

GIS Type ELK-14 for 300 kV

Environmental Product Declaration



Organisational Framework

Manufacturer

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Die ABB Switzerland Ltd, High Voltage Products, is part of ABB Division Power Products.

Environmental Management System (EMS)

The EMS of ABB Switzerland Ltd, High Voltage Products, has been implemented and certified since 1998 according to ISO14001.

Product Description

ABB gas-insulated switchgear (GIS) is characterized by optimized space requirement and reliability that enable intelligent and economic solutions for complex switchgear operations, also in highly populated areas. GIS are at favour where increased safety requirements and severe environmental conditions are present and where aesthetic qualities take precedence. Based on worldwide experience and technological leadership ABB GIS substations of type ELK-14 comply with highest demands in different areas of application, with rated voltages up to 300 kV.

Methods

This Environmental Product Declaration is based on the LCA study „Life Cycle Assessment of ELK-14 for 300 kV“. The LCA was carried out using the ABB standard program „ECOLAB (Version 5.3.2a)“ following the product specific requirements (PSR) for high voltage circuit breakers.

The life cycle of the product was divided into three phases: Manufacture, use and disposal/recycling. The manufacture scenario includes transport and SF₆ losses. The use scenario includes transport of products to the client as well as SF₆ and energy losses assuming a 40 years life time. The disposal phase regards SF₆ losses and the energy for making recycled metals reusable.

The result consists in material and energy inventories and environmental impacts in the three life cycle phases.

Inputs of the LCA

Functional Unit

The functional unit is one bay of a 3-pole ELK-14 (300 kV) GIS substation with a total weight of 7'502 kg. A typical ELK-14 GIS substation consists of 5 to 7 functional units.

Manufacture Phase

Following materials were used:

Material	Amount (kg)
Wood	100
Epoxy resin	528
Polyester	50
EPDM (rubber)	25
Copper	888
SF ₆	147
Aluminium	4'058
Steel	1'274
Stainless steel	420
Other	11
Total	7'502

Table 1: Inventory of materials

Average transport of components is 500 km by lorry (Aluminium: 300 km). SF₆ losses during manufacturing are 0.5 % of the total load or 0.7 kg. Energy and heat consumption in the manufacture phase were not included.

Use Phase

Products are transported to clients in different continents using different transport media. Therefore an average transport-mix for one functional unit was chosen. It consists of 10'500 km by ship and 2'350 km by lorry.

For the calculation of the energy losses the average load was estimated at 500 A. This value differs from the PSR (50 % of rated current) due to practical experience.

Energy	Manufacture	Use	Disposal
Power loss	0	34'164	0
Heating	0	84'797	0
SF ₆ -losses	0.7	6.0	1.5

Table 2: Energy consumption (kWh) and SF₆-losses (kg) assuming a 40 years life time

Environmental impacts due to generation of electrical energy to compensate energy losses were calculated regarding the OECD energy mix.

SF₆ emissions during the use phase were supposed to be 0.1 % per year and additional losses due to revisions were taken as 0.05 % in total.

Disposal and Recycling

Basic assumptions for the recycling of materials were: Copper: 95 %, Steel: 80 %, Aluminium: 100 % and SF₆: 99 %. The value of aluminium differs from the PSR due to practical experience. Energy needed for recycling the materials is included. The total amount of landfill waste is 1'424 kg.

Environmental Performance

The use of non renewable resources is based on energy consumption from fossil resources. Energy is used in manufacturing in metal forming processes and in the use phase of the product to compensate energy losses.

Resources	Manufacture	Use	Disposal
Coal	11'846	35'121	405
Oil	6'190	3'211	128
Gas	1'715	3'011	795
Uranium	0.4	0.8	0
Copper	896	0	0
Iron	1'298	0	0
Aluminium	4'140	0	0
Chromium	51	0	0
Manganese	7	0	0
Nickel	25	0	0

Table 3: Consumption of non renewable resources (kg)

Resources	Manufacture	Use	Disposal
Hydro power	33	0	0

Table 4: Consumption of renewable resources (kWh)

Environmental impacts in the life cycle are 24 % - 46 % in manufacture, 50 % to 64 % in use and 2 % to 12 % in disposal of the functional unit (see Table 5).

In manufacture most impacts are related to the production of aluminium. Other metals and SF₆-emissions are of minor importance.

During use the main impacts come from compensation of electrical and SF₆ losses.

In the disposal phase the relevant impacts come from loss of SF₆, but this phase plays only a minor role during life time of the product.

Impact	Manufacture	Use	Disposal
Global warming potential (GWP) in kg CO ₂ equivalents	86'029 (24 %)	223'779 (64 %)	43'097 (12 %)
Acidification potential (AP) in kmol H ⁺ equivalents	12 (45 %)	14 (53 %)	0.5 (2 %)
Ozone depletion potential (ODP) in kg CFC ₁₁ equivalents	0	0	0
Photochemical ozone creation potential (POCP) in kg C ₂ H ₄ equivalents	13 (46 %)	14 (50 %)	1 (4 %)
Nutrition potential in kg O ₂ equivalents	828 (40 %)	1'196 (58 %)	46 (2 %)

Table 5: Environmental impacts

Comments on GWP 100:

In manufacture GWP 100 is related mostly to the production of aluminium. In the use phase SF₆ losses are more important for the GWP than the production of electrical energy. In the disposal phase the GWP is due mostly to the losses of SF₆. The general contribution of SF₆-emissions on the GWP 100 in the life cycle

is about 51 %, in disposal: 76 %, in use: 59 % and in manufacturing: 19 %.

Comments on AP and POCP:

The acidification potential (acid rain) and the photochemical ozone creation potential (summer smog) are related to the consumption of fossil energy resources. About 53 % (50 % resp.) of these emissions are due to the use phase where energy losses are compensated. About 45 % (46 % resp.) of them are due to the manufacturing phase where they are mostly related to aluminium and other metal forming processes.

Comments on ODP:

The ozone depletion potential is negligible.

Comments on NP:

The nutrition potential in manufacture is mainly based on the production of aluminium followed by copper and epoxy resin. In the use phase the energy consumption is more important in regard of these emissions than transportation of products by ship and lorry.

SF₆ Infobox

In electrical equipment SF₆-gas exhibits outstanding insulating and arc-extinguishing properties. It retains these properties up to a moderate degree of decomposition product, air or moisture contamination. Through purification of the gas the contamination fractions can be removed, as a result of which the original quality of the SF₆-gas is restored.

For economic as well as ecological reasons it is therefore worthwhile and advisable to purify and reuse the gas again and again for as long as its quality criteria can be restored. SF₆-gas from installations which are taken out of service can be reused in newly installed equipment.

Prerequisite to the reuse of SF₆ is professional handling during evacuation, filling and recovery.

From a technical, economical and ecological standpoint, equivalent alternatives to SF₆ as an insulating and arc-extinguishing agent are as yet unknown.

Literature

- In-house document: Life Cycle Assessment of ELK-14 for 300 kV, 1HC0030603, Version AB, 2007
- PSR: High Voltage Circuit Breakers, 2002:3
- MSR: Enclosure A, 1999:1
- ABB Stromübertragung & Verteilung SF₆ Recycling Team, A. Lienhard, W. Knoth: SF₆-Handling-Führer, 1998
- ABB Switzerland: Swiss voluntary agreement for the use of SF₆ in electrical switching devices and switchgear, 2005

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