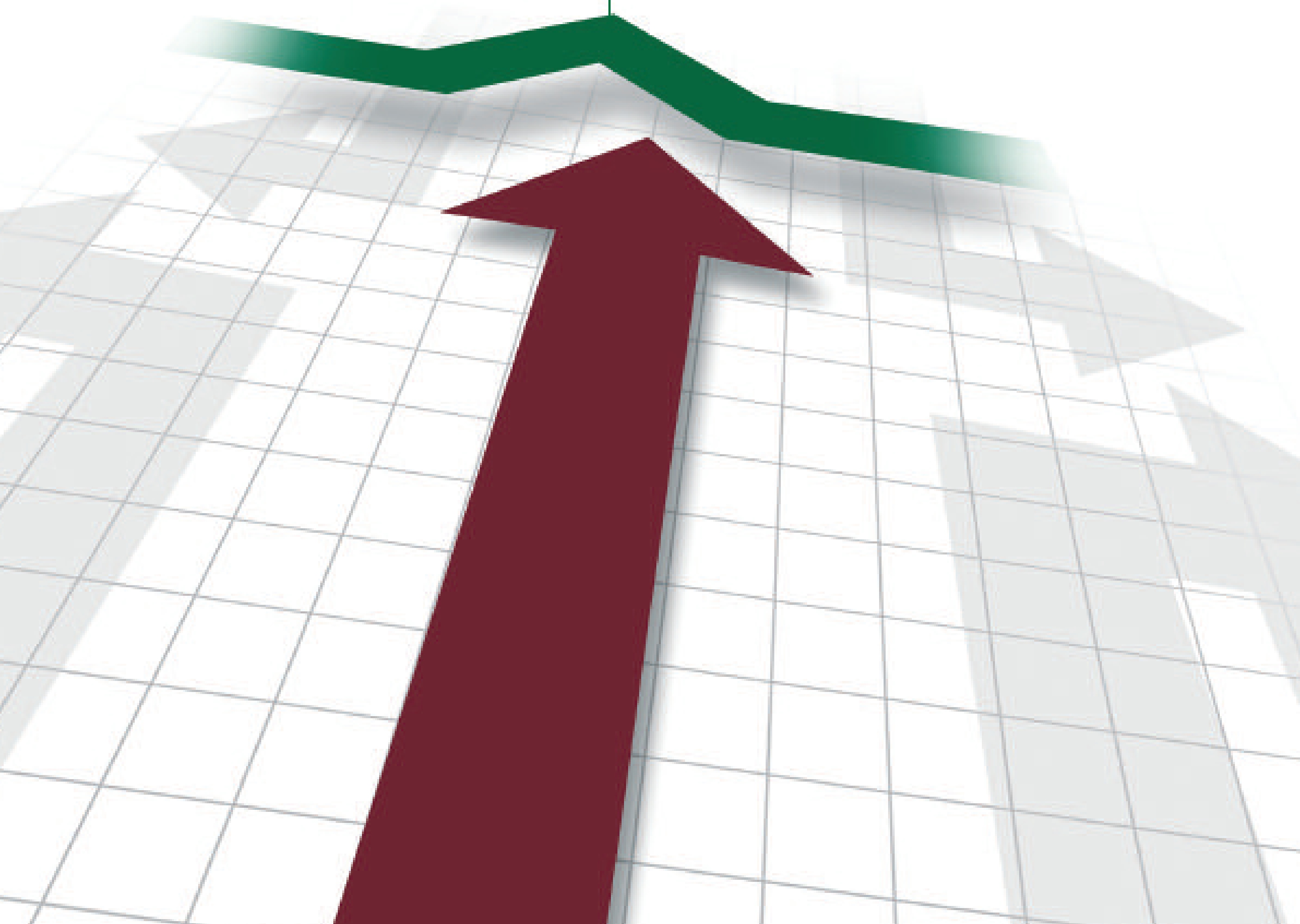
12 chapter
Eco-design

Environment concern shall take into account several requirements as:
selection of raw materiel at the design stage,
energy consumption during operation,
recycling capability at the end of lifetime.



Summary

12.1 Foreword

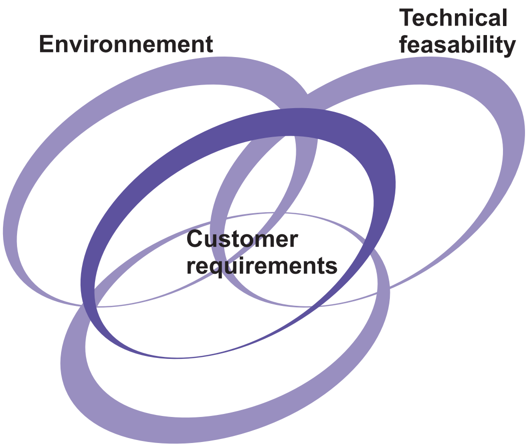


Fig. 1 Environmental parameters

The term “eco-design” means products (goods and services) designed with the environmental factor in mind.

It implies that this factor is included with the rest of the conventional design ones (customer requirements, cost control, technical feasibility, etc.) (⇨ Fig. 1).

This policy involves different players in the economy – suppliers, producers, distributors, consumers, and private buyers – who wish to offer or choose products that offer the same service but are more environment-friendly.

Because is it upstream of the decision-making process, eco-design is a preventive policy. It is based on a global attitude, a multicriteria approach to the environment (water, air, soils, noise, waste, energy, raw materials, etc.) encompassing all the stages in the lifecycle of a product: raw material extraction, production, distribution, use and disposal at the end of the lifetime.

This double nature of eco-design (multicriteria and multiple stages) is what may be called its signature.

Investigation methods can be described as in-depth or simplified depending on the degree to which they keep account of environmental impact throughout the product lifecycle.

Excerpt from the definition of eco-design by Ademe (the French environment and energy agency).

In this guide, we propose a general methodology for eco-design which can be used for any new development of products or services and for new versions of existing ones.

Introduction

It is Schneider Electric’s policy to act as an environmentally responsible company. As regards to products and services, this means that eco-design has to be part of any new development and any new version of existing ones if we want to mitigate the environmental impact of our products throughout their lifetime.

To achieve this goal, this guide must:

- state the environmental policy of Schneider Electric, the main object of which is to promote respect for all natural resources and act positively and constantly for a better environment for all;
- outline the main European regulations that will soon apply to us, in order to plan ahead;
- provide designers with a methodology to help them design eco-friendly products/services;
- describe the EIME software available from Schneider Electric for designers to use in eco-friendly design projects

Schneider Electric’s environmental policy

For Schneider Electric, behaving as an environmentally and, more widely, a socially responsible company contributes to performance by promoting relevance in long-term decision-making and winning the support of all partners in the group: employees, customers, suppliers and shareholders.

Schneider Electric therefore aims to be a “socially responsible company” wherever it is established throughout the world. This includes compliance with a dynamic and ambitious environmental policy based on the following principles:

- **Environmental protection as part of management policy**
  - by taking the requisite steps to make respect for the environment an integral part of Schneider Electric's common culture and a natural approach to all our work and throughout our industry;
  - by promoting environmental protection within Schneider Electric, through awareness raising, training and communication in line with our environmental policy;
  - by providing our customers, suppliers and partners with relevant information.
- **Sustainable environment-friendly industrial development**
  - by adopting an ongoing positive approach to mitigate the environmental impact of our products/services throughout their lifecycle;
  - by developing more environment-friendly new products/services and manufacturing procedures with special attention to forward planning;
  - by using new techniques that help to conserve natural resources and control our products' power consumption;
  - by designing our products with a view to making them recyclable;
  - by complying with current directives and anticipating new ones.
- **ISO 14001 certification for all our sites**
  - by adopting an environmental management system based on the international ISO 14001 standard;
  - by building and running our sites in a way worthy of Schneider Electric's local image, in compliance with rulings in force and going further whenever relevant,
  - By eliminating or reducing waste and improving its recovery;
  - by ongoing improvement of current manufacturing processes to optimise their environmental impact.

12.2 Concepts and main directives

Main concepts

□ Since 1987, **the concept of sustainable development** has been an incontrovertible reference with regard to protection of the environment. It can be resumed as follows:
- development which meets the needs of society today, without preventing future generations from meeting their own needs.

□ **The European Union's 6th Environment Action Programme** (drawn up for the next ten years), designed to implement sustainable development, is based on the precautionary principle, the principle of tackling pollution at the source and priority to preventive measures and the polluter pays principle (Treaty of Amsterdam).

□ The main objective of the **IPP (Integrated Product Policy),** a priority of the Action Programme, is:
- in relation to the concept of sustainable development, to stimulate environment-friendly product and service supply (eco-design, information on lifecycles) and demand (awareness, communication, provision of raw material and services more environmental friendly).

Main directives

The main directives based on these concepts, currently in the European discussion stage, are:

- **EUP (Energy Using Product):** Based on the IPP concept, this aims to standardise the design of electric and electronic equipment to ensure its free circulation and **mitigate its environmental impact throughout its lifecycle,** ensure more efficient use of resources and protect the environment in a way compatible with sustainable development.
- **WEEE (Waste of Electrical and Electronic Equipment)**
  - To reduce waste from electric and electronic equipment and, for this reason, commit the producer to recovering and recycling (70 to 80% in weight) equipment at the end of its lifetime.
- **RoHS (Restriction of Hazardous Substances)**
  - To restrict the use of certain substances considered hazardous for the environment and especially for health. These are heavy metals: lead ***(Pb)***, mercury ***(Hg)***, cadmium ***(Cd)***, hexavalent chromium ***(Cr6)*** and polybrominated biphenyl ***(PBB)*** and polybrominated biphenyl ether ***(PBDE)*** flame retardants.

Use of a number of other substances not covered by this directive should also be avoided. The EC jury is still out on the subject of PVC, the use and recycling of which are controlled by some local regulation.

12.3 Standards

In addition to the European directives, there are a number of other standards to regulate inclusion of environmental aspects in product design. These include:

ISO, NF and EN standards

- ISO 140xx: a set of environmental management standards;
- ISO TC 61: plastics – environmental aspects;
- ISO 64 guide: inclusion of environmental aspects in product standards;
- NF FD X30 310: inclusion of environmental aspects in product design;
- EN 13428 to 13432: packaging – environmental aspects.

This non-exhaustive list gives some idea of the rules on the inclusion of environmental aspects in product design. Designers have to consider them as well as the usual standards and directives such as:

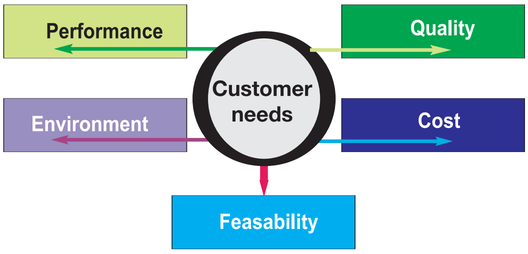
- LVD: Low Voltage Directive;
- IEC 60 947- 2: low voltage device standard – circuit breakers;
- IEC 60 947- 4 - 1: switchgear and control gear standard.

Note: there are also a number of national regulations (batteries, packaging, etc.) in addition to these standards and directives.

As an environmentally responsible company, Schneider Electric develops new, more environment-friendly products/services and manufacturing procedures compliant with the above directives, standards and rules and also plans ahead for them by implementing eco-design.

12. Eco-design

12.4 Eco-design



↑ *Fig. 2* *Balance between design criterias*

Eco-design, an important feature of sustainable development, as we saw in the foreword, is a proactive customer-oriented approach which can be defined as follows:

- products/services designed to best satisfy customer requirements and mitigate their environmental impact throughout their lifecycle.

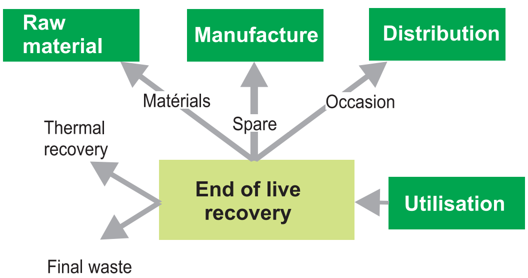
It involves ongoing dynamic progress which can, by common upstream thinking (techniques, marketing, training, etc.) change a restriction into an opportunity. This is clearly the strategy manufacturers should strive to follow.

This strategy, which should apply as much to design of new products as upgrading of existing ones, implies that the designer must include a further criterion when seeking solutions: minimum environmental impact throughout the entire lifecycle *(⇨ Fig. 2)*.

As stipulated in the EUP directive, the choice of an "optimal" solution meeting customer requirements must be consistent with maintaining a reasonable balance between the design criteria:

- performance, cost, quality, environment, industrialisation, etc., as well as complying with safety and health criteria.

12.5 Lifecycle



↑ *Fig. 3* *Product life cycle*

The point of eco-design, as we have seen, is to design products/services with a lesser impact on the environment throughout their entire lifecycle.

How can we define this lifecycle?

The lifecycle of a product goes from the "cradle to the grave", i.e. from the extraction of the raw material to ultimate disposal, via all the stages of manufacture/assembly, distribution, use and recovery at the end of the lifetime.

It is obvious that every stage in a product's lifecycle has an impact on the environment and it is this impact we must strive to mitigate. This is the aim of eco-design, which has to take into account all the stages together in order to prevent any improvement in the ecological behaviour of one stage having a detrimental effect on that of the others.

This requires full detailed analysis of the lifecycle (LCA) so the right choice can be made. This is what EIME software is for.

The end-of-lifetime recovery stage can involve major constraints and so must be considered from the outset of product design.

To comply with regulations, recovery should cover 70% to 80% of the product (in weight) and can be in the form of:

- repair/restoration of the product;
- reuse of parts/sub-units;
- recycling of materials;
- energy recovery.

The lifecycle of a product can be summed up as in the diagram *figure 3*.

12.6 Main rules of eco-design

With regard to compliance with the principal of sustainable development and the rulings on it, we may define a number of general rules to guide designers in all eco-design studies:
- conservation and efficient use of natural resources;
- reduction of emissions (greenhouse effect, noise, etc.);
- reduction of waste (manufacture, end of lifetime);
- prohibition or minimal use of hazardous substances;
- reduction of power consumption.

However, as we already pointed out, these general recommendations for making more environment-friendly products are not intended to replace regular design rules; rather they should be applied in addition to them to optimise the response to customer requirements with the following criteria in mind:
- performance;
- cost;
- quality;
- environment;
- industrialisation, etc.

But prior to any study, it is essential to look into how to optimise the function required. This means asking the following questions:
- What is the best way to respond to the customer's needs: product/service?
- Can the product offer include an environment-friendly service offer?
- Can a product offer lead to a service offer?
- Can new concepts be introduced?
- Can some sub-units be common to several products or product ranges?
- Should new functions be included?
- Can active materials be used?

Once the function optimisation stage is completed, the next step is to look closely at the stages in the product's lifecycle (choice of materials, production, distribution, end of lifetime) to which the basic rules may apply.

■ Choice of materials

The designer can have an effect on a product's environmental impact through the choice of materials. So, in line with the general rules of eco-design described above, this choice should be made using criteria targeting smaller consumption of the raw material and lower environmental impact of the materials used.

• **Reduction of the mass and volume of materials used**
- optimisation of the volume and mass of parts and products,
- reduction in number of parts.

• **Choice of non-toxic or only slightly toxic materials in extraction, production, utilisation and disposal (end of lifetime).**

• **Choice of materials based on renewable resources to save natural non-renewable resources.**

• **Choice of power-saving materials in raw material extraction, material processing and use.**

• **Use of recycled materials, the environmental impact is then due to recycling and not production.**

• **Use of recycled materials with a view to product recovery at the end of its lifetime.**

It goes without saying that compliance with these environmental criteria does not dispense the materials chosen from having to meet the usual requirements for the product with regard to mechanical, electrical, cost and manufacturing (casting, cutting, etc.) factors.

Production

The production stage is an important part of the lifecycle and should never be neglected in eco-design. Design choices can have significant effect on industrial processes and therefore on their environmental impact.

This is why a certain number of optimisation criteria should be considered from the outset.

- **Reduction in environmental discharges (water, soils, air)**
  - choice of production methods that cut down environmental dumps.

Example: wherever possible, avoid surface treatments

- **Reduction in power consumption at all stages of production**
  - choice of power-saving manufacturing, mounting and assembly methods.
- **Reduction in the amount of waste (machining, cutting, casting, etc.)**

Example:
  - parts designed to reduce offcuts;
  - reuse of casting sprues;
  - reduction of scrap.
- **Reduction in the number of production stages**
  - example: fewer different parts.
- **Less transport between stages**
  - less transport from plant to plant (parts, sub-units),
  - less power consumed for transport,
  - use of new production methods,
  - new methods with a lower environmental impact than conventional methods - BAT (Best Available Technique).

Distribution

Product distribution is another stage in the lifecycle which can have a substantial impact on the environment. This is why it is necessary to optimise packaging and the distribution system itself from the outset of product design.

To this end, in compliance with standards (EN 13428 to 13432) and the decree published 25/07/98, the following criteria should apply.

- **Reduction in the mass and volume of packaging**
  - reduction in volume and mass of products;
  - optimisation of the packaging function.
- **Fewer packages: packages common to several products**
- **Choice of greener packaging minimum heavy metal content (lead cadmium, mercury, etc.)**
- **Packages designed to be reused or recovered**
  - recovery of 50 to 65% in weight;
  - avoid use of different materials (cardboard, foam, etc.).
- **Optimisation/reduction in transport: fewer masses and volumes to transport**
- **Choice of means of transport using less fuel**

As always, compliance with these criteria should not be detrimental to the basic functions of packaging such as protection and safety.

12.6 Main rules of eco-design

Utilisation

Product utilisation is a stage in the lifecycle which can have a significant effect on the environment, especially with regard to electricity consumption. Here again, there are a number of criteria which can play a decisive part:

- **Lower power consumption when the product is used**
  - consumption in electrical contacts (contact resistance, welds, etc.) and bimetal strips;
  - consumption by control units (electromagnets, etc.);
  - power dissipated in electronic components, etc.
- **Reduction in leaks and discharges into the environment**
  - noise reduction;
  - less leakage (e.g. SF6).
- **Greater product durability**
- **Easier maintenance and repairs**
  - greater product reliability;
  - customer link (pre-alarm, etc.);
  - modular products.

Another important point in this stage is the use of clean renewable fuels but the designer's impact on this does not seem decisive.

End of lifetime

As we have already said, recovery at the end of a product's lifetime should be an important part of it (70 to 80% in weight) and should be taken in charge by its producer. If this environmental criterion is to be complied with at reasonable cost, the product must be designed so as to facilitate this operation.

This in turn implies a certain number of criteria.

- **Products easy to dismantle**
  - avoid the use of assembly systems that cannot be dismantled;
  - modular products.
- **Reuse of sub-units/components: preference for modular products**
- **Product repair/restoration (2nd hand)**
- **Recycled materials**
  - marked plastic parts (see technical directive FT 20 050);
  - fewer different materials.
- **Choice of non-toxic materials: incineration**
- **Easy dismantling of toxic products and/or products requiring special processing**
- **Easy access to and quick dismantling of batteries, mercury relays, electronic cards, LCD monitors, etc.**
- **Simple product safety devices (tension springs, etc.)**
- **End of lifetime guide enclosed with product**

This short list of design criteria for each stage in a product's lifecycle and the examples to illustrate them do not claim to cover all cases of eco-design. They are principally intended as a guide to help the designer's thought process.

Moreover, dividing the product's lifecycle into major stages (choice of material, production, distribution, utilisation and end of lifetime) should not get in the way of the final object, which is to mitigate the overall impact of the product from beginning to end of its lifecycle. It is therefore crucial, as we have already said, that improvement in the ecological behaviour of one stage should not have a detrimental effect on that of the others.

To achieve this requires full detailed analysis of the lifecycle (LCA) made. This is what EIME software (see further in this document) is used for.

12. Eco-design

12.7 Conclusion

The policy of Schneider Electric includes eco-design to:
- promote respect for all natural resources;
- constantly and positively improve conditions for a clean environment to satisfy its customers and users of its products, its employees and the communities where the company is established.

This constant positive progress policy can enhance the company's performance and should be seen as an opportunity. Therefore, **eco-design**, the purpose of which is to design products/services with a lower impact on the environment throughout their lifetime and which best satisfy customer requirements, **will be our general policy for the development of every new product/service, and for new versions of existing ones**.

12.8 Applications

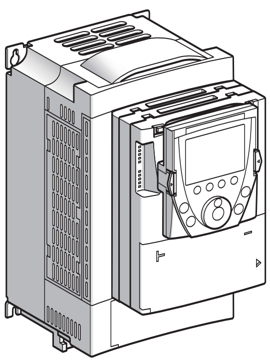
EIME software

EIME (Environmental Information and Management Explorer) is an application to help in the design of environment-friendly products. It is owned and controlled by Alcatel, Alstom, Legrand, Schneider Electric and Thomson Multimedia.

It is used to evaluate the environmental impact of a product from beginning to end of its lifecycle and guides designers in their choice of materials and designs. It can be accessed from anywhere in the world; its database (materials, procedures, etc.) is the same for all Schneider Electric designers all throughout the world.

The main features of this software are:
- help in the choice of materials and procedures;
- information on compliance with regulations;
- evaluation of environmental impact (LCA);
- help in identifying weak points;
- comparison of two design options.

The environmental profile of a product built with EIME is an essential basis for environmental product communication with customers.



↑ *Fig. 4* *This product has won the "Eco-product for sustainable development" prize*

Altivar 71: an example of eco-design Product Environment Profile (PEP)

Altivar 71 *(⇨ Fig. 4)* is a range designed to control and vary the rotation speed of electric asynchronous motors.

It consists of products rated from 0.37 to 18kW with single-phase or 3-phase input voltages of 200 and 500V.

The product used for this study is the complete Altivar 71 rated 0.75kW, 500V (ref. ATV71 H075N4). It is representative of the rest of the range. The other products in the range are built with the same technology and by the same manufacturing process.

The environmental analysis was made in compliance with standard ISO 14040 "Environmental management: lifecycle analysis, principle and framework". It covers all the stages in the product lifecycle.

12.8 Applications

◻ Constituent materials

In mass, the products in the range extend from 2680 g to 9000 g The Altivar 71 – rated 0.75kW, 500V, weighs 2680g without packaging. The constituent materials are made up as *figure 5* :

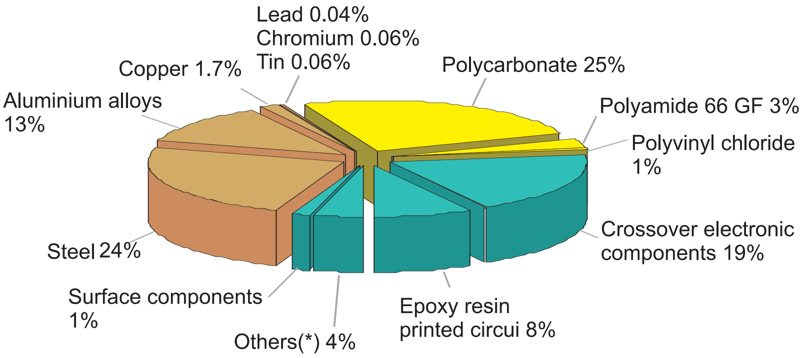


Fig. 5 *AT71 material constituents*
(*) "Others" comprises all elements at less than 1% such as shrinkable tubing, EPDM elastomers, etc.

All our departments, suppliers and subcontractors have been briefed to ensure that materials used in the Altivar 71 – 0.37 to 18kW range contain none of the substances prohibited by current legislation (list available on request) when it goes on the market.

The range is designed to need no batteries or accumulators. The site where this product family was designed is certified ISO 14001 for its eco-design process.

◻ Manufacture

The range is manufactured at a Schneider Electric production site which has set up an environmental management system certified ISO 14001.

Ongoing process enhancement reduces the annual average power consumption on site by 5%.

Waste is thoroughly sorted for a recovery rate of 99%.

◻ Distribution

The packaging is designed to cut down its weight and volume, in compliance with the European packaging directive 94/62/EC. Its overall weight is 1080 g, and it is made mainly of cardboard with a recyclable polyethylene bag. No packing foam or staples are used.

The distribution channels are optimised by local distribution centres in the vicinity of the market areas.

◻ Utilisation

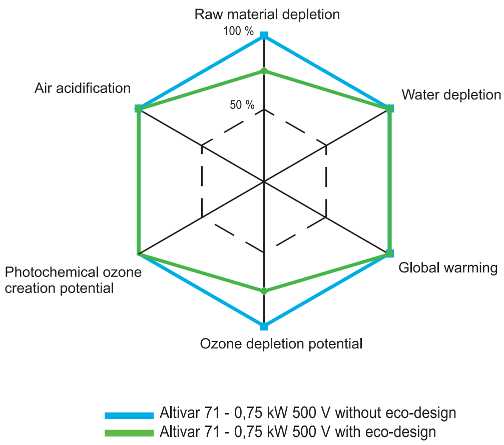
The products in the Altivar 71-0.37 to 18kW range cause no pollution requiring special conditions of use (noise, emissions). Their electricity consumption depends on how they are commissioned and operated.

Their power losses spread from 44 W to 620 W. For example the Altivar 71-0.75kW, 500V losses are 44W, i.e. under 6% of the total power circulating in it.

◻ End of lifetime

At the end of their lifetime, the products in the Altivar 71-0.37 to18 kW range shall be dismantled to recover their constituent materials. Their recycling potential is more than 80%. This includes ferrous metals, copper and aluminium alloys and marked plastics.

The products in the range also contain electronic cards which should be withdrawn and sent through special processing channels. The end-of-lifetime data is detailed in the relevant data sheets.



↑ *Fig. 6* *LCA comparison of impacts of Altivar 71-0.75W, 500V with and without eco-design*

Environmental impacts

The Lifecycle Analysis (LCA) was made with EIME (Environmental Impact and Management Explorer) version 1.6 and its database version 5.4 *(⇨ Fig.6)*.

The product's theoretical duration of use is 10 years and the electrical power model used was the European model.

The device analysed was an Altivar 71-0.75kW, 500V.

Environmental impacts were analysed in the stages of manufacturing (M) including processing of raw materials, distribution (D) and utilisation (U).

The environmental impact analysis was made by comparing the impacts of a non-eco-designed and an eco-designed product. The eco-designed product was 27% less in mass and 19% less in volume than the one from the earlier range.

The plastics used are 100% recoverable owing to the choice of materials and the new product architecture.

These modifications result in an overall reduction in the product's impact on the environment.

Product Environment Profile - PEP

System approach

Speed controllers help to save power by optimising the operating cycles of asynchronous electric motors.

In a transient state, the products in the Altivar 71 - 0.37 to 18kW range can cut more than halve the power consumption of an installation.

The figures cited for environmental impact on the previous page are solely valid for the stated context and cannot be used as is for an environmental assessment of an installation

Glossary

Raw Material Depletion (RMD)

This indicator quantifies raw material consumption during a product's lifetime. It is expressed as a fraction of the raw materials depleted every year in relation to their annual overall reserves.

- **Water Depletion (WD)**

This indicator calculates the amount of drinking water or industrial water consumed. It is expressed in cubicmeters.

- **Global Warming Potential (GWP)**

Global warming is the result of the increase in the greenhouse effect caused by greenhouse gas absorption of solar radiation reflected by the earth's surface. The effect is measured in grams of CO_2.

- **Ozone Depletion (OD)**

This indicator describes the part played by emissions of specifigases in the depletion of the ozone layer.

It is expressed in grams of CFC-11.

- **Photochemical Ozone Creation (POC)**

This indicator quantifies the part played by ozone-producing gases in the creation of smog and is expressed in grams of ethylene (CH_2:CH_2).

- **Air Acidification (AA)**

Acid substances in the atmosphere are carried by rainfall. Highly acid rain can destroy forests.

The degree of acidification is calculated using the acidification potential of the substance and is expressed in moles of H+.