EPD

# Environmental Product Declaration

VD4/SFU 24.06.12 DY501/1
VD4/SFU 24.12.12 DY501/3
VD4/SFU 24.25.12 DY501/4

Production site: Dalmine, Italy


| DOCUMENT KIND | IN COMPLIANCE WITH | | | |
|---|---|---|---|---|
| Environmental Product Declaration | ISO 14025 and EN50693 | | | |
| PROGRAM OPERATOR | PUBLISHER | | | |
| EPDItaly | EPDItaly | | | |
| EPDITALY REGISTRATION NUMBER | ISSUE DATE | | | |
| EPDITALY0326 | 2022-09-24 | | | |
| VALID TO | STATUS | SECURITY LEVEL | | |
| 2027-09-24 | Approved | Public | | |
| OWNING ORGANIZATION | DECLARATION NUMBER | REV. | LANG. | PAGE |
| ABB Switzerland Ltd, Group Technology Management | 2RDA044890 | A | en | 1/20 |

| | |
|---|---|
| **EPD Owner** | ABB Switzerland Ltd, Group Technology Management |
| **Manufacturer name and address** | ABB S.p.A.<br>Via Friuli, 4, 24044 Dalmine, Bergamo (Italy) |
| **Organization no** | CHE-101.538.426 |
| **Company Contact** | Seila Rodriguez Vilches – seila.rodriguez-vilches@ch.abb.com<br>Sustainability Product Manager |
| **Program operator** | EPDItaly – info@epditaly.it<br>Via Gaetano De Castillia n° 10 - 20124 Milano, Italia |
| **Declared product & Functional unit or declared unit** | VD4/SFU 24.06.12 DY501/1<br>VD4/SFU 24.12.12 DY501/3<br>VD4/SFU 24.25.12 DY501/4<br>FU: single circuit breaker, which establishes or interrupts the electrical continuity of the circuit to which it is applied, during a service of 20 years, including related accessories and packaging. |
| **Product Description** | VD4 breakers are used in electrical distribution for control and protection of cables, overhead lines, distribution substations, motors, transformers, generators and capacitor banks. The scope of the medium voltage circuit breakers is to interrupt an electric current with a mechanical actuator. |
| **CPC code** | 46211 - Electrical apparatus for switching or protecting electrical circuits, or for making connections to or in electrical circuits, for a voltage exceeding 1000 V |
| **Independent verification** | This declaration has been developed referring to EPDItaly, following the "Regolamento di EPDItaly"; further information and the document itself are available at: www.epditaly.it. EPD document valid within the following geographical area: Italy and other countries worldwide according to sales market conditions. Independent verification of the declaration and data was carried out according to ISO 14025: 2010.<br><br>☐ INTERNAL ☒ EXTERNAL<br><br>Third-party verification carried out by: ICMQ spa<br>Accredited by: ACCREDIA |
| **Reference PCR and version number** | Core PCR: EPDItaly007 – PCR for Electronic and Electrical Products and Systems, Rev. 2, 2020/10/21.<br>Sub PCR: EPDItaly012 - Electronic and electrical products and systems – Switches, Rev. 0, 2020/03/16. |
| **Other reference documents** | EN 50693:2019 - Product category rules for life cycle assessments of electronic and electrical products and systems<br>Regulations of the EPDItaly Programme rev. 5.2 (16 February 2022) |
| **Product RSL description** | 20 years |
| **Markets of applicability** | World (raw materials),<br>Italy (production, use and end-of-life) |
| **LCA study** | This EPD is based on the LCA study described in the LCA report 2RDA044876. |
| **EPD type** | Product specific |
| **EPD scope** | “Cradle to grave” |
| **Year of reported primary data** | 2021 |
| **LCA software** | SimaPro 9.3.0.3 (2021) |

| | |
|---|---|
| **LCI database** | ecoinvent v3.8 (2021) |
| **LCIA methodology** | EN 50693:2019 |
| **Author of the life cycle assessment** | Luca Marcolongo – luca.marcolongo@it.abb.com<br>Environmental Specialist |
| **Comparability** | EPDs published within the same product category, though originating from different programs, may not be comparable. Full conformance with a PCR allows EPD comparability only when all stages of a life cycle have been considered. However, variations and deviations are possible. |
| **Liability** | EPDItaly declines any responsibility regarding the manufacturer's information, data and results of the life cycle assessment. |

# Contents

# ABB Purpose & Embedding Sustainability

ABB is a leading global technology company that energizes the transformation of society and industry to achieve a more productive, sustainable future. By connecting software to its electrification, robotics, automation and motion portfolio, ABB pushes the boundaries of technology to drive performance to new levels. With a history of excellence stretching back more than 130 years, ABB's success is driven by about 110 thousand talented employees in over 100 countries.

ABB's Electrification business offers a wide-ranging portfolio of products, digital solutions and services, from the substation to the socket, enabling safe, smart and sustainable electrification. Offerings encompass digital and connected innovations for low and medium voltage, including EV infrastructure, solar inverters, modular substations, distribution automation, power protection, wiring accessories, switchgear, enclosures, cabling, sensing and control.

ABB is committed to continually promoting and embedding sustainability across its operations and value chain, aspiring to become a role model for others to follow. With its ABB Purpose, ABB is focusing on reducing harmful emissions, preserving natural resources and championing ethical and humane behavior.


**Figure 1** ABB Dalmine

# General Information

ABB S.p.A Electrification Distribution Solutions facility in Dalmine (ELDS Division) produces medium voltage circuit breakers, disconnectors, and contactors, medium voltage switchboards for primary and secondary distribution, low voltage switchboards, complete packages and services for substations. Smart systems and technologies for electrical distribution are supplied to utilities, industrial, and tertiary sector customers. Dalmine exports 85% of the volumes produced.

ABB ELDS division, Italy adopts and implements for its own activities an integrated Quality/Environmental/Health Management System in compliance with the following standards:

- UNI EN ISO 9001/2015 - Quality Management Systems- Requirements
- UNI EN ISO 14001/2015 – Environmental Management Systems-Requirements
- UNI EN ISO 45001:2018 - Occupational Health and Safety Management System

The manufacturing of circuit breakers is located in ABB facility of Dalmine, Italy.

In the factory, the different components and subassemblies are assembled on the so-called One Primary Line and a final assembly stage within the Speciali area. All components and subassemblies are produced by ABB's suppliers and are only assembled in the factory.

Product DY501 cluster declared in this EPD includes the following device:

Technical specifications are as follows:

| **Circuit breaker** | **VD4/SFU 24.06.12 DY501/1** | **VD4/SFU 24.12.12 DY501/3** | **VD4/SFU 24.25.12 DY501/4** |
|---|---|---|---|
| Rated voltage [kV] | 24 | 24 | 24 |
| Rated current [A] | 630 | 1250 | 2500 |
| Rated short circuit breaking current [kA] | 12 | 12 | 12 |
| Number of poles | 3 | 3 | 3 |

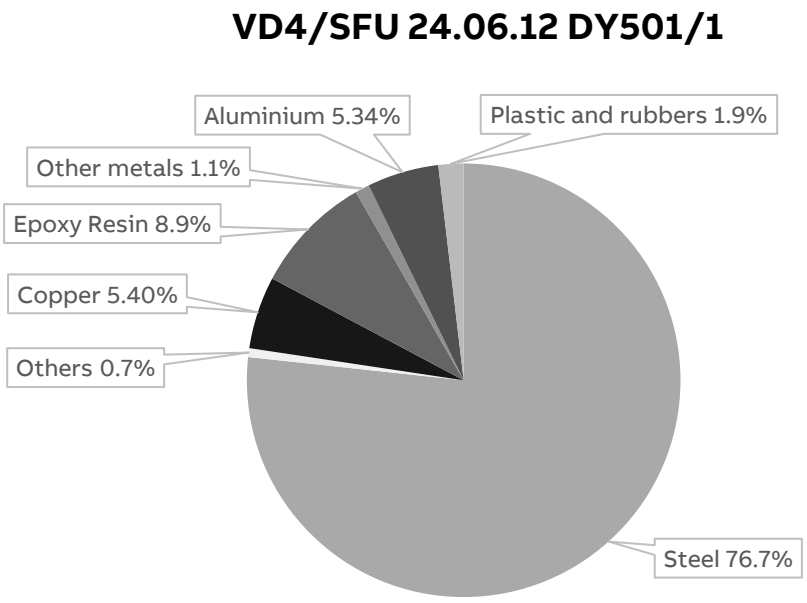
The accessories associated with these products are also included in the study.

VD4 circuit breakers are used in electrical distribution for control and protection of cables, overhead lines, distribution substations, motors, transformers, generators and capacitor banks. The scope of the medium voltage circuit breakers is to interrupt an electric current with a mechanical actuator (spring mechanism).

# Constituent materials

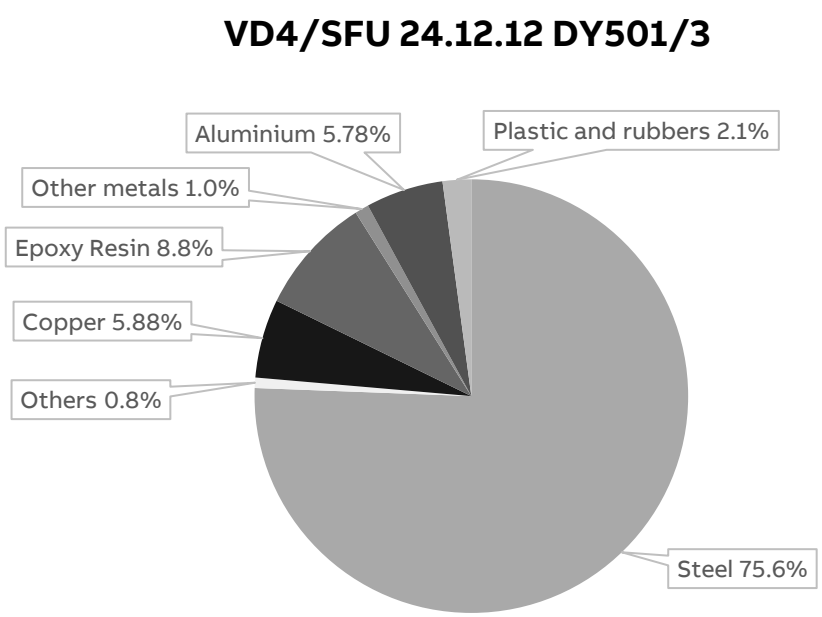
The **VD4/SFU 24.06.12 DY501/1** mass considered in this study is 185.1 kg. Some small parts were excluded because of lack of data, as their mass is estimated to be well below 2% of the total weight, according to the EPDItaly-012 cut-off criteria.

| VD4/SFU 24.06.12 DY501/1 | | | | |
|---|---|---|---|---|
| **Materials** | **Name** | **CAS Number** | **Weight [kg]** | **%** |
| **Plastics** | Plastics and rubber | | 3.46 | 1.9 |
| **Metals** | Steel | 7439-89-6 | 142 | 76.7 |
| | Copper | 7440-50-8 | 10 | 5.4 |
| | Aluminium | 7429-90-5 | 9.88 | 5.3 |
| | Other metals | | 1.97 | 1.1 |
| **Others** | Epoxy Resin | 25085-99-8 | 16.56 | 8.9 |
| | Others | | 1.22 | 0.7 |
| **Total** | | | 185.1 | 100 |



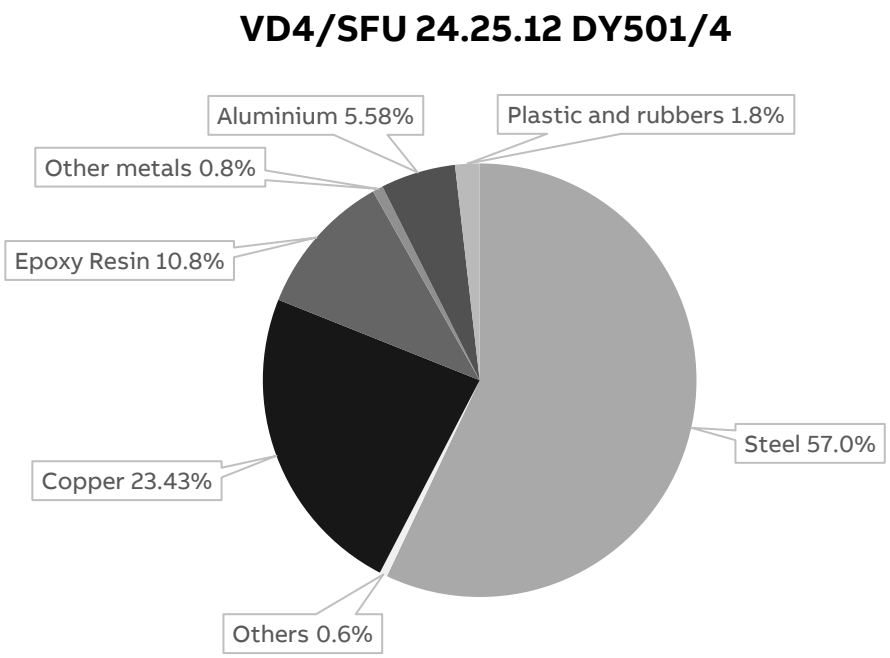
The **VD4/SFU 24.12.12 DY501/3** mass considered in this study is 188.2 kg. Some small parts were excluded because of lack of data, as their mass is estimated to be well below 2% of the total weight, according to the EPDItaly-012 cut-off criteria.

| VD4/SFU 24.12.12 DY501/3 | | | | |
|---|---|---|---|---|
| **Materials** | **Name** | **CAS Number** | **Weight [kg]** | **%** |
| **Plastics** | Plastics and rubber | | 4.01 | 2.1 |
| **Metals** | Steel | 7439-89-6 | 142.25 | 75.6 |
| | Copper | 7440-50-8 | 11.06 | 5.9 |
| | Aluminium | 7429-90-5 | 10.88 | 5.8 |
| | Other metals | | 1.96 | 1 |
| **Others** | Epoxy Resin | 25085-99-8 | 16.56 | 8.8 |
| | Others | | 1.46 | 0.8 |
| **Total** | | | 188.2 | 100 |



The **VD4/SFU 24.25.12 DY501/4** mass considered in this study is 250.8 kg. Some small parts were excluded because of lack of data, as their mass is estimated to be well below 2% of the total weight, according to the EPDItaly-012 cut-off criteria.

| VD4/SFU 24.25.12 DY501/4 | | | | |
|---|---|---|---|---|
| **Materials** | **Name** | **CAS Number** | **Weight [kg]** | **%** |
| **Plastics** | Plastics and rubber | | 4.57 | 1.8 |
| **Metals** | Steel | 7439-89-6 | 143.06 | 57 |
| | Copper | 7440-50-8 | 58.77 | 23.4 |
| | Aluminium | 7429-90-5 | 13.99 | 5.6 |
| | Other metals | | 1.96 | 0.8 |
| **Others** | Epoxy Resin | 25085-99-8 | 27 | 10.8 |
| | Others | | 1.46 | 0.6 |
| **Total** | | | 250.8 | 100 |




The packaging is composed of a wooden cage of 91.58 kg.

# LCA background information

## Functional Unit

The functional unit is a single VD4 circuit breaker, which establishes or interrupts the electrical continuity of the circuit to which it is applied, during a service of 20 years, including related accessories and packaging.

## System Boundaries

The life cycle of the medium voltage circuit breaker, an EEPS (Electronic and Electrical Products and Systems), is a “from cradle to grave” analysis and covers the following main life cycle stages: manufacturing, including the relevant upstream process (e.g. acquisition of raw material, preparation of semi-finished goods, etc.) and the main manufacturing and processing steps; distribution; installation, including the relevant steps for the preparation of the product for use; use including the required maintenance steps within the RSL (reference service life of the product) associated to the reference product; end-of-life stage, including the necessary steps until final disposal or recovery of the product system.

The following table shows the stages of the product life cycle and the information stages according to EN 50693 for the evaluation of electronic and electrical products and systems.

The stages of the product life cycle and the information considered for the evaluation of the cluster VD4 are:

- Manufacturing upstream includes raw materials, and production activities of ABB suppliers, including transport of semi-finished items and subassemblies to ABB Dalmine.
- Manufacturing core includes local consumptions (ABB Dalmine) due to manufacturing of the products (VD4) the relevant assembling and waste due to manufacturing. This includes also packaging production.
- Distribution stage includes the impacts related to the distribution of the product at the installation site.
- Installation stage includes the end of life of the packaging.
- Use and maintenance stages include the impact related to energy consumption during the service life of the product.
- End of life includes the operations for the disposal of the product at the end of its service life.

## Temporal and geographical boundaries

The component suppliers are sourced all over the world: Africa, Asia and Europe. All primary data collected from ABB are from 2021, which is a representative production year. Secondary data are provided by ecoinvent v3.8.

The selected ecoinvent processes in the LCA model have global representativeness, due to the unclear origin of each component. In this way, a conservative approach has been adopted.

The results of this study are only applicable to VD4/SFU circuit breakers produced in Dalmine in 2021.

## Boundaries in the life cycle

Capital goods, such as buildings, machinery, tools and infrastructure, the packaging for internal transport which cannot be allocated directly to the production of the reference product, may be excluded from the system boundary.

Infrastructures, when present, such as processes deriving from the ecoinvent database have not been excluded.

## Data quality

In this EPD, both primary and secondary data are used. Site-specific foreground data have been provided by ABB. The main data sources are the bill of materials available on the enterprise resource planning. For all processes for which primary are not available, generic data originating from the ecoinvent v3.8 database, allocation cut-off by classification, are used. The ecoinvent database is available in the SimaPro 9.3.0.3 software used for the calculations.

## Environmental impact indicators

The information obtained from the inventory analysis is aggregated according to the effects related to the various environmental issues. According to PCR EPDItaly012 and EN 50693 the environmental impact indicators must be determined using the characterization factors and impact assessment methods specified in EN 15804:2012+A2:2019.

PCR EPDItaly012 and the EN 50693 standard establish four indicators for climate impact (GWP-GHG): GWP (total) which includes all greenhouse gases; GWP (fossil fuels); GWP (biogenic carbon) which includes the emissions and absorption of biogenic carbon dioxide and biogenic carbon stored in the product; GWP (land use).

## Allocation rules

An allocation key is used for consumption related to the manufacturing process in the production site, as well as for company waste.

Allocation coefficients are based on the one primary line's and Speciali surface area for methane and water consumption. Allocation coefficient for waste generated is based on the apparatus line surface area. Electricity consumption has direct measurement data for apparatus line and is divided by the total production volume in 2021. Concerning end-of-life allocation, the "cut-off" approach has been applied. As a result, the ecoinvent database "allocation, cut-off by classification" has been applied. With this approach, outputs subject to recycling are considered as inputs to the next life cycle, and neither environmental burdens nor environmental gains deriving from the recycling process are allocated to the waste stream.

## Limitations and simplifications

The raw material life cycle stage includes the extraction of raw materials but neglects the production of various components at ABB's suppliers (e.g., glue, grease, and adhesive), as their mass represent less than 2% of that of the whole medium voltage circuit breaker, as stated in the paragraph of cut-off criteria of EPDItaly-012: "Materials making up the switch itself whose total mass does not exceed 2% of the total weight of the device".

This same applies to packaging, where small parts such as screws and fasteners are even a smaller fraction of the total mass. Also sticking labels and grease have been excluded since they are negligible.

Surface treatments like zinc coating, silver plating and painting have been considered in the LCA model. The silver plating of the bushings was assumed to be one-third of the total surface area of the component, based on the fact that only the ends are involved in the process Burnishing galvanizing surface and phosphated and oiled treatments have been excluded by operational choice.

Scraps for metalworking and plastic processes are included when already defined in ecoinvent.

# Inventory analysis

The ecoinvent v3.8 cut-off by classification system processes are used to model the background system of the processes. In addition, polyoxymethylene was taken from the database Industry Data 2.0, as it is not present in ecoinvent database. Secondary material constitutes are taken from ecoinvent database.

Due to the large amounts of components in the medium voltage circuit breaker, raw material inputs are modeled with data from ecoinvent representing a global market coverage. These datasets are assumed to be representative.

## Manufacturing stage

Steel is the most used material, followed by copper and epoxy resin in different proportions for the various circuit breakers. Stainless steel parts are modelled with *Steel, chromium steel 18/8 {GLO}| market for | Cut-off, S*. All other steel components (hot rolled, cold rolled, galvanized, low-alloyed steel) are modeled with the same kind of steel: *Steel, low-alloyed {GLO}| market for*, as it is representative of the large majority of the steel parts.

The single-use packaging is also included in the analysis in the manufacturing core stage. ABB receives packaging components from outside suppliers and packages circuit breaker before shipping them.

The distance from the subassembly manufacturing factory to ABB facility is calculated.

The manufacturing of the medium voltage circuit breaker is located in ABB facility of Dalmine, Italy. In the factory, the different components and subassemblies are assembled into the circuit breaker.

The energy mix used for the production phase is representative for Dalmine production site and includes green energy only (hydroelectric 62%, wind 16% and photovoltaic 6% and internal production photovoltaic 16%).

The waste generated by the production and assembly processes is included in the calculation.

The negative impact of biogenic climate change in the manufacturing core phase is due to wood packaging, derive from plants that absorb CO2 during growth.

## Distribution

The transport distances from ABB plant to the place of use are assumed to be 300 km.

## Installation

The installation phase only implies manual activities, and no energy is consumed. This phase also includes the disposal of the packaging of the medium voltage circuit breaker.

The end-of-life stage is modeled according to ISPRA. The percentages for end-of-life treatments of circuit breaker are taken from ISPRA.

## Use

Use and maintenance are modelled according to the PCR EPDItaly012 – Switches, for the circuit breaker.

For the use phase, the general Italian medium voltage electricity mix from ecoinvent v3.8 is used.

During the use phase, the VD4 dissipates some electricity due to ohmic losses. They are calculated according to the own internal resistance of the circuit breaker and the following PCR rules:

- nominal current reduced by a factor of 0.5;
- RSL of 20 years;
- functioning time of 30% of the RSL.

The formula for the calculation of the electricity consumed is shown in sub-PCR EPDItaly012 and it is described as follow, where $P_{use}$ is the power consumed by the circuit breaker at a given value of current:

$$E_{use}\ [kWh] = \frac{P_{use} * 8760 * RSL * \alpha}{1000}$$

| | VD4/SFU DY501/1 | VD4/SFU DY501/3 | VD4/SFU DY501/4 |
|---|---|---|---|
| **Nominal current [A]** | 630 | 1250 | 2500 |
| **$P_{use}$ [W]** | 17.25 | 39.48 | 86.31 |
| **$E_{use}$ [kWh]** | 906.58 | 2075.05 | 4536.59 |

Since no maintenance happens during the use phase, the environmental impacts linked to this procedure are omitted from the analysis.

## End of life

The transport distances from the place of use to the place of disposal are assumed to be 100 km.

The end-of-life stage is modeled according to IEC/TR 62635. The percentages for end-of-life treatments of circuit breakers are taken from IEC/TR 62635.

# Environmental indicators

The following tables show the environmental impact indicators of the life cycle of a single circuit breaker, as indicated by PCR EPDItaly012 and EN 50693:2019.

The indicators are divided into the contribution of the processes to the different modules (upstream, core and downstream) and stages (manufacturing, distribution, installation, use and end-of-life).

## VD4/SFU 24.06.12 DY501/1

| Impact category | Unit | Total | UPSTREAM | CORE | DOWNSTREAM | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Manufacturing | | Distribution | Installation | Use | End of life |
| **GWP - total** | kg $CO_2$ eq. | 1.47E+03 | 1.08E+03 | -5.46E+01 | 1.37E+01 | 2.61E+01 | 3.95E+02 | 3.38E+00 |
| **GWP - fossil** | kg $CO_2$ eq. | 1.50E+03 | 1.05E+03 | 7.25E+01 | 1.37E+01 | 1.93E+00 | 3.62E+02 | 3.38E+00 |
| **GWP - biogenic** | kg $CO_2$ eq. | -3.79E+01 | 3.23E+01 | -1.27E+02 | 1.24E-02 | 2.41E+01 | 3.29E+01 | 5.16E-03 |
| **GWP - luluc** | kg $CO_2$ eq. | 1.66E+00 | 1.50E+00 | 1.10E-01 | 5.42E-03 | 8.65E-04 | 4.69E-02 | 1.27E-03 |
| **ODP** | kg CFC-11 eq. | 1.39E-04 | 7.49E-05 | 1.01E-05 | 3.19E-06 | 4.23E-07 | 4.99E-05 | 7.46E-07 |
| **AP** | mol $H^+$ eq. | 1.56E+01 | 1.36E+01 | 1.69E-01 | 6.93E-02 | 1.17E-02 | 1.67E+00 | 1.63E-02 |
| **EP - freshwater** | kg P eq. | 1.18E+00 | 1.08E+00 | 6.62E-03 | 8.89E-04 | 2.42E-04 | 8.36E-02 | 2.07E-04 |
| **POCP** | kg NMVOC eq. | 5.94E+00 | 4.87E+00 | 1.67E-01 | 7.44E-02 | 1.34E-02 | 7.94E-01 | 1.76E-02 |
| **ADP – minerals and metals** | kg Sb eq. | 2.44E-01 | 2.43E-01 | 1.29E-04 | 4.80E-05 | 6.48E-06 | 7.93E-04 | 1.10E-05 |
| **ADP – fossil** | MJ, net calorific value | 2.00E+04 | 1.30E+04 | 1.16E+03 | 2.08E+02 | 2.93E+01 | 5.55E+03 | 4.89E+01 |
| **WDP** | $m^3$ eq. | 6.15E+02 | 3.73E+02 | 5.15E+00 | 6.28E-01 | 8.21E-02 | 2.36E+02 | 2.15E-01 |

GWP-fossil: Global Warming Potential fossil; GWP-biogenic: Global Warming Potential biogenic; GWP-luluc: Global Warming Potential land use and land use change; ODP: Depletion potential of the stratospheric ozone layer; AP: Acidification potential; EP-freshwater: Eutrophication potential-freshwater compartment; POCP: Formation potential of tropospheric ozone; ADP-minerals & metals: Abiotic Depletion for non-fossil resources potential; ADP-fossil: Abiotic Depletion for fossil resources potential, WDP: Water deprivation potential.

| Resource use parameters | Unit | Total | UPSTREAM | CORE | DOWNSTREAM | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Manufacturing | | Distribution | Installation | Use | End of life |
| **PENRE** | MJ, low cal. value | 1.99E+04 | 1.29E+04 | 1.16E+03 | 2.08E+02 | 2.93E+01 | 5.55E+03 | 4.89E+01 |
| **PERE** | MJ, low cal. value | 3.99E+03 | 1.43E+03 | 1.12E+03 | 2.94E+00 | 4.51E-01 | 1.44E+03 | 7.46E-01 |
| **PENRM** | MJ, low cal. value | 1.13E+02 | 1.13E+02 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| **PERM** | MJ, low cal. value | 1.71E+03 | 0.00E+00 | 1.71E+03 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| **PENRT** | MJ, low cal. value | 2.00E+04 | 1.30E+04 | 1.16E+03 | 2.08E+02 | 2.93E+01 | 5.55E+03 | 4.89E+01 |
| **PERT** | MJ, low cal. value | 5.69E+03 | 1.43E+03 | 2.82E+03 | 2.94E+00 | 4.51E-01 | 1.44E+03 | 7.46E-01 |
| **FW** | $m^3$ | 1.82E+01 | 1.15E+01 | 1.60E-01 | 2.32E-02 | 3.86E-03 | 6.52E+00 | 7.88E-03 |
| **MS** | kg | 5.31E+01 | 5.31E+01 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| **RSF** | MJ | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| **NRSF** | MJ | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |

PENRE: Use of non-renewable primary energy excluding non-renewable primary energy resources used as raw material; PERE: Use of renewable primary energy excluding renewable primary energy resources used as raw material; PENRM: Use of non-renewable primary energy resources used as raw material; PERM: Use of renewable primary energy resources used as raw material; PENRT: Total use of non-renewable primary energy resources (primary energy and primary energy resources used as raw materials); PERT: Total use of renewable primary energy resources (primary energy and primary energy resources used as raw materials); FW: Net use of fresh water; MS: Use of secondary materials; RFS: Use of renewable secondary fuels, NRSF: Use of non-renewable secondary fuels.

| Waste production indicators | Unit | Total | UPSTREAM | CORE | DOWNSTREAM | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Manufacturing | | Distribution | Installation | Use | End of life |
| **HWD** | kg | 2.42E-01 | 2.33E-01 | 2.04E-03 | 5.44E-04 | 7.13E-05 | 5.56E-03 | 1.25E-04 |
| **NHWD** | kg | 3.48E+02 | 2.77E+02 | 6.30E+00 | 1.07E+01 | 1.84E+01 | 1.71E+01 | 1.87E+01 |
| **RWD** | kg | 5.47E-02 | 3.53E-02 | 1.56E-03 | 1.41E-03 | 1.85E-04 | 1.60E-02 | 3.30E-04 |
| **MER** | kg | 1.77E+01 | 0.00E+00 | 1.70E-01 | 0.00E+00 | 2.05E+00 | 0.00E+00 | 1.55E+01 |
| **MFR** | kg | 2.51E+02 | 3.67E+01 | 3.49E+00 | 0.00E+00 | 5.72E+01 | 0.00E+00 | 1.53E+02 |
| **CRU** | kg | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| **ETE** | MJ | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| **EEE** | MJ | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |

HWD: hazardous waste disposed; NHWD: non-hazardous waste disposed; RWD: radioactive waste disposed; MER: materials for energy recovery; MFR: material for recycling; CRU: components for reuse; ETE: exported thermal energy; EEE: exported electricity energy.

## VD4/SFU 24.12.12 DY501/3

| Impact category | Unit | Total | UPSTREAM | CORE | DOWNSTREAM | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Manufacturing | | Distribution | Installation | Use | End of life |
| **GWP - total** | kg $CO_2$ eq. | 1.95E+03 | 1.06E+03 | -5.46E+01 | 1.38E+01 | 2.61E+01 | 9.03E+02 | 3.50E+00 |
| **GWP - fossil** | kg $CO_2$ eq. | 1.94E+03 | 1.02E+03 | 7.25E+01 | 1.38E+01 | 1.93E+00 | 8.28E+02 | 3.50E+00 |
| **GWP - biogenic** | kg $CO_2$ eq. | 4.77E+00 | 3.26E+01 | -1.27E+02 | 1.25E-02 | 2.41E+01 | 7.53E+01 | 5.48E-03 |
| **GWP - luluc** | kg $CO_2$ eq. | 1.63E+00 | 1.40E+00 | 1.10E-01 | 5.48E-03 | 8.65E-04 | 1.07E-01 | 1.29E-03 |
| **ODP** | kg CFC-11 eq. | 2.00E-04 | 7.15E-05 | 1.01E-05 | 3.23E-06 | 4.23E-07 | 1.14E-04 | 7.60E-07 |
| **AP** | mol $H^+$ eq. | 1.83E+01 | 1.42E+01 | 1.69E-01 | 7.01E-02 | 1.17E-02 | 3.82E+00 | 1.66E-02 |
| **EP - freshwater** | kg P eq. | 1.33E+00 | 1.13E+00 | 6.62E-03 | 8.98E-04 | 2.42E-04 | 1.91E-01 | 2.10E-04 |
| **POCP** | kg NMVOC eq. | 6.97E+00 | 4.88E+00 | 1.67E-01 | 7.52E-02 | 1.34E-02 | 1.82E+00 | 1.80E-02 |
| **ADP – minerals and metals** | kg Sb eq. | 2.59E-01 | 2.57E-01 | 1.29E-04 | 4.85E-05 | 6.48E-06 | 1.82E-03 | 1.12E-05 |
| **ADP – fossil** | MJ, net calorific value | 2.69E+04 | 1.28E+04 | 1.16E+03 | 2.11E+02 | 2.93E+01 | 1.27E+04 | 4.98E+01 |
| **WDP** | $m^3$ eq. | 9.30E+02 | 3.83E+02 | 5.15E+00 | 6.35E-01 | 8.21E-02 | 5.40E+02 | 2.19E-01 |

GWP-fossil: Global Warming Potential fossil; GWP-biogenic: Global Warming Potential biogenic; GWP-luluc: Global Warming Potential land use and land use change; ODP: Depletion potential of the stratospheric ozone layer; AP: Acidification potential; EP-freshwater: Eutrophication potential-freshwater compartment; POCP: Formation potential of tropospheric ozone; ADP-minerals & metals: Abiotic Depletion for non-fossil resources potential; ADP-fossil: Abiotic Depletion for fossil resources potential, WDP: Water deprivation potential.

| Resource use parameters | Unit | Total | UPSTREAM | CORE | DOWNSTREAM | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Manufacturing | | Distribution | Installation | Use | End of life |
| **PENRE** | MJ, low cal. value | 2.68E+04 | 1.26E+04 | 1.16E+03 | 2.11E+02 | 2.93E+01 | 1.27E+04 | 4.98E+01 |
| **PERE** | MJ, low cal. value | 7.40E+03 | 1.41E+03 | 2.69E+03 | 2.97E+00 | 4.51E-01 | 3.30E+03 | 7.68E-01 |
| **PENRM** | MJ, low cal. value | 1.37E+02 | 1.37E+02 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| **PERM** | MJ, low cal. value | 1.37E+02 | 0.00E+00 | 1.37E+02 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| **PENRT** | MJ, low cal. value | 2.69E+04 | 1.28E+04 | 1.16E+03 | 2.11E+02 | 2.93E+01 | 1.27E+04 | 4.98E+01 |
| **PERT** | MJ, low cal. value | 7.53E+03 | 1.41E+03 | 2.82E+03 | 2.97E+00 | 4.51E-01 | 3.30E+03 | 7.68E-01 |
| **FW** | $m^3$ | 2.67E+01 | 1.16E+01 | 1.60E-01 | 2.35E-02 | 3.86E-03 | 1.49E+01 | 8.18E-03 |
| **MS** | kg | 5.64E+01 | 5.64E+01 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| **RSF** | MJ | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| **NRSF** | MJ | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |

PENRE: Use of non-renewable primary energy excluding non-renewable primary energy resources used as raw material; PERE: Use of renewable primary energy excluding renewable primary energy resources used as raw material; PENRM: Use of non-renewable primary energy resources used as raw material; PERM: Use of renewable primary energy resources used as raw material; PENRT: Total use of non-renewable primary energy resources (primary energy and primary energy resources used as raw materials); PERT: Total use of renewable primary energy resources (primary energy and primary energy resources used as raw materials); FW: Net use of fresh water; MS: Use of secondary materials; RFS: Use of renewable secondary fuels, NRSF: Use of non-renewable secondary fuels.

| Waste production indicators | Unit | Total | UPSTREAM | CORE | DOWNSTREAM | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Manufacturing | | Distribution | Installation | Use | End of life |
| **HWD** | kg | 1.43E-01 | 1.27E-01 | 2.04E-03 | 5.50E-04 | 7.13E-05 | 1.27E-02 | 1.27E-04 |
| **NHWD** | kg | 3.70E+02 | 2.76E+02 | 6.30E+00 | 1.08E+01 | 1.84E+01 | 3.92E+01 | 1.95E+01 |
| **RWD** | kg | 7.45E-02 | 3.45E-02 | 1.56E-03 | 1.43E-03 | 1.85E-04 | 3.65E-02 | 3.37E-04 |
| **MER** | kg | 1.78E+01 | 0.00E+00 | 1.70E-01 | 0.00E+00 | 2.05E+00 | 0.00E+00 | 1.55E+01 |
| **MFR** | kg | 2.53E+02 | 3.72E+01 | 3.49E+00 | 0.00E+00 | 5.72E+01 | 0.00E+00 | 1.56E+02 |
| **CRU** | kg | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| **ETE** | MJ | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| **EEE** | MJ | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |

HWD: hazardous waste disposed; NHWD: non-hazardous waste disposed; RWD: radioactive waste disposed; MER: materials for energy recovery; MFR: material for recycling; CRU: components for reuse; ETE: exported thermal energy; EEE: exported electricity energy.

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| Impact category | Unit | Total | UPSTREAM | CORE | DOWNSTREAM | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Manufacturing | | Distribution | Installation | Use | End of life |
| **GWP - total** | kg $CO_2$ eq. | 3.55E+03 | 1.58E+03 | -5.46E+01 | 1.69E+01 | 2.61E+01 | 1.97E+03 | 4.58E+00 |
| **GWP - fossil** | kg $CO_2$ eq. | 3.44E+03 | 1.54E+03 | 7.25E+01 | 1.69E+01 | 1.93E+00 | 1.81E+03 | 4.57E+00 |
| **GWP - biogenic** | kg $CO_2$ eq. | 1.03E+02 | 4.14E+01 | -1.27E+02 | 1.54E-02 | 2.41E+01 | 1.65E+02 | 7.11E-03 |
| **GWP - luluc** | kg $CO_2$ eq. | 2.71E+00 | 2.36E+00 | 1.10E-01 | 6.70E-03 | 8.65E-04 | 2.35E-01 | 1.74E-03 |
| **ODP** | kg CFC-11 eq. | 3.71E-04 | 1.05E-04 | 1.01E-05 | 3.95E-06 | 4.23E-07 | 2.50E-04 | 1.02E-06 |
| **AP** | mol $H^+$ eq. | 5.48E+01 | 4.61E+01 | 1.69E-01 | 8.57E-02 | 1.17E-02 | 8.35E+00 | 2.23E-02 |
| **EP - freshwater** | kg P eq. | 4.05E+00 | 3.62E+00 | 6.62E-03 | 1.10E-03 | 2.42E-04 | 4.18E-01 | 2.82E-04 |
| **POCP** | kg NMVOC eq. | 1.53E+01 | 1.11E+01 | 1.67E-01 | 9.21E-02 | 1.34E-02 | 3.97E+00 | 2.41E-02 |
| **ADP – minerals and metals** | kg Sb eq. | 1.01E+00 | 1.01E+00 | 1.29E-04 | 5.94E-05 | 6.48E-06 | 3.97E-03 | 1.49E-05 |
| **ADP – fossil** | MJ, net calorific value | 4.87E+04 | 1.94E+04 | 1.16E+03 | 2.58E+02 | 2.93E+01 | 2.78E+04 | 6.68E+01 |
| **WDP** | $m^3$ eq. | 2.11E+03 | 9.21E+02 | 5.15E+00 | 7.77E-01 | 8.21E-02 | 1.18E+03 | 3.15E-01 |

GWP-fossil: Global Warming Potential fossil; GWP-biogenic: Global Warming Potential biogenic; GWP-luluc: Global Warming Potential land use and land use change; ODP: Depletion potential of the stratospheric ozone layer; AP: Acidification potential; EP-freshwater: Eutrophication potential-freshwater compartment; POCP: Formation potential of tropospheric ozone; ADP-minerals & metals: Abiotic Depletion for non-fossil resources potential; ADP-fossil: Abiotic Depletion for fossil resources potential, WDP: Water deprivation potential.

| Resource use parameters | Unit | Total | UPSTREAM | CORE | DOWNSTREAM | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Manufacturing | | Distribution | Installation | Use | End of life |
| **PENRE** | MJ, low cal. value | 4.85E+04 | 1.92E+04 | 1.16E+03 | 2.58E+02 | 2.93E+01 | 2.78E+04 | 6.68E+01 |
| **PERE** | MJ, low cal. value | 1.28E+04 | 2.87E+03 | 2.69E+03 | 3.64E+00 | 4.51E-01 | 7.21E+03 | 1.02E+00 |
| **PENRM** | MJ, low cal. value | 1.60E+02 | 1.60E+02 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| **PERM** | MJ, low cal. value | 1.37E+02 | 0.00E+00 | 1.37E+02 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| **PENRT** | MJ, low cal. value | 4.87E+04 | 1.94E+04 | 1.16E+03 | 2.58E+02 | 2.93E+01 | 2.78E+04 | 6.68E+01 |
| **PERT** | MJ, low cal. value | 1.29E+04 | 2.87E+03 | 2.82E+03 | 3.64E+00 | 4.51E-01 | 7.21E+03 | 1.02E+00 |
| **FW** | $m^3$ | 5.77E+01 | 2.49E+01 | 1.60E-01 | 2.88E-02 | 3.86E-03 | 3.26E+01 | 1.12E-02 |
| **MS** | kg | 6.84E+01 | 6.84E+01 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| **RSF** | MJ | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| **NRSF** | MJ | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |

PENRE: Use of non-renewable primary energy excluding non-renewable primary energy resources used as raw material; PERE: Use of renewable primary energy excluding renewable primary energy resources used as raw material; PENRM: Use of non-renewable primary energy resources used as raw material; PERM: Use of renewable primary energy resources used as raw material; PENRT: Total use of non-renewable primary energy resources (primary energy and primary energy resources used as raw materials); PERT: Total use of renewable primary energy resources (primary energy and primary energy resources used as raw materials); FW: Net use of fresh water; MS: Use of secondary materials; RFS: Use of renewable secondary fuels, NRSF: Use of non-renewable secondary fuels.

| Waste production indicators | Unit | Total | UPSTREAM | CORE | DOWNSTREAM | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Manufacturing | | Distribution | Installation | Use | End of life |
| **HWD** | kg | 2.13E-01 | 1.82E-01 | 2.04E-03 | 6.74E-04 | 7.13E-05 | 2.78E-02 | 1.70E-04 |
| **NHWD** | kg | 6.10E+02 | 4.57E+02 | 6.30E+00 | 1.33E+01 | 1.84E+01 | 8.58E+01 | 2.90E+01 |
| **RWD** | kg | 1.39E-01 | 5.48E-02 | 1.56E-03 | 1.74E-03 | 1.85E-04 | 7.99E-02 | 4.51E-04 |
| **MER** | kg | 2.76E+01 | 0.00E+00 | 1.70E-01 | 0.00E+00 | 2.05E+00 | 0.00E+00 | 2.54E+01 |
| **MFR** | kg | 3.10E+02 | 4.92E+01 | 3.49E+00 | 0.00E+00 | 5.72E+01 | 0.00E+00 | 2.00E+02 |
| **CRU** | kg | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| **ETE** | MJ | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| **EEE** | MJ | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |

HWD: hazardous waste disposed; NHWD: non-hazardous waste disposed; RWD: radioactive waste disposed; MER: materials for energy recovery; MFR: material for recycling; CRU: components for reuse; ETE: exported thermal energy; EEE: exported electricity energy.

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