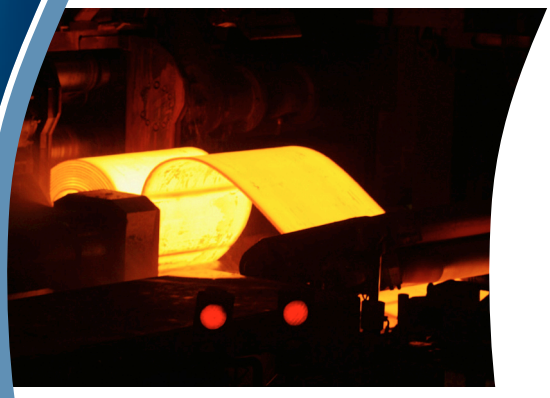
ECO-DESIGN PACKAGE

CONSUMER PRODUCT
DISHWASHER CASING



EUROFER

The European Confederation of Iron and Steel Industries

ABOUT EUROFER AND THE ECO-DESIGN PACKAGE

The European Confederation of Iron and Steel Industries, EUROFER, is committed to advancing sustainable development throughout the European steel industry.

This Eco-Design Package has been developed to promote the environmental credentials of steel and provide downstream users with environmental performance information. It demonstrates:

- the importance of life cycle considerations during product development
- the closed loop, material to material recycling of steel
- the availability of steel life cycle inventory data and information on the steel industry's sustainability development

This document follows the key philosophies of Eco-Design as described in ISO 14062 "Environmental Management - Integrating environmental parameters into product design and development".

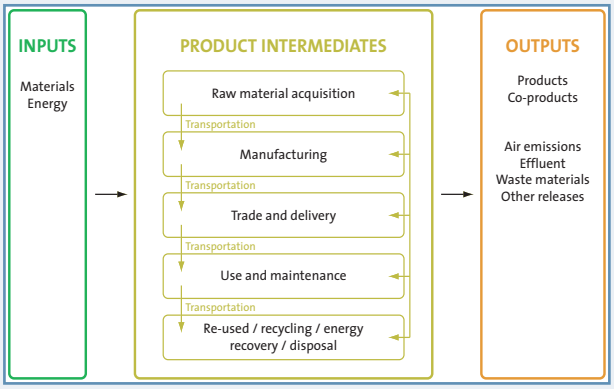


Figure 1: Scope of a life cycle consideration

In this Eco-Design package, life cycle considerations are integrated into the industry's product development and design environment. This provides product-specific environmental decision-making support for new and improved designs in early development phases and thereby assists with compliance of legislative requirements.

Discussions on Eco-design should be incorporated into the very early stages of product design to ensure optimum benefit to environmental, technical and economical performance.

THE CONSUMER PRODUCT DISHWASHER CASING

This Eco-Design package focuses on the application of a consumer product.

As there are many different consumer products made out of steel, the Eco-Design package focuses on the materials used in the casing of a dishwasher, namely 1 m² of organic coated carbon steel and 1 m² of stainless steel type 304 2B. The steel sheets both have a thickness of 0.7 mm.

Figure 2: Dishwasher **/1/**

Dishwasher casing material requirements (weight)

1 m² stainless steel:	5.6 kg
1 m² carbon steel:	5.5 kg

Due to its higher share of alloying elements such as chromium and nickel, the stainless steel has a slightly higher density compared to the carbon steel. Therefore the weight of the same sized steel sheets is higher for the stainless steel sheet.

The size of the steel sheets of 1 m² is an estimation since the dishwasher itself is not the main focus of this package. The dishwasher serves as an example for this Eco-Design package for the wide field of consumer products using different steel types.

The pre-painted carbon steel sheet is stamped and bent and the stainless steel sheet is deep drawn. The carbon steel is used for the external housing for the dishwasher, while the stainless steel is used for the interior.

The requirements for the surface of the dishwasher are high. The pre-painted carbon steel fulfils all requirements concerning the appearance and the durability. The stainless steel is ideal for the interior due to its corrosion resistant properties, its attractive appearance and the fact that this material requires very little maintenance.

ECO-DESIGN OF THE CASING OF A DISHWASHER OVER ITS LIFE CYCLE

Identifying the most environmentally-sound product design alternative requires tracing the ecological effects of each choice.

Life Cycle Thinking / Assessment

According to ISO 14044 'Environmental management – Life cycle assessment – Requirements and guidelines', Life Cycle Assessment (LCA) provides a systematic approach to integrated environmental analysis. Emissions to air, water and soil, as well as resource intensity along a products' life cycle, can be analysed, aggregated and assessed.

The **Life Cycle Inventory (LCI)** phase represents the compilation and quantification of inputs and outputs for a given product system throughout its life cycle. The **Life Cycle Impact Assessment (LCIA)** phase involves interpreting and evaluating the magnitude and significance of potential environmental impacts on the basis of the LCI results.

For the casing of a dishwasher, the impact on the environment is displayed in the table below, characterised by a number of these well-renowned LCI and LCIA categories **/2/**. For a selection of indicators, the impact is shown for each of the life cycle stages, as well as the total life cycle impact for both the carbon steel outer casing and the stainless steel inner liner. Further information can be obtained from EUROFER. LCI data from IISI and ISSF has been utilised for the various steel products, and where necessary, data from the GaBi 4 software and database is incorporated.

End of Life phase

The End of Life phase includes collection, separation and shredding (scrap processing) of the consumer product as well as the recycling of steel scrap at the end of the product's life.

Of high importance for the end of life phase is the effective recyclability of steel without loss of material properties (figure 3). Within the consumer product sector (e.g. white goods) carbon and stainless steel materials are recovered with a recovery rate of 97 % **/3/**.

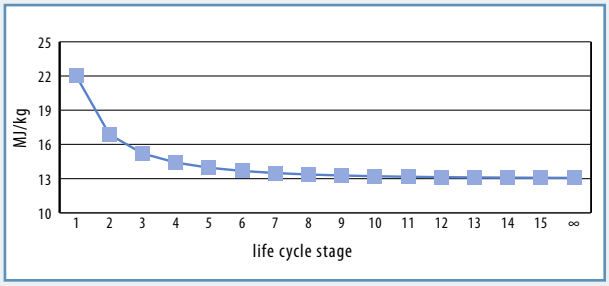


Figure 3: Multiple recycling reduces the average energy requirement per kg of steel **/4/**

As a requirement of the Waste Electrical and Electronic Equipment Directive 2003/108/EC, WEEE, producers of such equipment have the responsibility for treating and recycling household WEEE. Ensuring that design for disassembly is incorporated within the design of the product, this will help achieve the recycling requirements of the directive.

Environmental impacts	Units	Life cycle phases					Total
		Production		Use	End of Life		
		Materials	Processing		Scrap processing	Recycling	
Life Cycle Inventory (LCI)							
Primary energy demand	MJ	514	10		7	-180	351
Carbon dioxide (CO_2)	kg	50.5	0.5		0.3	-14.4	36.9
Life Cycle Impact Assessment (LCIA)							
Global warming potential	kg eq CO_2	51	0.5		0.3	-14.5	37.3
Acidification potential	kg eq SO_2	0.37	0.0046		0.003	-0.08	0.3
Eutrophication potential	kg eq PO_4	0.017	0.0004		0.0001	-0.005	0.01
Photo-chemical oxidant formation potential	kg eq ethylene	0.026	0.0005		0.0002	-0.006	0.02

Production phase

The production phase for the casing of a dishwasher covers steel production (materials), manufacturing and transportation (processing). The LCI result shows that the contribution from transport and product manufacturing is significantly less than that for material production.

The stainless steel sheet contributes approximately 60% to the overall primary energy demand and approximately 70% of the overall CO_2 emissions for material production. Overall, the production of steel is generally characterised by highly resource efficient production stages, with minimal potential for further improvement, and additional benefits of steel further demonstrated in the product's use phase. The use of pre-finished organic coated steel, manufactured by an efficient coil coating process, ensures that paint wastage and VOC emissions are minimised.

Use phase

The use phase impact will be significant and therefore needs to be considered fully to determine the products' overall life cycle impact. However, this package focuses solely on the dishwasher casing and so no maintenance, energy consumption (e.g. electricity) or water consumption is considered – this should be considered separately.

The End of Life is characterised by the additional burdens of preparing the residual material, and by the credit for the recovered material which can be used within a subsequent life cycle to save natural resources. Focusing on primary energy demand, this credit is 180 MJ (equivalent to 4.3 kg of 42.1 MJ/kg crude oil) for the recycled steel scrap. 68 % of the credit is due to the stainless steel scrap.

The recycling of scrap closes the loop of the material (steel) flow in the steel production process. Input of steel scrap to the steel production process can be up to 100 %, depending on the process route for steel production. Europe recycles 101 million tonnes of steel scrap per year, which represents 54 % of total steel production **/5/**. This saves 190 million tonnes of CO_2 emissions which is equivalent to saving CO_2 emissions generated by 34 million households **/6/**.

General information on material flows in steel making

Material flow analyses for steel products demonstrate that material-to-material recycling of post and pre-consumer scrap is already common practice. The fact that steel is 100% recyclable back into new steel products without loss of quality ensures that the material loop is closed.

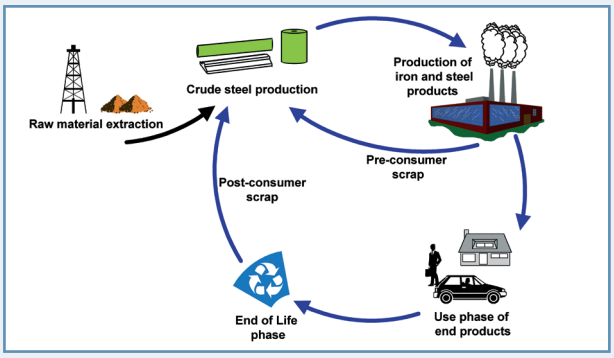


Figure 4: Flow of material through society **/7/**

Modern steel making is dominated by two principle process routes:

- **Iron ore-based production** where hot metal (pig iron) is produced by the reduction of iron oxide in the blast furnace, followed by refining in the basic oxygen furnace to produce steel. In the refining process, excess heat is produced, allowing steel scrap to be added to the melt.
- **Scrap-based production** where steel is produced by melting steel scrap in the electric arc furnace, sometimes followed by refining. Highly alloyed steel grades, like stainless steel and tool steels, are generally made from scrap. Alloying elements utilised, such as chromium and nickel, depend on the type of scrap used as well as from extra additions to the melt.

Energy efficiency has always been a priority within the steel industry and thus both process routes operate in a very energy efficient way. Continuous improvements to further develop this are ongoing **/8/**.

Steel product information

Stainless steel sheets, grade 304 2B, are produced using the electric arc furnace where steel scrap is melted in the process. Alloying elements are added to the melt to reach the required elemental composition of the chosen steel grade. For a dishwasher casing, the austenitic grade 304 2B is the most common grade utilised.

Stainless steel's resistance to corrosion and staining, low maintenance and relatively low cost make it a widely and commonly used material for many commercial applications. Different steel grades are generally processed into sheets, plates, bars, wire, and tubing to be used in major applications such as cookware, cutlery, surgical instruments, industrial equipment, as a structural alloy in automotive and aerospace assembly and as a building material in skyscrapers and other buildings.

Organic coated steel (OCS) is obtained by coating a steel substrate with organic layers such as paint or laminated film. The substrate is mainly hot dip galvanised coil but may also be electro galvanised coil, finished cold rolled coil or tin free steel. It can be found on the market in coil or in sheets and is further processed into finished products by the manufacturer. Organic coated steel is highly durable and comes in a wide variety of colours and finishes to suit the application.

Organic coated steel is used in all sectors such as construction (roofing, wall and ceiling claddings, lighting, radiators etc), general industry (e.g. office furniture, heating, ventilation, air conditioning etc), domestic appliances (refrigerators, washing machines, small kitchen appliances, computer casings, VCR & DVD casings, etc.), packaging etc.

Typical thickness ranges between 0.15 and 1.5 mm
Typical width ranges between 600 mm and 1300 mm

Further information

Steel products used within the consumer goods sector support existing legislation. The use of steel within such products helps to satisfy the recycling requirements of the Waste Electronic and Electronic Equipment Directive, and should be encouraged to be used due to their ability to improve the ease of dismantling and recyclability of the products. The steel materials also satisfy the requirements of the RoHS Directive, i.e. the Restriction on Hazardous Substances used within electrical and electronic equipment.

Eurofer has LCI data available for stainless steel and galvanised carbon steel and organic coated sheets, as well as other steel products, together with the methodology report and advice on use of the data and product applications. Contact lca@eurofer.be or visit www.eurofer.org.

Further information relating to steel in the consumer goods industry can be obtained from the following locations:

- Steel University - www.steeluniversity.org
- International Iron and Steel Institute, IISI - www.worldsteel.org.
- The International Stainless Steel Forum, ISSF – www.worldstainless.org
- EUROFER - www.eurofer.org

References & used data

/1/ Corus Colors
/2/ Impact methodology CML 2001 based on Centre for Environmental Studies (CML), University of Leiden, 2001
/3/ ISSF: www.worldstainless.org/
/4/ Eurofer: Steel Recycling, 2006
/5/ Eurofer: Annual Report, 2005
/6/ Office for National Statistics: The impact of UK households on the environment through direct & indirect generation of greenhouse gases, 2004
/7/ LBP, University of Stuttgart, 2007
/8/ IISI: Energy use in the steel industry, 1998

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