon footprint declaration purpose, in the declaration, information regarding commitment on GHG reduction should be included and shall ensure that the commitment is measurable, reportable and verifiable. The organization may also list environmental and energy management related information, such as awards, commendations and system certifications (e.g., ISO 14001, ISO 14064-1, IECQ HSPM) etc.

13. Information about the certification

The information on PCR review, EPD verification and verification organization shall be included.

EPD Certification is valid until 20XX-__-__

According to the Requirements for the international EPD system, *General Programme Instructions, Version 2.01 (2013)* – www.environdec.com.

The PCR review for _____ (PCR 2015:) was administered by the Environment and Development Foundation and carried out by an LCA expert panel chaired by Dr. Wen-Ching Chen (wencc@edf.org.tw).

Independent verification of the declaration, according to ISO 14025:2006

Internal External

Third party verifier: Environment and Development Foundation in Taiwan.

Accredited by :

Name:.....

Title:.....

Organization:.....

Signature:_____

Name:.....

Title:.....

Organization:.....

Signature:_____

Name:.....

Title:.....

Organization:.....

Signature:_____

Environmental declarations from different programmes may not be comparable.

14. References

The EPD shall refer to the following documents:

- GENERAL PROGRAMME INSTRUCTIONS FOR THE INTERNATIONAL EPD® SYSTEM, Version 2.01 (2013-09-18), downloadable from:
http://www.environdec.com/Documents/GPI/General_programme_instructions_2_01_20130918.pdf
- Relevant PCR documents
- The underlying LCA report

When available, the following documents shall also be referenced:

- Other documents and recycling instructions that verify and complement the EPD.

References for this PCR:

Appendix I – Generic Data Sources to Refer to

For processes located within Taiwan, Taiwan generic data or the data published by the commercial, industrial and energy competent authorities of the Republic of China (ROC) government, may be used. However, for other regions (such as EU), if there are more relevant generic data available, these data should be used instead. Most recent data from the following generic databases are recommended for use.

Material	Database	Published
Industrial processes	ecoinvent 3.1	2014
Packing materials, transport, Waste treatments	BUWAL 250, 2 nd edition	2004
Steel, Primary copper, Copper products, Electricity, Fuels, Aluminum, Chemicals, Transports, Waste management	ecoinvent 3.1	2014
	LCA Database for Taiwan : DoITPro	2008-2014
	PE-GaBi 14	2014
	ELCD version 3.2	1995-2014
	The Boustead Model 5.0	2013
	EIME (Environmental Information and Management Explorer) EcoBilan	1999-2014
Plastics	PE Plastics Europe (Association of Plastics Manufacturers in Europe)	1993-1998
	PE-GaBi 14	2014
	ELCD version 3.2	1995-2014
	ecoinvent 3.1	2014
	The Boustead Model 5.0	2013
	EIME (Environmental Information and Management Explorer) EcoBilan	1999-2014
Electronic components	LCA Database for Taiwan : DoITPro	2008-2014
	PE-GaBi 14	2014
	ELCD version 3.2	1995-2014
	ecoinvent 3.1	2014
	The Boustead Model 5.0	2013
	EIME (Environmental Information and Management Explorer) EcoBilan	1999-2014
LCA Database in Taiwan	Carbon factor database from EPA, ROC.	2013

	DoITPro	2014
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Appendix II – Reporting Format for the EPD

This appendix provides guidance information for the titles of sections, types of data and required information to be reported in the mandatory reporting part of the EPD. As a generic reporting template, the following titles and sub-titles are recommended:

(Refer to the PCR manual for the section numbering, the information in Italics are the recommended data/information for inclusion)

Introductory part

Each EPD should have an introduction part on the top part of the EPD which includes the following information:

- *Company/organization name*
- *Product name*
- *EPD registration number*

Description of the company/organization and product/service

Company/Organization

- *Description of company/organization*
- *Description of overall working environment, existing quality system and environmental management system*

Product and services (see Section 2)

- *Product's main applications*
- *Description of product specification, manufacturing process, manufacturing sites (if there are several sites)*
- *For product's environmental performance aspects, characteristics which may improve the usefulness of product*
- *Other types of relevant information, for example, special manufacturing processes with special advantages to the environment*

List of materials and chemical substances

- *Content declaration (see Section 3)*

Presentation of the environmental performance

- *Outline of the LCA methodology, for example, period of LCA, declared units, system boundaries (graphical presentation), cut-off and allocation rules, and data sources.*

Raw Materials Acquisition Stage (see Section 10)

Manufacturing stage (see Section 10)

Distribution, Use and End-of-Life stage (see Section 10)

- *Geographical region for product delivery*
- *Transportation data*
- *Design life*
- *Description of use stage and energy consumption*
- *Annual electricity consumption during use stage and global warming potential*
- *End-of-life information*

Information about Company and Certification Organization

Recycling information (see Section 11)

Other environmental information (see Section 12)

Information regarding certification (see Section 13)

- *Names of certification and verification organizations*
- *Validity of certification certificates*
- *Compliance with legal and relevant requirements*

References (see Section 14)

- *relevant PCR documents*
- *General Programme Instructions for the International EPD® System, Version 2.01 (2013-09-18)*
- *underlying LCA study*
- *other supporting documents for LCA information*

- other relevant documents regarding company/organization's environmental activities

Appendix III Abbreviations

Acronym	Common Name
APLAC	Asia Laboratory Accreditation Cooperation
CFP	Carbon Footprint of Product
EPD	Environmental Product Declaration
ErP	Energy Related Product
ILAC	International Laboratory Accreditation Cooperation
ILAC MAR	International Laboratory Accreditation Cooperation Mutual Recognition Arrangement
ISO	International Organization for Standardization
LCA	Life Cycle Assessment
PCR	Product Category Rule
RoHS	The Restriction of the use of certain Hazardous Substances in electrical and electronic equipment
SPI	Society of the Plastics Industry
TAF	Taiwan Accreditation Foundation
TEC	Typical Energy Consumption
Trpt	Transportation
WEEE	The Waste Electrical and Electronic Equipment Directive