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BASE IMPACTS® DATA DOCUMENTATION

CATEGORY: ELECTRICAL AND ELECTRONIC COMPONENTS

3 levels of documentation are available for the datasets in Base Impacts®:

- A **general documentation** explaining general information on the datasets and data general requirements
- A **sectorial documentation:** one document per sector describing the available datasets and their characteristics (technological representativeness, geographical representativeness), and providing the information on the datasets in a common layout. Information comes from the consultation specifications, the dataset commissioner technical proposal and the metadata
- The **datasets metadata** can be viewed directly in the datasets sheets. They include more detailed information (flow diagrams, Etc.)

This document is the category documentation for electric and electronic components.

CONTENTS

A. PRESENTATION OF THE DATASETS

1. List of available datasets

The following datasets are available:

Technological representativity			Geographical representa-tivity	Dataset type
Liquid crystal display panel	Light emitting diode backlight	26 inches	Republic of Korea, Taiwan	LCI Result[1]
		32 inches	Republic of Korea, Taiwan	LCI Result
		37 inches	Republic of Korea, Taiwan	LCI Result
		42 inches	Republic of Korea, Taiwan	LCI Result
		47 inches	Republic of Korea, Taiwan	LCI Result
		m²	Republic of Korea, Taiwan	LCI Result
	Cold-cathode fluorescent lamp backlight	32 inches	Republic of Korea, Taiwan	LCI Result
		37 inches	Republic of Korea, Taiwan	LCI Result
		42 inches	Republic of Korea, Taiwan	LCI Result
		47 inches	Republic of Korea, Taiwan	LCI Result
		m²	Republic of Korea, Taiwan	LCI Result
Printed circuit board assembly, LCD pixel controller		AuNi finish	Japan, Republic of Korea, Turkey, Taiwan	LCI Result
		Sn finish	Japan, Republic of Korea, Turkey, Taiwan	LCI Result
Printed circuit board assembly, power supply		AuNi finish	Japan, Republic of Korea, Turkey, Taiwan	LCI Result
		Sn finish	Japan, Republic of Korea, Turkey, Taiwan	LCI Result
TV motherboard	Basic	AuNi finish	Japan, Republic of Korea, Turkey, Taiwan	LCI Result
		Sn finish	Japan, Republic of Korea, Turkey, Taiwan	LCI Result
	Smart/ advanced	AuNi finish	Japan, Republic of Korea, Turkey, Taiwan	LCI Result
		Sn finish	Japan, Republic of Korea, Turkey, Taiwan	LCI Result
Electrical cable,	Mains power, Cu	Modified PPE insulation and jacket	Global	LCI Result

[1] Named « Partial vertical aggregation » datasets in the nomenclature of the UNEP-SETAC guide.

Technological representativity			Geographical representa-tivity	Dataset type
external	conductor	PVC insulation and jacket	Global	LCI Result
	HDMI, Cu conductor	PE insulation and PVC jacket	Global	LCI Result
Electrical cable, internal	Power, Cu conductor	Modified PPE insulation	Global	LCI Result
		PE insulation	Global	LCI Result
		PVC insulation	Global	LCI Result
	Signal, Cu conductor	Modified PPE insulation	Global	LCI Result
		PE insulation	Global	LCI Result
		PVC insulation	Global	LCI Result
Magnet		AlNiCo	Global	LCI Result
		NdFeB	Global	LCI Result
Remote control, television, universal			Global	LCI Result
Battery, AA cell, alkaline			Global	LCI Result
Battery, AAA cell, alkaline			Global	LCI Result

Table 1: Available datasets

2. Structure of available datasets

The data available in the Base IMPACTS® result from aggregated inventories, and can therefore be used separately.

The modeling of a television consists in combining these datasets, while also using datasets from other categories (e.g. plastics):

- LCD screen (screen module + plastic frame)
- LCD monitor (board + cables)
- Motherboard (board cables)
- Power supply (power supply connector + power cable + plastic case, …)
- Speaker system (magnet, case)
- Remote (remote + batteries)

3. Technical specifications

Technologies covered by the data are presented in Table 1.

B. SCOPE OF THE DATASETS

1. Reference flow, functional unit

The reference flows of the inventory data are defined based on the component type:

- Inventories of screens with size specification are provided for one item; those without size specification are provided for 1m².
- Inventories for electronic boards are provided for 1 m²
- Inventories for cables are provided for 1 m
- Inventories for magnets are provided for 1 kg
- Inventories for battery and remote control are provided for 1 item

2. System boundaries

2.1. General foreground system boundaries

Cut-off for each unit process:

The datasets cover at least 95% of mass and energy of the input and output flows, and 98% of the environmental relevance (according to expert judgment).

2.2. Dataset-specific foreground system boundaries

2.2.1. Liquid crystal display (LCD) panel

This datasets can be used to represent the manufacture of a liquid crystal display (LCD) panel using a mix of twisted pneumatic (TN) and in-plane switching (IPS) technologies.

- with a light-emitting diode (LED) backlight
- with cold-cathode fluorescent lamp (CCFL) backlight

They cannot be used to model touch screens.

It does not represent an entire television or computer monitor. The housing, printed wiring boards, cables, etc. must be modelled separately.

5 screen sizes are provided (26, 32, 37, 42 and 47 inches), as well as a more generic data expressed in m². Screens are modeled based on a density of 12 kg/m² for LED backlight screens, and 12,4 kg/m² for CCFL backlight screens.

The LCD panel consists of the following parts:

- LCD cell panel: Cell manufacture includes the preparation of raw materials (mother glass, liquid crystal polymer) and auxiliaries (target, developer, etchant, stripper, etc.), the water and energy consumed during manufacturing, and the direct emissions from manufacturing, notoriously sulphur hexafluoride.
- Backlight assembly sheets: This represents a mixture of TN and IPS technologies backlight sheets. The sheets contain polarizer, prism, diffuser and reflector sheets with scalability over the viewing area. The material of all sheets is mostly based on polyethylene terephthalate film.

- Backlight assembly: This represents a mixture of TN and IPS technologies backlight systems. The backlight contains mechanical components such as frames, light guide panel and light bar. The materials used contain aluminum, steel and various plastics.
- Bare die pixel control chips: The bare dice applied for column control chips are sized 3x20x0.1mm, totaling a die size of 60mm2. The dataset includes front-end and back-end processing of the wafer, including Czochralski method of silicon growing. No housing, lead frame or bond wires are assumed necessary for these components. This dataset represents a global technology and energy mix. The wafer processing model is representative of several manufacturing platforms (defined methods of IC production) developed and/or used by leading manufacturers of logic and memory (Intel, AMD/Global Foundries, IBM, TSMC, Samsung, Micron), which compose the majority of IC production worldwide. The production location (energy, materials and fuels) represents a mix of IC producing nations weighted by installed manufacturing capacity. The front-end technology node applied was MPU 130nm. Small mechanics and electro-mechanics: The module represents a mixture of small mechanics used as steel screws, gaskets, fillers and tapes (PU and PET) as well as electro-mechanical components such as internal cables (copper and PVC) and connectors (with gold, brass and polyamide 6.6).
- **LED Backlight:** The model assumes an edge-lit LED panel rather than a back-lit panel. Unlike the CCFL backlight, no inverter is required to power the LEDs.
- **CCFL Backlight:** 2 x CCFL tubes (top and bottom) are assumed per TV, with the diameter increasing for larger screen sizes. While many tubes have historically been used for larger TVs, CCFL technology has improved and the number of tubes required per TV has decreased over time. Electrical cables and inverter printed wiring boards are including. While production of the CCFL tubes is included, the mercury content is not modelled due to a lack of quality data on mercury production.

The mass of the panel was calculated from an internet survey of 150 LCD TVs on the market in 2013. As manufacturers do not list the mass of the LCD panel separately, it was assumed that the panel weighed 40% of mass of an average TV of a given size without its stand. This 40% figure was derived from the 2007 EuP preparatory study for televisions (see Lot 5, T4 page 12-16).

Packaging and transport from producer to consumer are not included.

Sources:

- Data on LCD cell manufacture were derived from two confidential industry sources and two public sources (CML, 2009; AOU, 2010).
- Individual industry data
- EuP Preparatory Studies "Televisions" (Lot 5), 2007
- SICAS Glob. Statistics Report 4th Quarter 2008: Integrated Circuit Wafer-Fab Capacity & Utilisation

2.2.2. Printed circuits assembly

2.2.2.1. Notice on the use of printed circuits data

Technical characteristics (electronic board composition, components, density) of printed circuits are indicated in metadata, and summarized in the present document.

This dataset should be scaled by area to reflect the real product.

2.2.2.2. General information on printed circuits modeling

Datasets geographical representativeness: Only PWB population is assumed to occur in the reference country. The bare PWB and all electronic components are assumed to be sourced globally and manufactured in Asia (using an average Asian energy mix). This is why the differences in impacts between manufacturing countries are small.

Inventory of components production:

- Printed wiring board (PWB): The copper tracks/traces are assumed to be applied to the PWB using the subtractive method (as opposed to additive method). All important manufacturing steps are included, specifically: (1) core preparation, including production of the copper-clad pre-preg, surface preparation, application of the photo-resist, development, etching, stripping, oxide treatment, and via drilling; (2) layering, for multi-layer boards, including collation and lamination; (3) outer layer preparation, including solder resist, curing and cleaning; and (4) finishing, using either a chemical bath or electrolytic plating. Overhead water consumption for cleaning and energy consumption for lighting, air conditioning, heating, conveyor belts, stacking and lifting machines, quality control equipment, etc. are included. Waste water is assumed to be treated in an average waste water treatment plant.
- Semiconductor components, including integrated circuits (ICs), transistors and diodes: All datasets assume a mono-crystalline, silicon-based semiconductor. All important manufacturing steps are included, specifically: (1) front-end wafer processing, which produces the dominant environmental effect, including manufacturing of mono-crystalline silicon via the Czochralski method of silicon growing and wafer structuring/design; (2) production of the packaging interconnect, which is either (i) wire bonded, using gold or aluminium wire bonds to connect to a leadframe, or (ii) flip-chip, using a printed wiring board to connect to solder bumps; and (3) encapsulation, using glass-filled epoxy resin with Tetrabromobisphenol A (TBBA) and/or antimony trioxide flame retardant. Electricity used in front-end wafer processing is a weighted average of national electricity mixes based on semiconductor wafer production capacity reported statistics [SICAS], checked against an additional source [WSTS]: Japan (32.2%), Taiwan (20.2%), USA (17.0%), South Korea (16.4%) and China (14.1%). Electricity used in back-end die assembly, testing and packaging is an average (evenly weighted) of national electricity mixes based on market reports and publicly-available information concerning the back-end manufacturing locations owned by major IC manufacturers: Taiwan (16.7%), China (16.7%), Malaysia (16.7%), Thailand/Singapore (16.7%), South Korea (16.7%) and Mexico (16.7%).
- Passive electronic components (capacitors, resistors, inductions/coils and oscillators): This category contains a large number of components. All important manufacturing steps are included. The following processes are commonly used, though not all are required for each component type: sputtering (coating), dip soldering (coating), sintering (ceramics), wet casting and burning (ceramics), stamping (metal sheet),

bending (metal sheet/wire), deep drawing (metal sheet), foil making (metal sheet), wire drawing (metal), wrapping (metal wire), and print-and-etch (metal sheet).

Data sources :

- Individual industry data
- EuP Preparatory Studies "Televisions" (Lot 5), 2007
- SICAS Glob. Statistics Report 4th Quarter 2008: Integrated Circuit Wafer-Fab Capacity & Utilisation

2.2.2.3. Printed circuit board assembly, LCD pixel controller

This dataset can be used to model the pixel control board (timing control board) of an LCD television. This board is typically mounted onto the rear of the LCD panel.

Only the populated printed wiring board is included. Any mechanical enclosures must be modeled separately.

Characteristics of the modeled printed circuit:

The composition of this populated printed wiring board is based on data collected by PE International. The bare PWB is ca. 100 cm2, 8-layer (i.e. 4 x double-sided laminate layers), rigid, glass-epoxy (FR4) laminate with tetrabromobisphenol-A as the flame retardant.

The board is populated with ICs (modelled as an average of 1.25 * TQFP-44 + 0.92 * SSOP-24 + 1.89 * SSOP-14 + 0.53 * SOIC-8), diodes and surface-mount resistors/ capacitors/ inductors.

The PWB is populated using reflow soldering for surface-mount device (SMD) components.

Difference of finish:

This dataset is provided in Base Impacts® with two types of finish:

- AuNi finish: the surface finish is assumed to be electroless nickel immersion gold (ENIG). The electronic boards density is thus 3,38 kg/m² ;
- Sn finish: the surface finish is assumed to be hot air solder levelled (HASL) tin. The electronic boards density is thus 3,67 kg/m².

2.2.2.4. Printed circuit board assembly, power supply

This datasets can be used to model internal and external power supplies.

It includes the populated printed wiring board and heatsinks. The enclosure for the power supply is not included and must be modelled separately

Characteristics of a modeled printed circuit:

The total mass of 829.8g is broken down as follows:

- 84.5g Al extrusion profile;
- 477.6g big capacitors and coils (modelled as 10 * 15.41g Al capacitor radial THT D18x41mm + 4.04 * 80g ring core coil with housing);

- 22.9g ICs with average 1% Si (modelled as 31.8 * 720mg transistor THT SOT82 10.6x7.6x2.5mm);
- 0.1g ICs with average 5% Si, Au (modelled as 1.25 * 80mg SOIC 8 4.9x3.9x1.7mm);
- 14.5g SnAg4Cu0.5 solder;
- 0.1g paper (excluded as below cut-off criteria);
- 39.7g PVC jacketed cable;
- 22.9g connectors;
- 0.5g SMD/ LEDs (modelled as 10 * 50mg ceramic MLCC capacitor 1210 3.2x3.2x1.6mm);
- 10.2g stainless steel sheet;
- 0.4g copper sheet;
- and 156.4g 1-2-layer PWB.

The PWB is modelled as a 0.0884m2, 2-layer (i.e. double-sided), rigid, glass-epoxy (FR4) laminate with tetrabromobisphenol-A as the flame retardant.

The PWB is populated using both reflow and wave soldering to accommodate PWBs with a mixture of through-hole technology (THT) and surface-mount device (SMD) components.

Finish difference:

This dataset is provided in Base Impacts® with two types of finish:

- AuNi finish: the surface finish is assumed to be electroless nickel immersion gold (ENIG). The electronic boards density is thus 8,94 kg/m² ;
- Sn finish: the surface finish is assumed to be hot air solder levelled (HASL) tin. The electronic boards density is thus 9,39 kg/m².

2.2.2.5. Printed circuit board assembly, TV motherboard

This datasets can be used to model the control board / mainboard / motherboard of a television. It is not suitable for power supplies.

Characteristics of a modeled printed circuit:

The total mass of 667.7g is broken down as follows:

- 27.7g stainless steel electromagnetic interference shielding;
- 0.3g ferrite;
- 20g aluminium extrusion profile;
- 1g copper sheet;
- 29g big capacitors and coils (modelled as 1 * 15.41g Al radial THT capacitor D18x41mm + 5.4 * 2.5g quad-chokes 14.5x13.3x8.0mm);
- 56.9g connectors;
- 12.5g ICs with 5% Si, Au (modelled as 4 * 466mg BGA-144 13x13x1.75mm + 10 * 180mg QFP-32 7x7x1.5mm + 2 * 520mg TQFP-100 14x14x1.0mm + 2 * 590mg TSOP-56 14x20x1.2 flash memory + 20 * 80mg SOIC-8 4.9x3.9x1.7 PE + 10 * 500mg SOIC-20 12.8x7.5x2.3mm);
- 0.6g ICs with 1% Si (60 * 10mg signal transistor SOT23 3 leads 1.4x3x1mm);
- 65g SMD/ LEDs (modelled as 300 * 10mg ceramic capacitor MLCC 0603 1.6x0.8x0.8mm + 500 * 2.1mg thick film flat chip resistor 0603 + 5 * 108mg multi-layer coil 1812 4.5x3.2x1.5mm + 2 * 500mg tantalum capacitor SMD E 7.3x4.3x4.1mm + 3 * 35mg 50mA SMD LED 3.2x2.8x1.9mm + 2 * 750mg crystal oscillator 11.35x4.65x3.6mm + 10 * 2.54g Al capacitor SMD D12.5x13.5mm + 10.8 * 3.12g miniature would coil SRR1806 D18.3x6.8mm);
- 454.5g PWB;
- 0.2g SnAg4Cu0.5 solder.

The PWB is populated using both reflow and wave soldering to accommodate PWBs with a mixture of through-hole technology (THT) and surface-mount device (SMD) components.

Electronic board difference:

In the database, this data is proposed with two types of motherboards: “basic” or “smart”.

A "basic" motherboard is differentiated from a "smart" motherboard by the level of integration. A "basic" motherboard assumes a 4-layer printed wiring board and less integrated circuit area. A "smart" motherboard assumes an 8-layer printed wiring board and more integrated circuit area.

- “Basic” motherboard: The PWB is modelled as a 0.207 m2, 4-layer (i.e. 2 x double-sided laminate layers), rigid, glass-epoxy (FR4) laminate with tetrabromobisphenol-A as the flame retardant.
- “Smart” motherboard: To reflect changes in technology since 2007, two major changes have been made: (1) 2 large integrated circuits (modelled as 2 * 4.9g BGA-672 35x35x2.37mm) have been added to represent a large microprocessor and onboard memory; and (2) the PWB is assumed to be 8-layer rather than 4-layer. The PWB is modelled as a 0.207 m2, 8-layer (i.e. 4 x double-sided laminate layers), rigid, glass-epoxy (FR4) laminate with tetrabromobisphenol-A as the flame retardant.

Finish difference:

This dataset is provided in Base Impacts® with two types of finish:

- AuNi finish: the surface finish is assumed to be electroless nickel immersion gold (ENIG).
- Sn finish: the surface finish is assumed to be hot air solder levelled (HASL) tin.

Surface weight	“Basic” motherboard	“Smart” motherboard
AuNi finish	3.22 kg/m2	4,16 kg/m2
Sn finish	3,51 kg/m2	4.45 kg/m2

2.2.3. Electrical cables

2.2.3.1. Notice on the use of electrical cables data

Technical characteristics (diameter, linear density) of cable are indicated in metadata, and synthesized in the present document. If the diameter of the cable to be modeled is significantly different from that specified, please scale the cable by mass rather than length. Multi-core cables should be modeled as multiple single-core cables.

As of 2013, flexible PVC is the most common cable insulator on the market, though there is strong pressure from environmental organisations for it to be phased out.

2.2.3.2. General information on electrical cables modeling

Cables consist of insulated wire cores, which may either be fused together (in the case of a ribbon cable) or wound together and covered with a jacket (in the case of a multi-core cable). In twisted-pair data cables, pairs of cores are twisted together (twinning) and then bunched together (cabling) before being covered by the jacket. Both single- and multi-core cables may have one or more layers of electromagnetic interference (EMI) shielding between the core(s) and the jacket. The metal wire conductor may be coated or uncoated. The insulation and jacket are typically polymers that may be modified (compounded) or largely unmodified. Most thermoplastic polymers can be extruded directly over the wire conductor using a continuous screw extruder. Compounding is typically performed by the polymer manufacturer; however, for PVC cables, the cable manufacturer may also perform the compounding step. Customized cables are often manufactured relatively close to market, particularly in Asia, Europe and North America. Well standardized cables are typically mass manufactured in Asia.

Foreground system: Insulation is extruded directly over the copper wire. The jacket is extruded directly over the bunched cores and any other inserts (mesh, ripcord, etc.). The energy for extrusion is included, but the energy for twinning and cabling is excluded as it falls below cut-off criteria. Production assumes a global energy mix. Distribution from the cable manufacturer to the customer is not included.

Background system: Wire drawing and polymer compounding both assume a global energy mix. Truck transport of 1000 km between drawing/compounding plants and cable manufacturer is assumed.

2.2.3.3. Electrical cable, external, mains power

Two external cables for the main power supply are proposed in the database.

This datasets can be used for all external power cables used to connect between the device and a wall socket.

In 2013, flexible PVC is the most common cable insulator on the market, though there is strong pressure from environmental organisations for it to be phased out.

Technical characteristics of the modeled cables:

- **modified PPE insulation and jacket PP:**10A/13A rating, 3-core 16AWG bare Cu wire, mPPE insulation, mPPE jacket, 6.3 mm outer diameter, unshielded, 60 g/m

  This dataset represents the production of a standard 10 amp / 13 amp, 3-core power cable. Each core is made of stranded, uncoated copper with a diameter of 1.291 mm (18 AWG) coated by 0.28 mm thick modified polyphenylene ether (mPPE) insulation. The cores are then enclosed in a 0.89 mm thick mPPE jacket. The total cable diameter is 6.3 mm. The mass is 60 g/m (60 kg/km). The composition of the insulation and jacket is 85% PPE granulate and 15% tricresyl phosphate (TCP) flame retardant. The cable is lead-free (Pb-free) and low smoke, zero halogen (LSZH).

  Data source: Alpha Wire, EcoCable and EcoFlex Cable, 2013

- **PE insulation and PVC jacket:** 10A/13A rating, 3-core 16AWG bare Cu wire, PVC insulation, PVC jacket, 8 mm outer diameter, unshielded, 100 g/m

  This dataset represents the production of a standard 10 amp / 13 amp, 3-core power cable. Each core is made of stranded, uncoated copper with a diameter of 1.291 mm (16 AWG) coated by 0.6 mm thick PVC insulation. The cores are then enclosed in a 0.8 mm thick PVC jacket. The total cable diameter is 8 mm. The mass is 100 g/m (100 kg/km). The composition of the insulation and jacket is 45% PVC granulate, 23.5% DINP plasticizer (phthalate-based), 29.5% calcium carbonate filler and 2% Ca/Zn stearate heat stabilizer. The cable is halogenated, but lead-free (Pb-free).

  Data source: Permanoid, Flexible Cables, 2008

2.2.3.4. External electric cable, HDMI

This dataset can be used for all external, signal (i.e. low current) cables with a PVC jacket used to connect between devices. It is based on an HDMI cable.

Technical characteristics of the modeled cable:

- **PE insulation PVC jacket:** HDMI v1.0-1.3, 19-core 28AWG tinned Cu wire, PE insulation, PVC jacket, 7.3 mm outer diameter, shielded, 80 g/m

  This dataset represents the production of a standard 19-core v1.0/v1.1/v1.2/ v1.3 HDMI cable (4 x twisted pairs + 7 x other wires + 4 x drain wires). All cores are made of stranded copper with a diameter of 0.321 mm (28 AWG) coated with a 2.54 um tin plating. Each cable in the twisted pairs has an LDPE insulator with outer diameter 1 mm. Each pair is enclosed together with a drain wire in a PET-backed aluminium EMI shield. The other 7 insulated cores use an HDPE insulator with other diameter 0.7 mm. The bundle of cables is then enclosed in an PET-backed aluminium EMI screen and a woven copper mesh EMI shield. The jacket is 0.762 mm thick PVC and has an outer diameter of 7.3 mm. The mass is 80 g/m (80 kg/km). The composition of the jacket is 54.5% PVC granulate, 27% DINP plasticizer (phthalate-based), 16.5% calcium carbonate filler and 2% Ca/Zn stearate heat stabilizer. The cable is halogenated, but lead-free (Pb-free).

  Data sources: pro-SIGNAL, HDMI Lead (PSG01093), 2012; Multicomp, Cable Assembly, HDMI - HDMI (8-941926), 2009

2.2.3.5. Electrical cable, internal, power

Three internal cables for power supply are proposed in the database.

This dataset can be used for single-core, internal (i.e. cables used inside the electric/electronic product), power (i.e. high current) cables.

As of 2013, flexible PVC is the most common cable insulator on the market, though there is strong pressure from environmental organisations for it to be phased out.

Technical characteristics of the modeled cables:

- **Insulation and jacket in modified PPE:** 1-core tinned 18AWG Cu wire, mPPE insulation, 1.7 mm outer diameter, 10 g/m

  This dataset represents the production of a standard 1-core hook-up power wire. The core is made of stranded, tinned copper (Sn plating = 2.54 µm) with a diameter of 1.024 mm (18 AWG) coated by 0.33 mm thick modified polyphenylene ether (mPPE) insulation. The total cable diameter is 1.7 mm. The mass is 10 g/m (10 kg/km). The composition of the insulation is 85% PPE granulate and 15% tricresyl phosphate (TCP) flame retardant. The cable is lead-free (Pb-free) and low smoke, zero halogen (LSZH).

  Data source:Alpha Wire, 6715 Hookup Wire, 2009

- **PE insulation:** 1-core tinned 18AWG Cu wire, PE insulation, 2.8 mm outer diameter, 16 g/m

  This dataset represents the production of a standard 1-core hook-up power wire. The core is made of stranded, tinned copper (Sn plating = 2.54 µm) with a diameter of 1.024 mm (18 AWG) coated by 0.76 mm thick flame retardant cross-linked polyethylene (PEX/XLPE) insulation. The total cable diameter is 2.8 mm. The mass is 16 g/m (16 kg/km). The composition of the insulation is 38% PEX granulate, 60%

aluminium hydroxide flame retardant filler and 2% organosilane coupling agent. The cable is lead-free (Pb-free) and low smoke, zero halogen (LSZH).

Data source: Belden, 35618 Hook-up/Lead - UL AWM Style 3173 - XL-DUR, 2011

- **PVC insulation:** 1-core tinned 18AWG Cu wire, PVC insulation, 2.9 mm outer diameter, 16 g/m

  This dataset represents the production of a standard 1-core hook-up power wire. The core is made of stranded, tinned copper (Sn plating = 2.54 µm) with a diameter of 1.024 mm (18 AWG) coated by 0.42 mm thick modified polyvinyl chloride (PVC) insulation. The total cable diameter is 1.4 mm. The mass is 4.5 g/m (4.5 kg/km). The composition of the insulation is 45% PVC granulate, 23.5% DINP plasticizer (phthalate-based), 29.5% calcium carbonate filler and 2% Ca/Zn stearate heat stabilizer. The cable is halogenated, but lead-free (Pb-free).

  Data source: Lapp Group, Multi-Standard single core UL(MTW)-CSA-HAR 1015, 2008

2.2.3.6. Electrical cable, internal, signal

Three internal signal cables are proposed in the database.

This dataset can be used for all single-core, internal (i.e. cables used inside the electric/electronic product), signal (i.e. low current) cables.

Technical characteristics of the modeled cables:

- **Insulation and jacket in modified PPE:** 1-core tinned 24AWG Cu wire, mPPE insulation, 1.1 mm outer diameter, 3.0 g/m

  This dataset represents the production of a standard 1-core hook-up signal wire. The core is made of stranded, tinned copper (Sn plating = 2.54 µm) with a diameter of 0.511 mm (24 AWG) coated by 0.24 mm thick modified polyphenylene ether (mPPE) insulation. The total cable diameter is 1.1 mm. The mass is 3.0 g/m (3.0 kg/km). The composition of the insulation is 85% PPE granulate and 15% tricresyl phosphate (TCP) flame retardant. The cable is lead-free (Pb-free) and low smoke, zero halogen (LSZH).

  Data source: Alpha Wire, 6712 Hookup Wire, 2009

- **PE insulation:** 1-core tinned 24AWG Cu wire, PE insulation, 1.4 mm outer diameter, 4.5 g/m

  This dataset represents the production of a standard 1-core hook-up signal wire. The core is made of stranded, tinned copper (Sn plating = 2.54 µm) with a diameter of 0.511 mm (24 AWG) coated by 0.41 mm thick flame retardant cross-linked polyethylene (PEX/XLPE) insulation. The total cable diameter is 1.4 mm. The mass is 4.5 g/m (4.5 kg/km). The composition of the insulation is 38% PEX granulate, 60% aluminium hydroxide flame retardant filler and 2% organosilane coupling agent. The cable is lead-free (Pb-free) and low smoke, zero halogen (LSZH).

  Data source: Belden, Zyrad 500 Industrial Cable, 2006

- **PVC insulation:** 1-core tinned 24AWG Cu wire, PVC insulation, 1.4 mm outer diameter, 4.5 g/m

  This dataset represents the production of a standard 1-core hook-up signal wire. The core is made of stranded, tinned copper (Sn plating = 2.54 µm) with a diameter of 0.511 mm (24 AWG) coated by 0.41 mm thick modified polyvinyl chloride (PVC) insulation. The total cable diameter is 1.4 mm. The mass is 4.5 g/m (4.5 kg/km). The composition of the insulation is 54.5% PVC granulate, 27% DINP plasticizer (phthalate-based), 16.5% calcium carbonate filler and 2% Ca/Zn stearate heat stabilizer. The cable is halogenated, but lead-free (Pb-free).

Data source: Alpha Wire, 1550 Hookup Wire, 2005

2.2.4. Magnets

Two types of magnets are proposed in Base Impacts®:

AlNiCo magnets are particularly suitable in high-temperature applications as they have excellent thermal stability

Neodymium magnets of type NdFeB are now extremely widely used due to their outstanding magnetic properties even at small sizes. Example applications include speakers, cordless tools, hard disk drives, magnetic clips on bags and purses, and other types of magnetic fasteners. Neodymium magnets are high-energy permanent magnets from the rare-earth group made from an alloy of neodymium, iron, and boron. The high magnetic energy starting at 385 kJ/m^3 enables new technical solutions. When compared to conventional magnets made from barium ferrite or AlNiCo, for example, they allow for physically smaller magnet systems or a considerably higher magnetic energy within the same space. To achieve equivalent energy content, a barium ferrite magnet would require a volume 6 times that of an NdFeB magnet. In order to generate a field of 100 mT (1000 Gauss) 1 mm distance from the polar face, a barium ferrite magnet would require a size 25 times larger than a samarium-cobalt magnet. The magnetic energy of neodymium magnets is ca. 70% higher still than the quoted samarium-cobalt magnet.

Technical characteristics of the modeled magnets:

- **AlNiCo magnet:** Production of AlNiCo magnet alloy assuming a global electricity mix, a global thermal energy mix, and an alloy composition of 55% iron oxide, 10% aluminium, 15% nickel and 20% cobalt.

  Transport from the manufacturer to the customer is not included.

  Data source: individual industry data

- **NdFeB magnet:** The alloy is assumed to be Nd2Fe14B (30% Nd, 69% Fe, 1% B wt./wt.).

  The modelled production route represents classical powder metallurgy. The NdFeB alloy is first smelted. The cooled alloy is then pulverised and the powder is magnetically aligned, isostatically pressed and then sintered into large blocks. The blocks are cut using a diamond saw into smaller shapes. The combined manufacturing loss of the NdFeB alloy across all process steps is 25%. 50% of these losses are internally recycled and 50% enter an external recycling route. 1% wt./wt. polyethylene glycol is added during pressing as a binder, of which 50% enters waste treatment. In addition to emissions from energy production, VOC and CO2 emissions to air are also produced during sintering. After the forming process, the pieces are magnetised until saturation, a process requiring high field intensity. To generate this high field intensity, charged condenser batteries are impulse-charged in a solenoid. The magnetic body is placed in the inner hole of the low-resistance solenoid and is magnetised until saturation by firing charged impulses through the strong, induced magnetic field.

  Neodymium is based on mining and production data from China. Iron oxide is based on data from Germany.

Due to the scarcity of data on boron and its production, this part of the alloy has been neglected; however, boron accounts for less than 1% of the finished magnet by mass.

Data sources: individual industry data

2.2.4.1. Remote control, television, universal

This dataset can be used to represent a standard remote control for a television. It is not suitable for "smart" remote controls with LCD screens.

Batteries are not included and must be modelled separately.

The composition of the remote control is based on that of the 2007 EuP preparatory study for televisions (see Lot 5, T4 page 14). The most important difference is that the whole enclosure is modelled as ABS rather than a combination of ABS and high-impact polystyrene.

The total mass is 80g.

The mass breakdown is as follows: 54g ABS enclosure/mechanics, 12g silicon rubber button mat, 13.3g printed wiring board (PWB), 0.1g integrated circuits (ICs), 0.26g capacitors and resistors, 0.16g light-emitting diodes (LEDs), 0.1g stainless steel screws, and 0.1g SnAg3Cu0.5 solder paste.

The integrated circuits are modelled as a single 48-pin TSSOP chip.

The PWB is modelled as a 0.01m2, 2-layer (i.e. double-sided), rigid, glass-epoxy (FR4) laminate with tetrabromobisphenol-A as the flame retardant. Pour plus d'information concernant la modélisation des cartes électroniques, se reporter au paragraphe **Erreur ! Source du renvoi introuvable.**. The surface finish is assumed to be chemically-applied tin under electrolytic gold-on-nickel. The PWB is populated using both reflow and wave soldering to accommodate PWBs with a mixture of through-hole technology (THT) and surface-mount device (SMD) components.

Data sources:

- EuP Preparatory Studies "Televisions" (Lot 5), 2007
- SICAS Glob. Statistics Report 4th Quarter 2008: Integrated Circuit Wafer-Fab Capacity & Utilisation

2.2.4.2. Battery, AA or AAA cell, alkaline

The datasets can be used in any application where a single-use, non-rechargeable AA or AAA cell is required. As AA or AAA cells are a standard size, no scaling is required if the mass varies slightly from that specified:

- Pile AA:23g, 50.5 mm long, 14 mm diameter
- Pile AAA:12g, 44.5 mm long, 10.5 mm diameter

The composition of the cell is an average based on material safety data sheets (MSDSs) from many manufacturers. The composition is: zinc powder anode (19%), manganese dioxide cathode (40%), KOH / NaOH electrolyte (8%), polymer separator/ insulator/ gasket (6%), and nickel-plated steel case (27%).

Manufacturing energy and water are based on a study by Olivetti et al. (2011): 2.18 MJ electricity, 0.75 MJ natural gas, 0.28 MJ heavy fuel oil and 0.97 kg water per kg cell.

The process of producing zinc powder comprises the steps of mining and concentrating, roasting and sintering, leaching, cementation, electrolysis, stripping and drying, melting and powdering.

Data source:

- Life cycle impacts of alkaline batteries with a focus on end-of-life
- Individual industry data

2.3. Background system boundaries

Background system boundaries follow the rules defined by PE International.

C. DATA SOURCES AND QUALITY

1. Data quality requirements

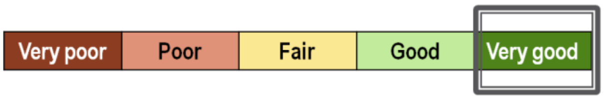
Quality requirements for Base Impacts® datasets are detailed in the general Base Impacts® documentation. No specific quality requirements were set for the electric and electronic component datasets.

2. Types and sources of data

The data sources for the complete product system are sufficiently consistent: primary data from industry was supplemented and validated with different literature data (see technology description for references).

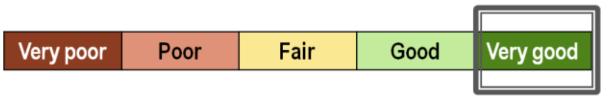
3. Data quality

3.1. Technological representativeness



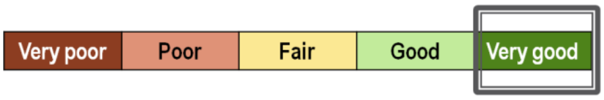
3.2. Time-related coverage

Reference year: 2011 (Data collection period 2010-2012)

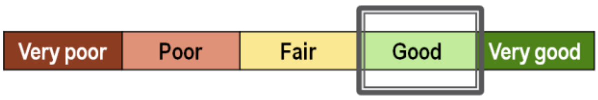


3.3. Geographical coverage

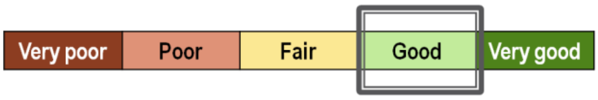
When relevant, datasets are provided for several geographical locations.



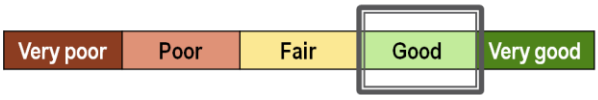
3.4. Precision



3.5. Completeness



3.6. Consistency



4. Multi-functionality and allocation procedure

4.1. Foreground system allocation procedure

These datasets do not require allocation procedures.

4.2. Background system allocation procedure

Background system allocation procedure follows the rules defined by PE International.

D. CRITICAL REVIEW

All Base Impacts® datasets follow the ILCD Entry Level requirements, which require a review either internal with public report or external.

The datasets were reviewed by internal review:

- Raw data: Validation of data sources, Sample tests on calculations, Cross-check with other source, expert judgment
- Unit process(es), single operation, black box: Energy balance, Element balance, Cross-check with other source, Cross-check with other data set, Mass balance, Compliance with ISO 14040 to 14044
- LCI results or Partly aggregated system: Energy balance, Element balance, Cross-check with other source, Cross-check with other data set, Expert judgment, Mass balance, Compliance with ISO 14040 to 14044
- LCIA results: Cross-check with other source, Cross-check with other data set, Expert judgment, Compliance with ISO 14040 to 14044
- Documentation: Compliance with ISO 14040 to 14044, Documentation
- Life cycle inventory methods: Compliance with ISO 14040 to 14044
- LCIA results calculation: Expert judgement, Compliance with ISO 14040 to 14044
- Goal and scope definition: expert judgement, compliance with ISO 14040 to 14044

E. REPORTS FOR MORE INFORMATIONS

The following documents should be used for more information:

- Gabi Modelling Principles 2013 ;
- General Base Impacts® documentation
- Review report, available in the metadata of each dataset.

F. ADMINISTRATIVE INFORMATION

1. Commissioner

PE International.

2. Dataset modeler

PE International.

APPENDIX: DATA NEED AND DATA SELECTION

A Technical Committee was held on 19 April 2012 to identify the datasets of electrical and electronic components required for environmental labeling.

So far, electronic datasets are required for the following Product Category Rules:

- television

The conclusions of this Technical Committee were a synthesis of data need for electrical and electronic components.

The datasets identified by the Technical Committee are provided in Base Impacts®, with the following modifications:

Consultation specification	Implementation in Base Impacts®	Justification
Screen sizes: • 24, 32, 40 inches	• 26, 32, 37, 42, 47 inches + a generic inventory in m²	Data available and relevant
Cables insulation types: • PVC or PE	• For some cables: PVC, PE, or insulation an jacket in modified PPE	Data available and relevant
Types of power supply circuit boards: • 4 layers board's inventory with 2 finishes (HASL & AuNi) • 2 layers board's inventory with 1 finish (HASL)	• 2 layers board's inventory with 2 finishes (HASL & AuNi)	
Types of motherboards: • 6 layers board's inventory	• 4 layers board's inventory (« basic » motherboard) • 8 layers board's inventory (« smart » or «advanced » motherboard)	Distinction available and relevant
Types of circuit boards: • Mainboard • Power supply board	• mainboard • power supply board • circuit board, LCD pixel controller	Data available and relevant