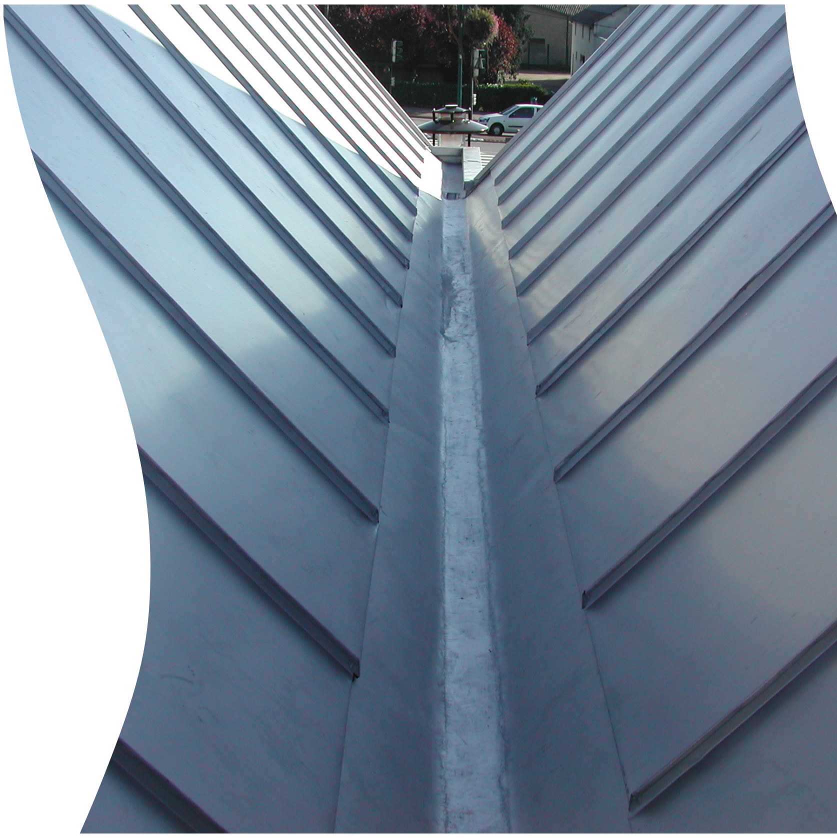
ECO-DESIGN PACKAGE

STAINLESS STEEL ROOFING SYSTEMS



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".

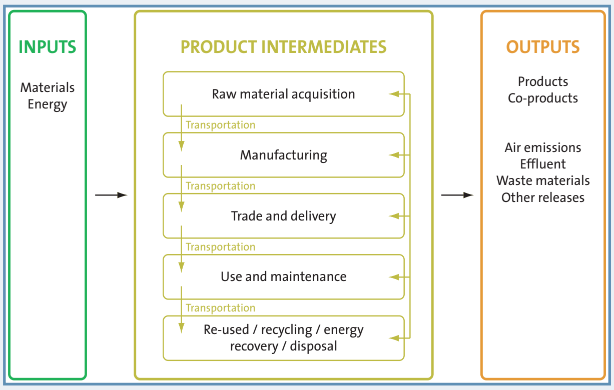


Figure 1: Scope of a life cycle consideration

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.

STAINLESS STEEL ROOFING SYSTEMS

This Eco-Design package focuses on the application of stainless steel roofing systems.

Typical areas of stainless steel in the construction sector are interior claddings, facades, lifts and escalators, parapets and handrails. Architects use stainless steel primarily for its attractive appearance. However, besides the appearance, stainless steel has advantageous technical properties, which makes it ideal as a material for further building applications such as roofing systems. A well-known and exceptional stainless steel roofing system shelters the Chrysler Building in New York.

Stainless steel has a long life expectancy due to its corrosion resistance, requires very little maintenance and owing to its high mechanical performance, relatively thin sections can be used, reducing the structure's overall weight.

The construction of stainless steel roofing systems varies greatly. An example of such a structure is shown in figure 2. As illustrated, the stainless steel roof is normally laid on a supporting structure, which is commonly constructed from wood, concrete or carbon steel. An insulation layer between the support and the stainless roof is also provided, for purposes such as energy preservation or noise insulation. The choice of support will vary depending on the geographical location, the prevalence of the material available, the expected weather conditions, potential snow load, availability and price.

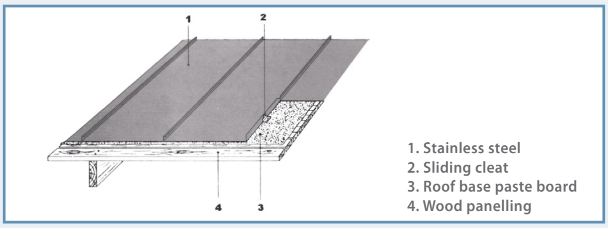


Figure 2: Exemplary structures of a stainless steel roofing system **/1/**

For roofing, grade 304 stainless steel is commonly used where the surrounding environment is not too harsh, from a corrosion point of view. Grade 304 contains chromium and nickel as alloying elements. When enhanced corrosion resistance is needed, for example in marine environments, grade 316 is recommended.

For this Eco-Design package, a 1 m^2 surface area of a stainless steel roof, grade 304 2B, is analysed. Though the supporting structures and insulation are necessary for the system, they have been neglected in these calculations.

Stainless steel roof (weight)

Stainless steel cover (0.4mm thick):	3.5 kg
Fittings (nails and clips):	0.1 kg

The processing of the stainless steel roof involves stamping, bending and folding, which is included in the processing data. The fittings comprise steel nails and stainless steel clips.

During the entire product life, the building material has no adverse effects on the environment. Stainless steel has a special homogenous passive layer which ensures that no leaching of the material occurs that would adversely affect the rainwater that finds its way into the ground water **/2/**.

Regarding reuse, it can be stated that the recovery rate of stainless steel in the construction sector is very high (90%). The material itself is produced from a high amount of recycled material (up to 71 % in Europe **/3/**).

ECO-DESIGN OF A STAINLESS STEEL ROOFING SYSTEM OVER ITS LIFE CYCLE

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

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 roofing system, the impact on the environment is displayed in the table below, characterised by a number of these well-renowned LCI and LCIA categories **/4/**. For a selection of indicators, the impact is shown for each of the life cycle stages, as well as the total life cycle impact. Further information can be obtained from EUROFER. LCI data from 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 demolition, separation and shredding (scrap processing) of the stainless steel roofing as well as the recycling of stainless steel scrap.

Of high importance for the end of life phase is the effective recyclability of stainless steel without loss of material properties (figure 3). Within the construction sector, stainless steel materials are recovered with a recovery rate of 90 %.

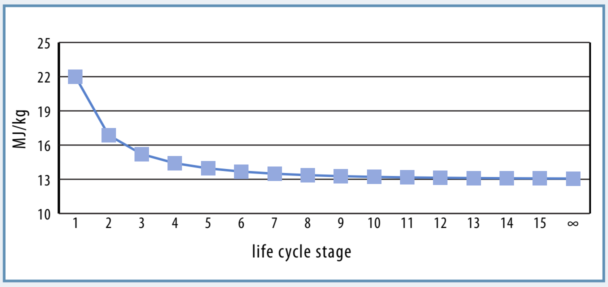


Figure 3: Multiple recycling reduces the average energy requirement per kg of steel **/5/**

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

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	212.9	3.4		2.1	-59.5	158.9
Carbon dioxide (CO_2)	kg	23.79	0.16		0.08	-3.96	20.07
Life Cycle Impact Assessment (LCIA)							
Global warming potential	kg eq CO_2	23.82	0.17		0.09	-3.96	20.12
Acidification potential	kg eq SO_2	0.21	0.0015		0.0008	-0.031	0.18
Eutrophication potential	kg eq PO_4	0.009	0.00013		0.00003	-0.0019	0.007
Photo-chemical oxidant formation potential	kg eq ethylene	0.011	0.00016		0.00005	-0.0017	0.010

Production phase

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

Prior to installation, the stainless steel sheets are protected with an adhesive plastic film – this will help protect against mortar and cement splashes, or iron particles created during construction operations.

Use phase

Stainless steel contains alloying elements such as chromium, which gives the steel an inherent ability to protect itself from corrosion, even when the material is scratched or damaged. No coating or other corrosion protection is therefore required. The advantage of this self-repair capability of stainless steel ensures that the maintenance efforts for stainless steel roofing are negligible and that environmental impacts in the use phase can be neglected. Rainfall will normally wash off accumulations of dirt and other deposits. However, attention should be given to those areas where a build-up of airborne contaminants/chlorides or SOx (e.g. in coastal regions) can result in local corrosion.

life cycle. Focusing on primary energy demand, this credit is 59.5 MJ (equivalent to 1.4 kg of 42.1MJ/kg crude oil).

The recycling of scrap closes the loop of the material (steel) flow in stainless steel production. In Europe, the average scrap input in new stainless steel production is 71% of produced material **/3/**. Europe recycles 101 million tonnes of steel scrap per year, which represents 54% of total steel production **/6/**. This saves 190 million tonnes of CO_2 emissions which is equivalent to saving CO_2 emissions generated by 34 million households **/7/**.

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.

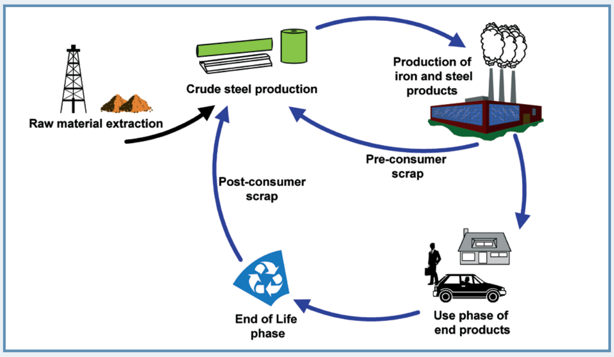


Figure 4: Flow of material through society /8/

Modern stainless steel in Europe is produced by melting steel scrap in the electric arc furnace, followed by refining. 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 the EAF process operates in a very energy efficient way. Continuous improvements to further develop this are ongoing /9/.

Steel product information

Stainless steel sheets are produced from 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.

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

Stainless steel, grade 304 2B, is an austenitic steel that is commonly used for roofing systems, particularly in urban or light industrial areas due to its corrosion resisting properties. It is most commonly available within the following dimensions when used for roofing:

Typical thickness:	0.4 to 0.5 mm
Typical width:	650 mm

Further information

Steel products used within the construction industry support existing legislation or standards. The use of stainless steel for roofing is specified by European standards EN 502 Roofing products from metal sheet – Specification for fully supported roofing products of stainless steel sheet and EN 508-3 Roofing products from metal sheet – Specification for self-supported roofing products of steel, aluminium and stainless steel sheet – Part 3: Stainless steel.

It is also necessary that relevant country-specific guidelines are followed. Further information may be gained from other publications such as Environmental Product Declarations or environmental assessment schemes. The use of steel in such construction products will assist in achieving the requirements specified by these various guidelines.

Eurofer has LCI data available for stainless steel sheets and 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 available relevant information relating to the stainless roofing system:

- Stainless Steel for Roofing (www.euro-inox.org/fla_6_EN.html)
- Technical Guide to Stainless Steel for Roofing (www.euro-inox.org/fla_5_EN.html)
- Stainless Steel for Rainwater Goods and Accessories (www.euro-inox.org/fla_76_EN.html)
- The Recycling of Stainless Steel (www.euro-inox.org/fla_40_EN.html)
- Life Cycle Costing (www.euro-inox.org/fla_73_EN.html)
- The European Convention for Constructional Steelwork - covering a worldwide network of Industrial Companies, Universities and Research Institutes - www.steelconstruct.com
- Living Steel - online resource for information on residential steel matters - www.livingsteel.org
- The International Stainless Steel Forum, ISSF – www.worldstainless.org
- EUROFER – www.eurofer.org

References & used data

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/4/ Impact methodology CML 2001 based on Centre for Environmental Studies (CML), University of Leiden, 2001
/5/ Eurofer: Steel Recycling, 2006
/6/ Eurofer: Annual Report, 2005
/7/ Office for National Statistics: The impact of UK households on the environment through direct & indirect generation of greenhouse gases, 2004
/8/ LBP, University of Stuttgart, 2007
/9/ IISI: Energy use in the steel industry, 1998

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