

ENVIRONMENTAL PRODUCT DECLARATION

as per /ISO 14025/ and /EN 15804/

Owner of the Declaration	Outokumpu Oyj
Programme holder	Institut Bauen und Umwelt e.V. (IBU)
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Valid to	18/09/2024

Stainless Steel Rebar Outokumpu Oyj

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1. General Information

<p>Outokumpu</p> <hr/> <p>Programme holder IBU - Institut Bauen und Umwelt e.V. Panoramastr. 1 10178 Berlin Germany</p> <hr/> <p>Declaration number EPD-OTO-20190108-IBC1-EN</p> <hr/> <p>This declaration is based on the product category rules: Structural steels, 07.2014 (PCR checked and approved by the SVR)</p> <hr/> <p>Issue date 19/09/2019</p> <hr/> <p>Valid to 18/09/2024</p> <hr/> <p></p> <hr/> <p>Dipl. Ing. Hans Peters (President of Institut Bauen und Umwelt e.V.)</p> <hr/> <p></p> <hr/> <p>Dr. Alexander Röder (Managing Director IBU)</p>	<p>Stainless Steel Rebar</p> <hr/> <p>Owner of the declaration Outokumpu Oyj Salmisaarenranta 11 FI-00181 Helsinki Finland</p> <hr/> <p>Declared product / declared unit This EPD applies to 1 ton of stainless steel rebar. It covers steel delivered for building and civil work.</p> <hr/> <p>Scope: The declaration applies to 1 ton of stainless steel rebar produced by Outokumpu. The Life Cycle Assessment is based on data from the following Outokumpu production plants: - Outokumpu Stainless Ltd, Sheffield, UK</p> <p>Production has been modeled using annual production data from 2017. Where required averaging is based on production output from each site.</p> <p>The owner of the declaration shall be liable for the underlying information and evidence; the IBU shall not be liable with respect to manufacturer information, life cycle assessment data and evidences.</p> <hr/> <p>Verification</p> <p>The standard /EN 15804/ serves as the core PCR</p> <p>Independent verification of the declaration and data according to /ISO 14025:2010/</p> <p><input type="checkbox"/> internally <input checked="" type="checkbox"/> externally</p> <hr/> <p></p> <hr/> <p>Angela Schindler (Independent verifier appointed by SVR)</p>
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2. Product

2.1 Product description / Product definition

This EPD describes stainless steel rebar produced by Outokumpu. Stainless steel rebar is supplied as coil, cut lengths, shapes or welded mesh. Stainless steel rebar is available in a wide range of sizes in both standard and special grades. The data have been provided by a representative mix of three manufacturing plants in the UK.

For the use and application of the product the respective national provisions at the place of use apply, in Germany for example the building codes of the countries and the corresponding national specifications.

2.2 Application

Stainless steel rebar is used as reinforcement in concrete. Stainless rebar replaces ordinary carbon steel rebar where non-magnetic reinforcement is required or as a durability solution for long-life design buildings or in aggressive environments (marine or

other construction sites exposed to high chloride concentrations).

2.3 Technical Data

Constructional data

Name	Value	Unit
Density	7900	kg/m ³
Modulus of elasticity	205000	N/mm ²
Coefficient of thermal expansion	14	10 ⁻⁶ K ⁻¹
Thermal conductivity	19	W/(mK)
Melting point	1450	°C

Performance data of the product with respect to its characteristics in accordance with the relevant technical provision (no CE-marking).

2.4 Delivery status

The products are produced in accordance with various national and/or international technical regulations. The

products are certified in accordance with product standards:

**/EN 10088-1/
/BS 6744/
/BS 8666/
/ASTM A955/**

The dimensions of the declared product may vary according to the final use.

2.5 Base materials / Ancillary materials

Stainless steels are iron alloys that contain more than 10.5% chromium and less than 1.2% carbon. Composition below is given in weight percentages:

Chromium: 10.5% to 30%
Nickel: max. 38%
Molybdenum: max. 11%
Carbon: max. 1.2%
Iron: balance (>50%)

Manufacturing is based on recycling and ferrous scrap, (predominantly stainless steel scrap) is used as raw material. Alloying elements are also added as ferroalloys or metals. Other elements such as Manganese (Mn), Nitrogen (N), Niobium (Nb), Titanium (Ti), Copper (Cu) and Silicon (Si) may be present. The presence and rates of these alloying elements depend on the stainless steel designation as set out in /EN 10088-1/.

This product contains substances listed in the candidate list (date: 05.08.2019) exceeding 0.1 percentage by mass: no

This product contains other CMR substances in categories 1A or 1B which are not on the candidate list, exceeding 0.1 percentage by mass: no
Biocide products were added to this construction product or it has been treated with biocide products: no

2.6 Manufacture

The steel scrap is melted in an electric arc furnace to obtain a steel melt. The liquid steel is further refined (adjustment of sulfur, carbon and phosphorous) and alloyed to give the stainless steel the required characteristics. The molten steel is then cast into billets before being sent to the rolling mill where they are rolled to the required dimensions. After hot rolling the steel is pickled and coiled to rod. The stainless steel rebar rod coil can be cut to straightened lengths or bent to shape.

Quality management are in accordance with /ISO 9001/.

2.7 Environment and health during manufacturing

Environmental, occupational health and safety management are in accordance with /ISO 14001/ and /OHSAS 18001/.

2.8 Product processing/Installation

Processing of the coil, lengths or shapes has to be carried out depending on the respective application according to the generally recognised rules of engineering and the manufacturer's recommendation.

Eurocode 2 /EC2/ applies to the design of concrete structures. EC2 includes requirements regarding performance, durability and fire resistance of concrete structures.

During handling and the use of the products, normal occupational safety measures should be applied. Any instructions from the manufacturer concerning welding as well as hot and cold forming are to be followed. Under normal conditions there will be no significant environmental impact on water, air or soil. Residual material, for example steel scrap, should be collected as it is 100% recyclable.

2.9 Packaging

Stainless reinforced bar is supplied in coil form, straight lengths or in shapes using plastic strapping.

2.10 Condition of use

The maintenance requirements depend on the specific design and application, but typically stainless steel only requires minimal or no maintenance.

2.11 Environment and health during use

Under normal conditions of use, stainless steel products do not cause adverse health effects and stainless steel does not release volatile organic compounds (VOC) to indoor air.

Similarly, no significant environmental impact on water, air or soil is expected, due to the extremely low metal release from stainless steel and the low maintenance requirements.

2.12 Reference service life

Stainless rebar is used in concrete to offer corrosion resistance to either carbonation-induced corrosion or chloride-induced corrosion.

In the case of carbonation-induced corrosion, the environment is not aggressive, and the service life of the rebar reinforced structure is up to 1000 years. Buildings do not generally have 1000-year lifetimes, but in these cases, the lifetime is limited by the use of the building or degradation of other structures in the building, not the rebar. Grade selection within standards is not an issue.

In the case of chloride-induced corrosion service life is dependent on grade selection being at least a critical chloride threshold level (CCTL) higher than the predicted chloride concentration at rebar depth for a given design life. There are several service life models commercially available to predict this chloride concentration; Outokumpu will provide test information on the CCTL of our stainless rebar.

2.13 Extraordinary effects

Fire

Structural steel products meet the requirements of building material safety class A1 (i.e. non-flammable according to /EN 13501-1/).

Fire protection

Name	Value
Building material class	A1

Water

In the event of unforeseeable exposure to water caused by sudden flooding, no risks to the environment or human health are expected to occur.

Mechanical destruction

In the event of mechanical destruction, no risks to the environment or human health are expected to occur.

2.14 Re-use phase

Stainless steel structures are not generally reused at end-of-life. Reuse is possible and stainless steel reinforced bar can be re-used after recovery. In order to maximise the potential to re-use or recycle stainless steel the design of the application should facilitate the disassembly at the end of its useful life.

2.15 Disposal

Stainless steel is 100% recyclable and keeps the same high quality when recycled. Recycling routes are well-established, and recycling is therefore the preferred disposal route.

Disposal is not recommended, but no adverse environmental impact is known.

The /European Waste Catalogue/ code for iron and steel products is 17 04 05.

2.16 Further information

For further information on these products please refer to <http://www.outokumpu.com>.

3. LCA: Calculation rules

3.1 Declared Unit

The declaration applies to one ton of stainless steel rebar. The declared unit is the production and recycling of one ton of stainless steel rebar.

Declared unit

Name	Value	Unit
Declared unit	1000	kg

3.2 System boundary

This EPD is cradle-to-gate with options, and includes the following process steps:

- Upstream production of raw materials, fuels and energy and all relevant upstream transport and packaging processes.
- Production/manufacturing of the stainless steel product.
- Waste water and treatment of wastes generated on site including swarf, dusts, scrap, slag, and waste water.
- End-of-life (recycling, remelting or disposal of steel scrap).

3.3 Estimates and assumptions

Primary data was used to model all on-site processes. This data was cross-checked to identify and eliminate data gaps. High quality secondary data from the GaBi database was used to model upstream material and energy flows. Secondary data was as technologically and geographically representative as possible. However, for some of minor auxiliary materials such as limestone, grease, lubricant similar or best estimated datasets are used to make sure that the data was still considered to be technologically representative for European production.

Due to lack of available dataset for some alloying elements e.g. Ferro-Vanadium South-African data sets were used instead of local data. It's considered as conservative choice.

Sorting and Shredding data from Ecoinvent Database is chosen to model the module C3.

At end-of-life, a 95 % recycling rate for the steel product is assumed. The remaining 5 % is assumed to remain uncollected or to go to disposal e.g. landfill.

3.4 Cut-off criteria

All reported data were incorporated and modelled i.e. all raw materials, water, thermal and electrical energy, and production waste.

The principal material transport processes (such as alloys and scrap) are also considered. Thus, even minor material and energy flows of less than 1 % mass are included.

No processes, materials or emissions that are known to make a significant contribution to the environmental impact of the products studied have been omitted.

It can be assumed, that all excluded flows contribute less than 5% to the impact assessment categories. Packaging materials and its transportation were considered in data collection and in LCA model but doesn't have noticeable effects on the results.

Machines, facilities and infrastructure required during manufacture are not taken into account.

3.5 Background data

Background data for upstream materials, fuels and energy production are taken from the /GaBi DatabaseSP36/.

3.6 Data quality

Production has been modeled using 2017 average production data provided by Outokumpu's own sites and has been quality-checked by Outokumpu and thinkstep.

3.7 Period under review

Modelling is based on production data from 2017. Background data used are from the 2018 version of /GaBi Database SP36/. Documentation related to all the processes used in the stainless steel production model can be found in the GaBi documentation /GaBi Documentation/.

3.8 Allocation

Slag generated as a by-product of electric arc furnace (EAF) steelmaking is used as an input to a variety of industries including as a constituent of cement, in road building or as fill material.

This study has adopted a conservative approach and has assumed that all the environmental burdens associated with the production of stainless steel products and EAF slag are allocated to the production of steel, with slag included under the material for recycling (MFR) category.

Production losses of steel during the production process are recycled in a closed loop reducing the requirement for external scrap.

Specific information on allocation within the background data is given in the GaBi datasets documentation (**GaBi Documentation**).

3.9 Comparability

Basically, a comparison or an evaluation of EPD data is only possible if all the data sets to be compared were created according to /EN 15804/ and the building context, respectively the product-specific characteristics of performance, are taken into account.

4. LCA: Scenarios and additional technical information

For this steel product following the average end of life scenarios were considered with the corresponding benefits and burdens:

Landfilling of 5%, a recycling rate of 95%.

The stainless steel scrap input into Modul A is 721,5 kg; this results in a value of scrap benefit of 228,5 kg.

End of life (C3)

Name	Value	Unit
Sorting&Shredding	100	%

Reuse, recovery and/or recycling potentials (D), relevant scenario information

Name	Value	Unit
End-of-life recycling rate	95	%
Stainless steel scrap input (into module A)	72	%
Net stainless steel scrap credit	23	%
Equiv. Mass of stainless steel scrap credited per ton product	228,5	kg

5. LCA: Results

DESCRIPTION OF THE SYSTEM BOUNDARY (X = INCLUDED IN LCA; MND = MODULE NOT DECLARED)

PRODUCT STAGE			CONSTRUCTION PROCESS STAGE		USE STAGE							END OF LIFE STAGE				BENEFITS AND LOADS BEYOND THE SYSTEM BOUNDARIES
Raw material supply	Transport	Manufacturing	Transport from the gate to the site	Assembly	Use	Maintenance	Repair	Replacement	Refurbishment	Operational energy use	Operational water use	De-construction demolition	Transport	Waste processing	Disposal	Reuse-Recovery-Recycling-potential
A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D
X	X	X	MND	MND	MND	MND	MNR	MNR	MNR	MND	MND	MND	MND	X	MND	X

RESULTS OF THE LCA - ENVIRONMENTAL IMPACT: 1 t Stainless Steel Rebar

Parameter	Unit	A1-A3	C3	D
Global warming potential	[kg CO ₂ -Eq.]	3.78E+3	2.48E+0	-1.15E+3
Depletion potential of the stratospheric ozone layer	[kg CFC11-Eq.]	4.42E-9	7.00E-12	-8.86E-13
Acidification potential of land and water	[kg SO ₂ -Eq.]	2.59E+1	9.61E-3	-7.24E+0
Eutrophication potential	[kg (PO ₄) ³ -Eq.]	1.29E+0	1.19E-3	-4.00E-1
Formation potential of tropospheric ozone photochemical oxidants	[kg ethene-Eq.]	1.16E+0	6.99E-4	-4.33E-1
Abiotic depletion potential for non-fossil resources	[kg Sb-Eq.]	2.39E-1	1.14E-6	-6.32E-2
Abiotic depletion potential for fossil resources	[MJ]	3.86E+4	2.87E+1	-1.38E+4

RESULTS OF THE LCA - RESOURCE USE: 1 t Stainless Steel Rebar

Parameter	Unit	A1-A3	C3	D
Renewable primary energy as energy carrier	[MJ]	8.23E+3	1.20E+1	-2.20E+3
Renewable primary energy resources as material utilization	[MJ]	0.00E+0	0.00E+0	0.00E+0
Total use of renewable primary energy resources	[MJ]	8.23E+3	1.20E+1	-2.20E+3
Non-renewable primary energy as energy carrier	[MJ]	4.45E+4	4.07E+1	-1.40E+4
Non-renewable primary energy as material utilization	[MJ]	0.00E+0	0.00E+0	0.00E+0
Total use of non-renewable primary energy resources	[MJ]	4.45E+4	4.07E+1	-1.40E+4
Use of secondary material	[kg]	7.22E+2	0.00E+0	0.00E+0
Use of renewable secondary fuels	[MJ]	0.00E+0	0.00E+0	0.00E+0
Use of non-renewable secondary fuels	[MJ]	0.00E+0	0.00E+0	0.00E+0
Use of net fresh water	[m ³]	3.90E+1	1.65E-2	-1.61E+1

RESULTS OF THE LCA – OUTPUT FLOWS AND WASTE CATEGORIES:

1 t Stainless Steel Rebar

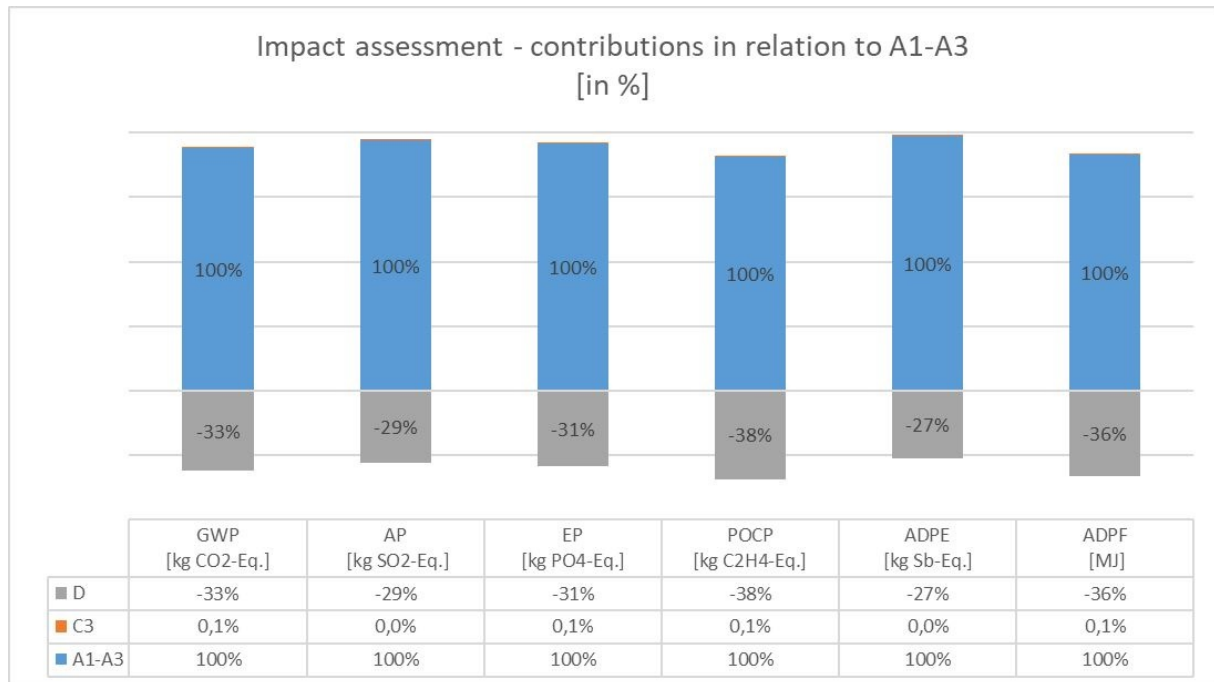
Parameter	Unit	A1-A3	C3	D
Hazardous waste disposed	[kg]	4.01E-2	3.28E-7	-1.45E-1
Non-hazardous waste disposed	[kg]	2.66E+2	5.01E+1	1.53E+1
Radioactive waste disposed	[kg]	2.44E+0	4.80E-3	-1.18E-1
Components for re-use	[kg]	0.00E+0	0.00E+0	0.00E+0
Materials for recycling	[kg]	0.00E+0	9.50E+2	0.00E+0
Materials for energy recovery	[kg]	0.00E+0	0.00E+0	0.00E+0
Exported electrical energy	[MJ]	0.00E+0	0.00E+0	0.00E+0
Exported thermal energy	[MJ]	0.00E+0	0.00E+0	0.00E+0

*NOTE: The results above represent an average of multiple stainless steel grades for Rebar – produced at Outokumpu. In case of specific product with precise information on manufacturing site and/or grade of steel, an individual request to Outokumpu is required.

6. LCA: Interpretation

This chapter contains an interpretation of the Life Cycle Impact Assessment categories with regards to the functional unit – 1 ton of stainless steel rebar. It

focuses on the dominant contributions during the production process and recycling steel at its end of life.



The figure above shows the relative contribution of the production stages (Module A1-A3), waste treatment (Module C3) and the benefits and loads beyond the product system boundary (Module D).

For all categories, the results for the product stage (A1-3) contributes with the highest shares. Overall, C3 has a minimized contribution. The credits in Module D have a considerable share, thanks to the recycling.

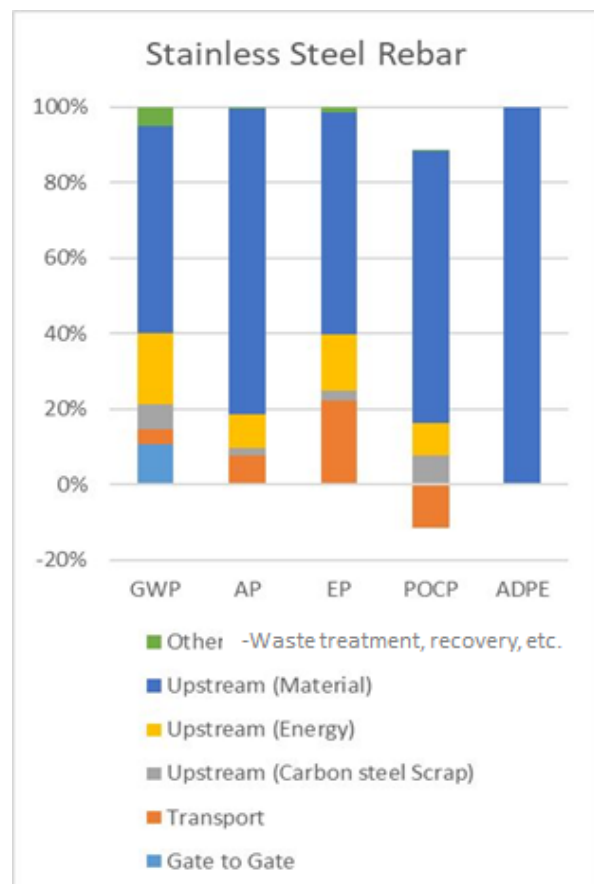
The most relevant emissions on stainless steel production:

for **Global Warming Potential (GWP)** are CO₂, CH₄
for **Acidification Potential (AP)** are SO₂ and NO_x;
for **Eutrophication Potential (EP)** are NO_x
for **Photochemical Ozone Creation Potential (POCP)** are CO, SO₂, NO_x, and NMVOC.

The main contribution to A1-A3 is the production of upstream materials, which is dominated by the production of the Fe-alloys Fe-Cr, Fe-Ni, Fe-Si, and Fe-Mo. The production of the listed Fe-alloys is high in energy consumption on Primary Energy Demand and registers high emissions of carbon dioxide, nitrogen oxides, and sulfur dioxide with the resulting effect on Global Warming Potential, Acidification Potential, Eutrophication Potential and Photochemical Ozone Creation Potential.

In addition to the upstream material production, a certain influence on the overall results is given by the upstream energy production related to the electricity and fuel consumption on-site. Depending on the location of the site this influence might vary related to the country specific energy supply.

The following figure summarises percentage contributions to selected impact category for each of the products (cradle-to-gate), showing the large contribution from upstream materials.



7. Requisite evidence

7.1 Weathering performance

Stainless rebar is used in concrete to offer corrosion

resistance to either carbonation-induced corrosion or chloride-induced corrosion.

8. References

/IBU 2016/

IBU (2016): General Programme Instructions for the Preparation of EPDs at the Institut Bauen und Umwelt e.V., Version 1.1 Institut Bauen und Umwelt e.V., Berlin.
www.ibu-epd.de

/ISO 14025/

DIN EN /ISO 14025:2011-10/, Environmental labels and declarations — Type III environmental declarations — Principles and procedures

/EN 15804/

/EN 15804:2012-04+A1 2013/, Sustainability of construction works — Environmental Product Declarations — Core rules for the product category of construction products

/PCR Part A/

Institut Bauen und Umwelt e.V., Berlin (pub.) Product Category Rules for Building-Related Products and Services, Calculation Rules for the Life Cycle Assessment and Requirements on the Project Report. Version 1.8 July 2019. www.bau-umwelt.de

/PCR Part B/

Institut Bauen und Umwelt e.V., Berlin (pub.): PCR Guidance Texts for Building Related Products and Services, Part B: Requirements on the EPD for Structural Steels. 2017

/EN 10088-1/

EN 10088-1:2014: Stainless Steels. List of stainless steels

/BS 6744:2016/

Stainless steel bars. Reinforcement of concrete. Requirements and test methods.

/ASTM A955/A955M -16/

Standard specification for deformed and plain stainless-steel bars for concrete reinforcement.

/BS 8666:2005/

Scheduling, dimensioning, bending and cutting of steel reinforcement for concrete.

/SVHC/

Candidate List of substances of very high concern for Authorisation in accordance with Article 59(10) of the REACH Regulation (EC) No 1907/2006 as of 30 June 2019

/ISO 9001/

ISO 9001:2015: Quality management systems - Requirements

/ISO 14001/

ISO 14001:2015: Environmental management

/OHSAS 18001/

BS OHSAS 18001:2007: Occupational health and safety management systems – Requirements

/EC2/

EN1992-1-1:2004 Eurocode 2: Design of concrete structures, Part 1-1 General rules and rules for buildings

EN1992-1-2:2004 Eurocode 2: Design of concrete structures, Part 1-2 General rules – structural fire design

/EN 13501-1/

EN 13501-1: 2007: Fire classification of construction products and building elements-Part1

/European Waste Catalogue/

2000/532/EC - European Waste Catalogue. Commission Decision of 3 May 2000.

/GaBi Database SP36/

GaBi Software and Databasis for Life Cycle Engineering. IABP, University of Stuttgart und thinkstep AG, 2018.

/GaBi Documentation/

GaBi ts Documentation GaBi ts: Documentation of the GaBi datasets for Life Cycle Engineering. IABP, University of Stuttgart und thinkstep AG, 2018.
<http://www.gabi-software.com/international/support/gabi/>



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