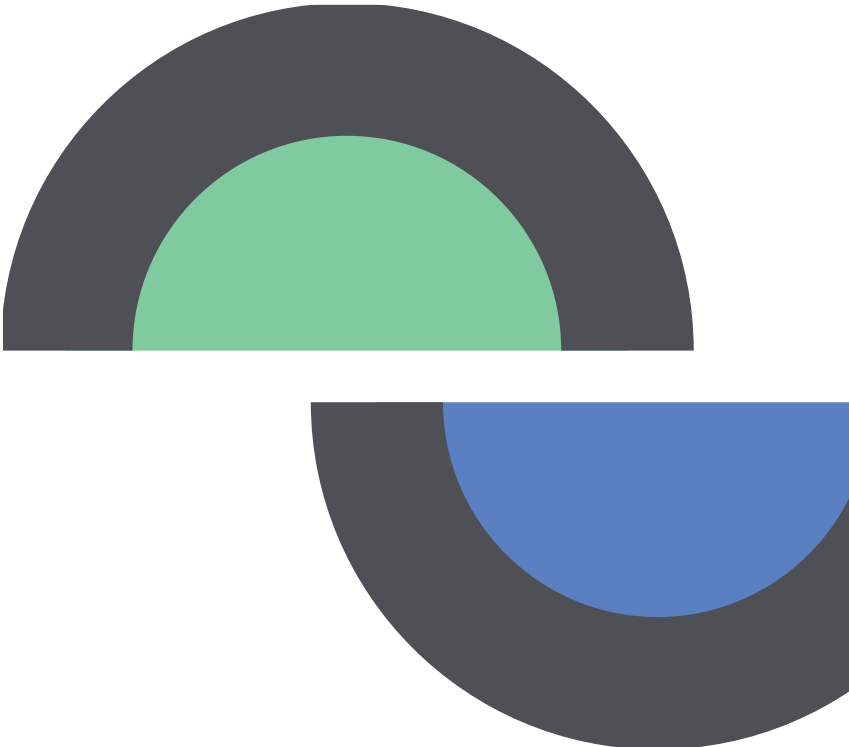


Annex to the LESS-Rulebook



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Annex II-a Emission Factors

	Unit	Scope 1 emissions factor	Scope 2 emissions factor	Scope 3 emissions factor	50 % reduced Scope 3 emissions factor	Source Scope 1 emissions factor	Source Scope 2 emissions factor	Source Scope 3 emissions factor	Additional information for Scope 3 emission factor
		kg CO ₂ per Unit	kg CO ₂ per Unit	kg CO ₂ per Unit	kg CO ₂ per Unit				
Scrap	kg	not publicly available		not publicly available	not publicly available	ISO 19694-2		Ecoinvent 3.9.1: market for scrap steel, Europe without Switzerland & transportation over 150km with 70% truck (market for transport, freight, lorry, unspecified RER), 30 % train (market for transport, freight train, Europe without Switzerland)	3.9.1 Allocation at the point of substitution IPCC 2021 (GWP100)
Scrap (BST)	kg	not publicly available		not publicly available	not publicly available	ISO 19694-2		Ecoinvent 3.9.1: market for scrap steel, Europe without Switzerland & transportation over 150km with 70% truck (market for transport, freight, lorry, unspecified RER), 30 % train (market for transport, freight train, Europe without Switzerland)	3.9.1 Allocation at the point of substitution IPCC 2021 (GWP100)
Coking coal	kg	not publicly available		not publicly available	not publicly available	ISO 19694-2		Ecoinvent 3.9.1: market for hard coal, Europe, without Russia and Turkey	3.9.1 Allocation at the point of substitution IPCC 2021 (GWP100)
Injection coal	kg	not publicly available		not publicly available	not publicly available	ISO 19694-2		Ecoinvent 3.9.1: market for hard coal, Europe, without Russia and Turkey	3.9.1 Allocation at the point of substitution IPCC 2021 (GWP100)
EA coal	kg	not publicly available		not publicly available	not publicly available	ISO 19694-2		Ecoinvent 3.9.1: market for hard coal, Europe, without Russia and Turkey	3.9.1 Allocation at the point of substitution IPCC 2021 (GWP100)
Biochar	kg	not publicly available		not publicly available	not publicly available	Biogen		Ecoinvent 3.9.1: market for transport, freight train, Europe without Switzerland, market for transport, freight, sea, bulk carrier for dry goods, GLO, market for transport, freight, lorry, unspecified, RER	3.9.1 Allocation at the point of substitution IPCC 2021 (GWP100), Assumption 800 km train, 10150 km ship, 100 km truck
Coke	kg	not publicly available		not publicly available	not publicly available	ISO 19694-2		Ecoinvent 3.9.1: market for hard coal, Europe, without Russia and Turkey	3.9.1 Allocation at the point of substitution IPCC 2021 (GWP100)
Lump ore BF	kg	not publicly available		not publicly available	not publicly available	ISO 19694-2		Ecoinvent 3.9.1: market for iron ore, crude ore, 63% Fe, GLO	3.9.1 Allocation at the point of substitution IPCC 2021 (GWP100)
Sinter	kg	not publicly available		not publicly available	not publicly available	ISO 19694-2			
Sinter fines	kg	0,0055		not publicly available	not publicly available	German Federal Environment Agency (LBA)- Report "Abwärmutzungspotenziale in Anlagen integrierter Hüttenwerke der Stahlindustrie", ISSN 1862-4804 (without recovered material)		Ecoinvent 3.9.1: market for iron ore, crude ore, 63% Fe, GLO	3.9.1 Allocation at the point of substitution IPCC 2021 (GWP100)
Pellets	kg	not publicly available		not publicly available	not publicly available	ISO 19694-2		Ecoinvent 3.9.1: market for iron pellet, GLO & transportation emissions from market for iron ore, crude ore, 63% Fe, GLO, as no transportation is included for pellets	3.9.1 Allocation at the point of substitution IPCC 2021 (GWP100)
Oil	kg	not publicly available				ISO 19694-2			
Benzol / Benzen	kg	not publicly available				ISO 19694-2			
Lime	kg	not publicly available		not publicly available	not publicly available	ISO 19694-2		Ecoinvent 3.9.1: market for quicklime, milled, packed, RER	3.9.1 Allocation at the point of substitution IPCC 2021 (GWP100)
Limestone	kg	not publicly available		not publicly available	not publicly available	ISO 19694-2		Ecoinvent 3.9.1: market for limestone, crushed, washed, ROW	3.9.1 Allocation at the point of substitution IPCC 2021 (GWP100)
Dolomite	kg	not publicly available		not publicly available	not publicly available	ISO 19694-2		Ecoinvent 3.9.1: market for dolomite, RER	3.9.1 Allocation at the point of substitution IPCC 2021 (GWP100)
Dolomitic lime	kg	not publicly available		not publicly available	not publicly available	ISO 19694-2		Ecoinvent 3.9.1: market for quicklime, milled, packed, RER	3.9.1 Allocation at the point of substitution IPCC 2021 (GWP100)
Anthraxite	kg	not publicly available		not publicly available	not publicly available	ISO 19694-2		Ecoinvent 3.9.1: market for hard coal, Europe, without Russia and Turkey	3.9.1 Allocation at the point of substitution IPCC 2021 (GWP100)
Graphite electrodes	kg	3,6337		not publicly available	not publicly available	German Emissions Trading Authority (DEHS) electrode burrap		Ecoinvent 3.9.1: market for graphite, battery grade, GLO	3.9.1 Allocation at the point of substitution IPCC 2021 (GWP100)
Aluminium	kg	not publicly available		not publicly available	not publicly available	Cut Off		Ecoinvent 3.9.1: market for aluminium, cast alloy, GLO	3.9.1 Allocation at the point of substitution IPCC 2021 (GWP100)
Ferrosilicone	kg	not publicly available		not publicly available	not publicly available	Cut Off		Ecoinvent 3.9.1: market for ferrosilicon, GLO	3.9.1 Allocation at the point of substitution IPCC 2021 (GWP100)
Ferrocromium	kg	not publicly available		not publicly available	not publicly available	ISO 19694-2		Ecoinvent 3.9.1: market for ferrocromium, high-carbon, 68% Cr, GLO	3.9.1 Allocation at the point of substitution IPCC 2021 (GWP100)
Ferromanganese/ Silicomanganese	kg	not publicly available		not publicly available	not publicly available	ISO 19694-2		Ecoinvent 3.9.1: market for ferromanganese, high-carbon, 74.5% Mn, GLO & transportation emissions from market for ferrocromium, high-carbon, 68% Cr, GLO, as no transportation is included for ferromanganese	3.9.1 Allocation at the point of substitution IPCC 2021 (GWP100)
Tar	kg	not publicly available		not publicly available	not publicly available	ISO 19694-2			
Olivine	kg	not publicly available		not publicly available	not publicly available	CUT OFF		Ecoinvent 3.9.1: market for silica sand, GLO	3.9.1 Allocation at the point of substitution IPCC 2021 (GWP100)
Electricity	kWh		0,4280	0,0570	0,0285		German Federal Environmental Agency (LBA)	German Federal Environmental Agency (LBA) Report "Emissionsfaktoren der Stromerzeugung - Betrachtung der Vorkettenemissionen von Erdgas und Steinkohle", ISSN 1862-4359	
Electricity (renewable)	kWh		0,0000	0,0262	0,0131		German Federal Environmental Agency (LBA)	German Federal Environmental Agency LBA (assuming current distribution of wind and PV)	
Natural-Gas	GJ	56,0000		11,3000	5,6500	German Emissions Trading Authority (DEHS) Commission Regulation (EU) No601/2012		German Federal Environmental Agency (LBA)	
COG-Gas	GJ	44,4000				Commission Regulation (EU) No601/2012			
BF-Gas	GJ	260,0000				Commission Regulation (EU) No601/2012			
OSBF Offgas	GJ	165,0000				Estimation based on the expected gas composition/amortized by use in the DRI			
BOF Gas	GJ	182,0000				Commission Regulation (EU) No601/2012			
Hydrogen	GJ			not publicly available	not publicly available			Calculation based on ecoinvent transport data and estimate from "Hydrogen in climate protection"	3.9.1 Allocation at the point of substitution IPCC 2021 (GWP100), Assumption 11790 km ship
Oxygen	m ³	not publicly available		not publicly available	not publicly available	ISO 19694-2		Ecoinvent 3.9.1: market for oxygen, liquid, RER, Conversion with density of 1.429 kg/m ³	3.9.1 Allocation at the point of substitution IPCC 2021 (GWP100)
Oxygen (renewable)	m ³			0,0002	0,0001			Assumption regeneratively produced	
Hot metal	kg	not publicly available				ISO 19694-2			
DRI	kg	not publicly available				Duarte et al.: Decarbonising the steelmaking industry, Steel Times International, 2021			
Steelmaking Slag	kg dry	0,0060				Estimation based on analysis values of the slag			
Granulated BF slag	kg dry	0,0010		0,1000		Estimation based on assumed process parameters		German Federal Ministry for Economic Affairs and Climate Action	
Granulated OSBF slag	kg	not publicly available		0,1000	0,0500			German Federal Ministry for Economic Affairs and Climate Action	
Liquid to cast/ Liquid steel	kg	0,0038				Estimate for C22 based on empirical values for carbon content in tapping and lack of need for further reduction as up to 0.24 % C in C22 is permitted.			

Annex II-b Reference Plant Integrated Steelworks, Part 1

Process step	Unit	Quantity	Scope 1 emissions factor kg CO2 per Unit	Scope 3 emissions factor kg CO2 per Unit	Scope 1 emissions kg CO2 per t product	Scope 3 emissions kg CO2 per t product	Total kg CO2 per t product	Comment		
								Quantity	Scope 1 emissions factor	Scope 3 emissions factor
Coke plant	Coking coal	kg						Ironmaking Textbook IEHK of RWTH Aachen University	ISO 19694-2	Ecoinvent 3.9.1: market for hard coal, Europe, without Russia and Turkey
	Oil	kg						German National Inventory Report 2006	ISO 19694-2	
	Electricity	kWh						German National Inventory Report 2007	German Emissions Trading Authority (DEHS)	German Federal Environment Agency (UBA)
	NG-Gas	GJ						German National Inventory Report 2008	Commission Regulation (EU) N601/2012	
	COG-Gas	GJ						German National Inventory Report 2009	Commission Regulation (EU) N601/2012	
	BF-Gas	GJ						Ironmaking Textbook IEHK of RWTH Aachen University	ISO 19694-2	
	Coke	kg						Estimation based on: Generated on the white side of the coking plant and washed out of the coke ovens gas. Tar, benzene and sulphur contain approx. 0.5 GJ per ton of crude steel solid, see Stahl und Eisen 2014 Reichel et al. The proportion of benzene/benzene is approx. 8 kg / t coke. See also 1953 Hoffmann: Die chemische Veredelung der Stenichte	ISO 19694-2	
	Benzol / Benzen	kg						Sustainable carbon sources	ISO 19694-2	Commission Regulation (EU) N601/2012
Net (input - Output)					794	451	1246			
Sinter plant	Limestone	kg						German Federal Environment Agency (UBA)-Report "Abwärmungspotenziale in Anlagen integrierter Hüttenwerke der Stahlindustrie", ISSN 1862-4804	ISO 19694-2	Ecoinvent 3.9.1: market for dolomite, RER
	Dolomite	kg						German Federal Environment Agency (UBA)-Report "Abwärmungspotenziale in Anlagen integrierter Hüttenwerke der Stahlindustrie", ISSN 1862-4804	ISO 19694-2	Ecoinvent 3.9.1: market for quicklime, milled, packed, RER
	Lime	kg						German Federal Environment Agency (UBA)-Report "Abwärmungspotenziale in Anlagen integrierter Hüttenwerke der Stahlindustrie", ISSN 1862-4804	ISO 19694-2	Ecoinvent 3.9.1: market for quicklime, milled, packed, RER
	Olivine	kg						German Federal Environment Agency (UBA)-Report "Abwärmungspotenziale in Anlagen integrierter Hüttenwerke der Stahlindustrie", ISSN 1862-4804	CUT OFF	Ecoinvent 3.9.1: market for silica sand, GLO
	Coke breeze	kg						German Federal Environment Agency (UBA)-Report "Abwärmungspotenziale in Anlagen integrierter Hüttenwerke der Stahlindustrie", ISSN 1862-4804	ISO 19694-2	Own model
	Anthracite	kg						German Federal Environment Agency (UBA)-Report "Abwärmungspotenziale in Anlagen integrierter Hüttenwerke der Stahlindustrie", ISSN 1862-4804	ISO 19694-2	Ecoinvent 3.9.1: market for hard coal, Europe, without Russia and Turkey
	Electricity	kWh						Statistical Annual report VV Stahl		
	BF-Gas	GJ						German Federal Environment Agency (UBA)-Report "Abwärmungspotenziale in Anlagen integrierter Hüttenwerke der Stahlindustrie", ISSN 1862-4804	Commission Regulation (EU) N601/2012	
	COG-Gas	GJ						German Federal Environment Agency (UBA)-Report "Abwärmungspotenziale in Anlagen integrierter Hüttenwerke der Stahlindustrie", ISSN 1862-4804	Commission Regulation (EU) N601/2012	
	Natural gas	GJ						German Federal Environment Agency (UBA)-Report "Abwärmungspotenziale in Anlagen integrierter Hüttenwerke der Stahlindustrie", ISSN 1862-4804	German Emissions Trading Authority (DEHS)	German Federal Environment Agency (UBA)
	Sinter fines	kg						German Federal Environment Agency (UBA)-Report "Abwärmungspotenziale in Anlagen integrierter Hüttenwerke der Stahlindustrie", ISSN 1862-4804 (without returned goods)		Ecoinvent 3.9.1: market for iron ore, crude ore, 63% Fe, GLO
	Sinter	kg						Ironmaking Textbook IEHK of RWTH Aachen University	ISO 19694-2	
	Net (input - Output)					495	145	640		
Blast furnace	Lump ore BF	kg						German Federal Environment Agency (UBA)-Report "Abwärmungspotenziale in Anlagen integrierter Hüttenwerke der Stahlindustrie", ISSN 1862-4804	ISO 19694-2	Ecoinvent 3.9.1: market for iron ore, crude ore, 63% Fe, GLO
	Sinter	kg						German Federal Environment Agency (UBA)-Report "Abwärmungspotenziale in Anlagen integrierter Hüttenwerke der Stahlindustrie", ISSN 1862-4804	ISO 19694-2	Own model
	Pellets BF	kg						German Federal Environment Agency (UBA)-Report "Abwärmungspotenziale in Anlagen integrierter Hüttenwerke der Stahlindustrie", ISSN 1862-4804	ISO 19694-2	Ecoinvent 3.9.1: market for iron pellet, GLO & Transportemissionen von market for iron ore, crude ore, 63% Fe, GLO, as transportation is not included in pellets
	Scrap	kg						German Federal Environment Agency (UBA)-Report "Abwärmungspotenziale in Anlagen integrierter Hüttenwerke der Stahlindustrie", ISSN 1862-4804	ISO 19694-2	
	Coke	kg dry						German Federal Environment Agency (UBA)-Report "Abwärmungspotenziale in Anlagen integrierter Hüttenwerke der Stahlindustrie", ISSN 1862-4804	ISO 19694-2	
	Natural Gas (heating)	GJ						German Federal Environment Agency (UBA)-Report "Abwärmungspotenziale in Anlagen integrierter Hüttenwerke der Stahlindustrie", ISSN 1862-4804	German Emissions Trading Authority (DEHS)	German Federal Environment Agency (UBA)
	Natural Gas (injection)	kg						German Federal Environment Agency (UBA)-Report "Abwärmungspotenziale in Anlagen integrierter Hüttenwerke der Stahlindustrie", ISSN 1862-4804		German Federal Environment Agency (UBA)
	BF-Gas	GJ						German Federal Environment Agency (UBA)-Report "Abwärmungspotenziale in Anlagen integrierter Hüttenwerke der Stahlindustrie", ISSN 1862-4804	Commission Regulation (EU) N601/2012	
	COG-Gas	GJ						German Federal Environment Agency (UBA)-Report "Abwärmungspotenziale in Anlagen integrierter Hüttenwerke der Stahlindustrie", ISSN 1862-4804	Commission Regulation (EU) N601/2012	
	Coal	kg						German Federal Environment Agency (UBA)-Report "Abwärmungspotenziale in Anlagen integrierter Hüttenwerke der Stahlindustrie", ISSN 1862-4804	ISO 19694-2	Ecoinvent 3.9.1: market for hard coal, Europe, without Russia and Turkey
	Electricity	kWh						Statistical Annual report VV Stahl		
	Oxygen	m ³						German Federal Environment Agency (UBA)-Report "Abwärmungspotenziale in Anlagen integrierter Hüttenwerke der Stahlindustrie", ISSN 1862-4804	ISO 19694-2	Ecoinvent 3.9.1: market for oxygen, liquid, RER. Calculation with density of 1,429 kg/m ³
	Hot metal	kg						German Federal Environment Agency (UBA)-Report "Abwärmungspotenziale in Anlagen integrierter Hüttenwerke der Stahlindustrie", ISSN 1862-4804	ISO 19694-2	
	Blast Furnace Gas	GJ						German Federal Environment Agency (UBA)-Report "Abwärmungspotenziale in Anlagen integrierter Hüttenwerke der Stahlindustrie", ISSN 1862-4804	Commission Regulation (EU) N601/2012	
PI Slag	kg dry						German Federal Environment Agency (UBA)-Report "Abwärmungspotenziale in Anlagen integrierter Hüttenwerke der Stahlindustrie", ISSN 1862-4804	CUT OFF		
Granulated BF slag	kg dry						German Federal Environment Agency (UBA)-Report "Abwärmungspotenziale in Anlagen integrierter Hüttenwerke der Stahlindustrie", ISSN 1862-4804	CUT OFF		
Net (input - Output)					407	1171	1608			
BOF	Hot metal	kg						German Federal Environment Agency (UBA)-Report "Abwärmungspotenziale in Anlagen integrierter Hüttenwerke der Stahlindustrie", ISSN 1862-4804	ISO 19694-2	
	Scrap	kg						German Federal Environment Agency (UBA)-Report "Abwärmungspotenziale in Anlagen integrierter Hüttenwerke der Stahlindustrie", ISSN 1862-4804	ISO 19694-2	Ecoinvent 3.9.1: market for scrap steel, Europe without Switzerland & transportation 150km with 70% truck (market for transport, freight, lorry, unspecified), RER, 30 % train (market for transport, freight train, Europe without Switzerland)
	Gas	GJ						CUT-OFF		
	Lime	kg						German Federal Environment Agency (UBA)-Report "Abwärmungspotenziale in Anlagen integrierter Hüttenwerke der Stahlindustrie", ISSN 1862-4804	ISO 19694-2	Ecoinvent 3.9.1: market for quicklime, milled, packed, RER
	Oxygen	m ³						German Federal Environment Agency (UBA)-Report "Abwärmungspotenziale in Anlagen integrierter Hüttenwerke der Stahlindustrie", ISSN 1862-4804	ISO 19694-2	Ecoinvent 3.9.1: market for oxygen, liquid, RER. Calculation with density of 1,429 kg/m ³
	Limestone	kg						German Federal Environment Agency (UBA)-Report "Abwärmungspotenziale in Anlagen integrierter Hüttenwerke der Stahlindustrie", ISSN 1862-4804	ISO 19694-2	Ecoinvent 3.9.1: market for limestone, crushed, washed, RoW
	Dolomitic lime	kg						German Federal Environment Agency (UBA)-Report "Abwärmungspotenziale in Anlagen integrierter Hüttenwerke der Stahlindustrie", ISSN 1862-4804	ISO 19694-2	Ecoinvent 3.9.1: market for quicklime, milled, packed, RER
	Electricity	kWh						CUT-OFF		
	Liquid steel	kg						Assumption based on production data		Estimate for C22 based on empirical values for C content in lagging, lack of need for further reduction up to 0.24% C in C22 is permitted.
	BOF Gas	GJ						German Federal Environment Agency (UBA)-Report "Abwärmungspotenziale in Anlagen integrierter Hüttenwerke der Stahlindustrie", ISSN 1862-4804	Commission Regulation (EU) N601/2012	
Steelmaking Slag	kg dry						German Federal Environment Agency (UBA)-Report "Abwärmungspotenziale in Anlagen integrierter Hüttenwerke der Stahlindustrie", ISSN 1862-4804		Estimation based on analysis values of the slag	
Net (input - Output)					12	1573	1585			

Annex II-b Reference Plant Integrated Steelworks, Part 2

Process step	Unit	Quantity	Scope 1 emissions factor kg CO2 per Unit	Scope 3 emissions factor kg CO2 per Unit	Scope 1 emissions kg CO2 per t product	Scope 3 emissions kg CO2 per t product	Total kg CO2 per t product	Comment		
								Quantity	Scope 1 emissions factor	Scope 3 emissions factor
Secondary Metallurgy	Liquid Steel	kg							Estimate for C22 based on empirical values for carbon content in tapping and lack of need for further reduction as up to 0.24 % C in C22 is permitted.	
	Gas	GJ							CUT-OFF	
	Electricity	kWh							Reference product was defined as aluminum killed, estimation of the required quantity in the converter process from empirical values.	Cut Off
	Aluminium	kg							Adopted from secondary route to look at comparable alloys	ISO 19594-2
	Ironmanganese/Silicomanganese Liquid to cast	kg			3	1693	1696			Ecoinvent 3.9.1: market for aluminium, cast alloy, CLO Ecoinvent 3.9.1: market for ferromanganese, high-coal, 74.5% Mn, GLO & transportation emissions of market for ferrochromium, high-carbon, 68% Cr, GLO, as transport is not included for ferromanganese
Net (Input - Output)										
Casting	Liquid to cast	kg							German Federal Environment Agency (UBA)-Report "Abwärmernutzungspotenziale in Anlagen integrierter Hüttenwerke der Stahlindustrie", ISSN 1862-4804	
	Electricity	kWh							Statistical Annual report VV Stahl	(Summarized for Oxygen steelworks)
	Oxygen	m3							German Federal Environment Agency (UBA)-Report "Abwärmernutzungspotenziale in Anlagen integrierter Hüttenwerke der Stahlindustrie", ISSN 1862-4804	Ecoinvent 3.9.1: market for oxygen, liquid, RER. Calculation with density of 1.429 kg/m³
	Gas	GJ							CUT-OFF	
	Cast steel	kg			0	1730	1730			German Federal Environment Agency (UBA)-Report "Abwärmernutzungspotenziale in Anlagen integrierter Hüttenwerke der Stahlindustrie", ISSN 1862-4804
Net (Input - Output)										
Hot rolling	Cast steel	kg							Assumption based on production data	Own model
	BF-Gas	GJ							German Federal Environment Agency (UBA)-Report "Abwärmernutzungspotenziale in Anlagen integrierter Hüttenwerke der Stahlindustrie", ISSN 1862-4804	
	COG-Gas	GJ							German Federal Environment Agency (UBA)-Report "Abwärmernutzungspotenziale in Anlagen integrierter Hüttenwerke der Stahlindustrie", ISSN 1862-4804	Commission Regulation (EU) No601/2012
	Natural Gas	GJ							German Federal Environment Agency (UBA)-Report "Abwärmernutzungspotenziale in Anlagen integrierter Hüttenwerke der Stahlindustrie", ISSN 1862-4804	German Emissions Trading Authority (DEHS)
	BOF-Gas	GJ							German Federal Environment Agency (UBA)-Report "Abwärmernutzungspotenziale in Anlagen integrierter Hüttenwerke der Stahlindustrie", ISSN 1862-4804	Commission Regulation (EU) No601/2012 (inkl. cold rolling)
	Electricity	kWh							Statistical Annual report VV Stahl	
	Oxygen	m3							Assumption based on Statistical Annual report VV Stahl	Ecoinvent 3.9.1: market for oxygen, liquid, RER, calculation with density of 1.429 kg/m³
	Steel Scrap	kg							external scrap (worksteel)	
	Hot rolled steel	kg			105	1828	1933			
	Net (Input - Output)									
Power plant Gas Balance	COG-Gas	GJ							per ton of hot rolled product	Commission Regulation (EU) No601/2012
	BF-Gas	GJ							per ton of hot rolled product	Commission Regulation (EU) No601/2012
	BOF-Gas	GJ							per ton of hot rolled product	Commission Regulation (EU) No601/2012
	Natural Gas in PP	GJ							CUT-OFF, since it has no impact	
	Gases produced (total)	GJ						1577	per ton of hot rolled product	
	by_product gases used (coke)	GJ							per ton of hot rolled product	
	by_product gases used (sinter)	GJ							per ton of hot rolled product	
	by_product gases used (BF)	GJ							per ton of hot rolled product	
	by_product gases used (BOF)	GJ							CUT-OFF	
	by_product gases used (SecMet)	GJ							CUT-OFF	
by_product gases used (Casting)	GJ							CUT-OFF		
by_product gases used (Rolling)	GJ							per ton of hot rolled product		
by-product gases used (total)	GJ						979			
Net (Input - Output)	GJ						598			
									CO2 added (output) in PP	
Power plant Electricity Balance	Electricity Generation	kWh							Calculation with 37% electrical PP efficiency	
	Electricity used (coke)	kWh							per ton of hot rolled product	
	Electricity used (sinter)	kWh							per ton of hot rolled product	
	Electricity used (BF)	kWh							per ton of hot rolled product	
	Electricity used (BOF)	kWh							per ton of hot rolled product	
	Electricity used (SecMet)	kWh							per ton of hot rolled product	
	Electricity used (Casting)	kWh							per ton of hot rolled product	
	Electricity used (Rolling)	kWh							per ton of hot rolled product	
	Electricity used (total) plants	kWh							per ton of hot rolled product	
	Electricity used (Powerplant)	kWh							2% within the PP	
Electricity used (total)	kWh									
Net (Input - Output)	kWh									
Electricity (grid)	Electricity to the grid	kWh					-485	-86	per ton of hot rolled product	German Federal Environment Agency (UBA)
BF-Slag	Granulated BF-slag	kg					0	-26	per ton of hot rolled product	German Federal Ministry for Economic Affairs and Climate Action (BMWK)
					Scope 1	Scope 3	Scope 1-3			
					1904	627	2531			per ton of hot rolled product
					inkl. credits	545				Scope 1 / Scope 2 and technical gases and pellet/time upstream
								20,0%		scrap rate (scrap input in BF and BOF per ton of casted steel)
					Result Matrix					
							2.531	kg CO2: Scope 1 / Scope 2 and technical gases and pellet/time upstream		
							-56	kg CO2: Electricity (grid) Allocation		
							-26	kg CO2: Granulated BF slag Allocation		
							0	kg CO2: Extraction and Transport Emissions		
							Sum	2.449	kg CO2 per ton hot rolled product	
								20,0%	scrap rate (scrap input in BOF per ton of casted steel)	

Reference Plant DRI-EAF under Ideal Conditions

Process step	Unit	Quantity	Scope 1	Scope 2	Scope 3	Scope 1	Scope 2	Scope 3	Total	Comment	
			emissions factor kg CO2 per Unit	emissions factor kg CO2 per Unit	emissions factor kg CO2 per Unit	emissions kg CO2 per t product	emissions kg CO2 per t product	emissions kg CO2 per t product			emissions kg CO2 per t product
DRI	Lump Ore	kg								ISO 19694-2	Ecointer 3.9.1: market for iron ore, crude ore, 63% Fe, GLO
	Pellets	kg								Adopted from Lump Ore	Ecointer 3.9.1: market for iron pellets, GLO & transportation emissions from market for iron ore
	Hydrogen	GJ								Cavaliere et al.: Decarbonising the steelmaking industry, Steel Times International, 2021	Calculation based on ecointer transport data and estimate from "Hydrogen in climate protector"
	Electricity	MWh								German Federal Environmental Agency (UBA)	German Federal Environmental Agency UBA (assuming current distribution of wind and PV)
	Oxygen	m3N									Assumption regeneratively produced
	DRI	kg									
	Net (Input - Output)						0	0	325	325	
EAF	DRI	kg								Determination of scrap share for the label	
	Scrap	kg								Determination of scrap share for the label	
	Dolomitic lime	kg								ISO 19694-2	Ecointer 3.9.1: market for scrap steel, Europe without Switzerland & transportation over 150km with 70% truck (market for transport, freight, lorry, unspecified RER), 30 % train (market for transport, freight train, Europe without Switzerland)
	Graphite electrodes	kg								Cavaliere et al.: Integration of Open Slag Bath Furnace with Direct Reduction Reactors for New-Generations Steelmaking, Metals, 2022	Ecointer 3.9.1: market for graphite, battery grade, GLO
	Biochar	kg								German Emissions Trading Authority (DEHS) electrode burnup	Switzerland, market for transport, freight, sea, bulk carrier for dry goods, GLO market for transport, freight, lorry, Calculation based on ecointer transport data and estimate from "Hydrogen in climate protector"
	Hydrogen	GJ								Biogen	German Federal Environmental Agency UBA (assuming current distribution of wind and PV)
	Electricity	MWh								Derived from the natural gas consumption of the reference plant	Assumption regeneratively produced
	Oxygen	m3								Cavaliere et al.: Integration of Open Slag Bath Furnace with Direct Reduction Reactors for New-Generations Steelmaking, Metals, 2022	
	Liquid Steel	kg								Estimate for C22 based on empirical values for carbon content in tapping and lack of need for further reduction as up to 0.24 % C in C22 is permitted.	
	Net (Input - Output)						11	0	373	390	
Secondary Metallurgy	Liquid Steel	kg								Estimation CUT-OFF	
	Gas	GJ									German Federal Environmental Agency (UBA)
	Electricity	MWh								No alloy necessary, reference product was defined as aluminum killed, estimation of the necessary quantity in the converter process from empirical values.	Ecointer 3.9.1: market for aluminum, cast alloy, GLO
	Aluminium	kg								Cut Off	Ecointer 3.9.1: market for ferromanganese, high-coal, 74.5% Mn, GLO & transportation emissions from market for ferrosilicomanganese, 68% Cr, GLO, as no transportation is included for ferromanganese
	Net (Input - Output)						3	0	486	489	
Casting	Liquid to cast	kg								German Federal Environment Agency (UBA)-Report "Abwärmenutzungspotenziale in Anlagen integrierter Hüttenwerke der Stahlindustrie", ISSN 1862-4804	
	Electricity	MWh								Statistical Annual report VV Stahl (Summarized for Oxygen steelworks)	German Federal Environmental Agency UBA (assuming current distribution of wind and PV)
	Oxygen	m3								German Federal Environment Agency (UBA)-Report "Abwärmenutzungspotenziale in Anlagen integrierter Hüttenwerke der Stahlindustrie", ISSN 1862-4804	
	Gas	GJ								CUT-OFF	
	Net (Input - Output)						0	0	500	500	
Hot rolling	Cast steel	kg								Assumption	
	Hydrogen	GJ								German Federal Environment Agency (UBA)-Report "Abwärmenutzungspotenziale in Anlagen integrierter Hüttenwerke der Stahlindustrie", ISSN 1862-4804 (Hydrogen replaces natural gas)	Calculation based on ecointer transport data and estimate from "Hydrogen in climate protector"
	Electricity	MWh								Statistical Annual report VV Stahl (inkl. cold rolling)	German Federal Environmental Agency (UBA)
	Oxygen	m3								No co-gases, therefore no corresponding oxygen requirement external scrap (worldsteel)	German Federal Environmental Agency UBA (assuming current distribution of wind and PV)
	Net (Input - Output)						0		644	644	
Scope 2	Electricity used (DRI)	MWh								per ton of hot rolled product	
	Electricity used (EAF)	MWh								per ton of hot rolled product	
	Electricity used (SecMet)	MWh								per ton of hot rolled product	
	Electricity used (Casting)	MWh								per ton of hot rolled product	
	Electricity used (total) plants	MWh							0		
						Scope 1	Scope 2	Scope 3	Scope 1-3		
						16	0	829	844		
										per ton of hot rolled product	
										Scope 1 / Scope 2 and technical gases and pellet/lime upstream	
									20.00%	scrap rate (scrap input in BOF per ton of casted steel)	

Reference Plant EAF-QST

Process step	Unit	Quantity	Scope 1	Scope 2	Scope 3	Scope 1	Scope 2	Scope 3	Total	Comment
			emissions factor	emissions factor	emissions factor	emissions	emissions	emissions		
			kg CO2 per Unit	kg CO2 per Unit	kg CO2 per Unit	kg CO2 per t product	kg CO2 per t product	kg CO2 per t product	kg CO2 per t product	
Steel plant	Scrap	kg								ISO 19694-2 Ecoinvent 3.9.1: market for scrap steel, Europe without Switzerland & transportation over 150km with 70% truck (market for transport, freight, lorry, unspecified RER), 30 % train (market for transport, freight train, Europe without Switzerland)
	Lime	kg								ISO 19694-2 German Emissions Trading Authority (DEHS) Ecoinvent 3.9.1: market for quicklime, milled, packed, RER
	Graphite electrodes	kg								ISO 19694-2 German Emissions Trading Authority (DEHS) Ecoinvent 3.9.1: market for graphite, battery grade, GLO
	Coal	kg								ISO 19694-2 German Emissions Trading Authority (DEHS) German Federal Environmental Agency (LBA)
	Natural-Gas	GJ								German Federal Environmental Agency (LBA) Report "Emissionsfaktoren der Stromerzeugung - Betrachtung der Vorkettenemissionen von Erdgas und Steinkohle", ISSN 1862-4359
	Electricity	KWh								German Federal Environmental Agency (LBA) Ecoinvent 3.9.1: market for oxygen, liquid, RER, Umrechnung mit Dichte von 1,429 kg/m³
	Oxygen	m³								Cut Off Ecoinvent 3.9.1: market for aluminium, cast alloy, GLO
	Aluminium	kg								ISO 19694-2 Ecoinvent 3.9.1: market for ferromanganese, high-coal, 74.5% Mn, GLO & transportation emissions from market for ferrochromium, high-carbon, 66% Cr, GLO, as no transportation is included for ferromanganese
	Ferromanganese/Silicomangan	kg								Estimate for C22 based on empirical values for carbon content in tapping and lack of need for further reduction as up to 0.24 % C in C22 is permitted.
	Liquid Steel	kg								
Net (Input - Output)						114	235	248	598	
Casting	Liquid to cast	kg								Estimate for C22 based on empirical values for carbon content in tapping and lack of need for further reduction as up to 0.24 % C in C22 is permitted.
	Electricity	KWh								considered under steel mill German Federal Environmental Agency (LBA) Report "Emissionsfaktoren der Stromerzeugung - Betrachtung der Vorkettenemissionen von Erdgas und Steinkohle", ISSN 1862-4359
	Oxygen	m³								considered under steel plant Ecoinvent 3.9.1: market for oxygen, liquid, RER, Umrechnung mit Dichte von 1,429 kg/m³
	Gas	GJ								
	Cast steel	kg								considered under steel plant German Federal Environmental Agency (LBA) Report "Emissionsfaktoren der Stromerzeugung - Betrachtung der Vorkettenemissionen von Erdgas und Steinkohle", ISSN 1862-4359
	Net (Input - Output)						0	0	610	610
Hot rolling	Cast steel	kg								German Emissions Trading Authority (DEHS) German Federal Environmental Agency (LBA)
	Natural-Gas	GJ								German Federal Environmental Agency (LBA) Report "Emissionsfaktoren der Stromerzeugung - Betrachtung der Vorkettenemissionen von Erdgas und Steinkohle", ISSN 1862-4359
	Electricity	KWh								German Federal Environmental Agency (LBA) Ecoinvent 3.9.1: market for oxygen, liquid, RER, Umrechnung mit Dichte von 1,429 kg/m³
	Oxygen	m³								Estimate for C22 based on empirical values for carbon content in tapping and lack of need for further reduction as up to 0.24 % C in C22 is permitted.
	Steel Scrap	kg								Estimate for C22 based on empirical values for carbon content in tapping and lack of need for further reduction as up to 0.24 % C in C22 is permitted.
Net (Input - Output)						84	43	663	790	
						Scope 1	Scope 2	Scope 3	Scope 1-3	
						207	284	289	790	

Reference Plant EAF-QST under Ideal Conditions

Process step		Unit	Quantity	Scope 1	Scope 2	Scope 3	Scope 1	Scope 2	Scope 3	Total	Comment				
				emissions factor	emissions factor	emissions factor	emissions	emissions	emissions	emissions	emissions	emissions	emissions	emissions	emissions
				kg CO2 per Unit	kg CO2 per Unit	kg CO2 per Unit	kg CO2 per t product	kg CO2 per t product	kg CO2 per t product	kg CO2 per t product	Quantity	Scope 1 emissions factor	Scope 2 emissions factor	Scope 3 emissions factor	
Steel plant	Scrap	kg									ISO 19694-2			Ecoinvent 3.9.1: market for scrap steel, Europe without Switzerland & transportation over 150km with 70% truck (market for transport, freight, lorry, unspecified RER), 30 % train (market for transport, freight train, Europe without Switzerland)	
	DRI	kg									ISO 19694-2			Ecoinvent 3.9.1: market for quicklime, milled, packed, RER	
	Lime	kg									German Emissions Trading Authority (DEHSt) electrode burnup			Ecoinvent 3.9.1: market for graphite, battery grade, GLO	
	Graphite electrodes	kg									Biogen			Ecoinvent 3.9.1: market for transport, freight train, Europe without Switzerland, market for transport, freight, sea, bulk carrier for dry goods, GLO, market for transport, freight, lorry, unspecified, RER	
	Biochar	kg												Calculation based on ecoinvent transport data and estimate from "Hydrogen in climate protection"	
	Hydrogen	GJ										German Federal Environmental Agency (UBA)			German Federal Environmental Agency UBA (assuming current distribution of wind and PV)
	Electricity (renewable)	kWh												Assumption regeneratively produced	
	Oxygen (renewable)	m3												Ecoinvent 3.9.1: market for aluminium, cast alloy, GLO	
	Aluminium	kg												Ecoinvent 3.9.1: market for ferromanganese, high-coal, 74.5% Mn, GLO & transportation emissions from market	
	Ferromanganese/Silicomanganese	kg												for ferromanganese, high-carbon, 68% Cr, GLO, as no transportation is included for ferromanganese	
Liquid Steel	kg														
Net (Input - Output)							17	0	212	229					
Casting	Liquid to cast	kg												Estimate for C22 based on empirical values for carbon content in tapping and lack of need for further reduction as up to 0.24 % C in C22 is permitted.	
	Electricity	kWh												German Federal Environmental Agency (UBA)	
	Oxygen	m3												German Federal Environmental Agency UBA (assuming current distribution of wind and PV)	
	Gas	GJ												Assumption regeneratively produced	
	Cast steel	kg												Estimate for C22 based on empirical values for carbon content in tapping and lack of need for further reduction as up to 0.24 % C in C22 is permitted.	
Net (Input - Output)							0	0	233	234					
Hot rolling	Cast steel	kg												Estimate for C22 based on empirical values for carbon content in tapping and lack of need for further reduction as up to 0.24 % C in C22 is permitted.	
	Hydrogen	GJ												German Federal Environmental Agency (UBA) Calculation based on ecoinvent transport data and estimate from "Hydrogen in climate protection"	
	Electricity (renewable)	kWh												German Federal Environmental Agency UBA (assuming current distribution of wind and PV)	
	Oxygen (renewable)	m3												Assumption regeneratively produced	
	Steel Scrap	kg												Estimate for C22 based on empirical values for carbon content in tapping and lack of need for further reduction as up to 0.24 % C in C22 is permitted.	
Hot rolled steel	kg														
Net (Input - Output)							0	0	264	264					
							Scope 1	Scope 2	Scope 3	Scope 1-3					
							18	0	246	264					

Reference Plant EAF-BST

Process step	Unit	Quantity	Scope 1 emissions factor	Scope 2 emissions factor	Scope 3 emissions factor	Scope 1 emissions	Scope 2 emissions	Scope 3 emissions	Total	Comment			
										kg CO2 per Unit	kg CO2 per Unit	kg CO2 per Unit	kg CO2 per t product
Steel plant	Scrap	kg									ISO 19694-2		Ecoinvent 3.9.1: market for scrap steel, Europe without Switzerland & transportation over 150km with 70% truck (market for transport, freight, lorry, unspecified RER), 30 % train (market for transport, freight train, Europe without Switzerland)
	Lime	kg									ISO 19694-2		Ecoinvent 3.9.1: market for quicklime, milled, packed, RER
	Graphite electrodes	kg									German Emissions Trading Authority (DEHSt)		Ecoinvent 3.9.1: market for graphite, battery grade, GLO
	Coal	kg									ISO 19694-2		
	Natural-Gas	GJ									German Emissions Trading Authority (DEHSt)		German Federal Environmental Agency (UBA)
	Electricity	kWh									German Federal Environmental Agency (UBA)		German Federal Environmental Agency (UBA) Report "Emissionsfaktoren der Stromerzeugung - Betrachtung der Vorkettenemissionen von Erdgas und Steinkohle", ISSN 1862-4359
	Oxygen	m3											Ecoinvent 3.9.1: market for oxygen, liquid, RER, Conversion with density of 1.429 kg/m³
	Ferrosilicone	kg									Cut Off		Ecoinvent 3.9.1: market for aluminium, cast alloy, GLO
	Ferromanganese/Silicomanganese	kg									ISO 19694-2		Ecoinvent 3.9.1: market for ferromanganese, high-coal, 74.5% Mn, GLO & transportation emissions from market for ferrochromium, high-carbon, 68% Cr, GLO, as no transportation is included for ferromanganese
	Liquid Steel	kg											
Net (Input - Output)						77	177	167	421				
Casting	Liquid to cast	kg											Estimate for C22 based on empirical values for carbon content in tapping and lack of need for further reduction as up to 0.24 % C in C22 is permitted.
	Electricity	kWh									German Federal Environmental Agency (UBA)		German Federal Environmental Agency (UBA) Report "Emissionsfaktoren der Stromerzeugung - Betrachtung der Vorkettenemissionen"
	Oxygen	m3											Ecoinvent 3.9.1: market for oxygen, liquid, RER, Conversion with density of 1.429 kg/m³
	Gas	GJ											
	Cast steel	kg											Estimate for C22 based on empirical values for carbon content in tapping and lack of need for further reduction as up to 0.24 % C in C22 is permitted.
	Net (Input - Output)						0	0	429	430			
Hot rolling	Cast steel	kg											Estimate for C22 based on empirical values for carbon content in tapping and lack of need for further reduction as up to 0.24 % C in C22 is permitted.
	Natural-Gas	GJ									state of technology for iron metal processing plants (UBA-Federal Environmental Agency) Austria		
	Electricity	kWh									German Emissions Trading Authority (DEHSt)		German Federal Environmental Agency (UBA)
	Oxygen	m3									German Federal Environmental Agency (UBA)		German Federal Environmental Agency (UBA) Report "Emissionsfaktoren der Stromerzeugung - Betrachtung der Vorkettenemissionen von Erdgas und Steinkohle", ISSN 1862-4359
	Steel Scrap	kg											Ecoinvent 3.9.1: market for oxygen, liquid, RER, Conversion with density of 1.429 kg/m³
Hot rolled steel	kg											Estimate for C22 based on empirical values for carbon content in tapping and lack of need for further reduction as up to 0.24 % C in C22 is permitted.	
Net (Input - Output)						26	43	462	531				
						Scope 1	Scope 2	Scope 3	Scope 1-3				
						109	232	190	531				

Reference Plant EAF-BST under Ideal Conditions

	Unit	Quantity	Scope 1	Scope 2	Scope 3	Scope 1	Scope 2	Scope 3	Total	Comment
			emissions factor kg CO2 per Unit	emissions factor kg CO2 per Unit	emissions factor kg CO2 per Unit	emissions kg CO2 per t product	emissions kg CO2 per t product	emissions kg CO2 per t product		
Steel plant	Scrap	kg								ISO 19694-2 Ecoinvent 3.9.1: market for scrap steel, Europe without Switzerland & transportation over 150km with 70% truck (market for transport, freight, lorry, unspecified RER), 30 % train (market for transport, freight train, Europe without Switzerland)
	DRI	kg								ISO 19694-2 Ecoinvent 3.9.1: market for quicklime, milled, packed, RER
	Lime	kg								ISO 19694-2 Ecoinvent 3.9.1: market for quicklime, milled, packed, RER Ecoinvent 3.9.1: market for graphite, battery grade, GLO
	Graphite electrodes	kg								ISO 19694-2 Ecoinvent 3.9.1: market for graphite, battery grade, GLO
	Biochar	kg								Biogen Ecoinvent 3.9.1: market for transport, freight train, Europe without Switzerland, market for transport, freight, sea, bulk carrier for dry goods, GLO, market for transport, freight, lorry, unspecified, RER Calculation based on ecoinvent transport data and estimate from "Hydrogen in climate protection"
	Hydrogen	GJ								German Federal Environmental Agency (LBA) German Federal Environmental Agency LBA (assuming current distribution of wind and PV) Assumption regeneratively produced
	Electricity (renewable)	kWh								Cut Off Ecoinvent 3.9.1: market for aluminium, cast alloy, GLO
	Oxygen (renewable)	m3								ISO 19694-2 Ecoinvent 3.9.1: market for ferromanganese, high-coal, 74.5% Mn, GLO & transportation emissions from market for ferrochromium, high-carbon, 68% Cr, GLO, as no transportation is included for ferromanganese
	Ferrosilicone	kg								
	Ferromanganese/Silicomanganese	kg								
	Liquid Steel	kg								
Net (Input - Output)						15	0	137	152	
Casting	Liquid to cast	kg								Estimate for C22 based on empirical values for carbon content in tapping and lack of need for further reduction as up to 0.24 % C in C22 is permitted.
	Electricity	kWh								German Federal Environmental Agency (LBA) German Federal Environmental Agency LBA (assuming current distribution of wind and PV) Assumption regeneratively produced
	Oxygen	m3								
	Gas	GJ								
	Cast steel	kg								Estimate for C22 based on empirical values for carbon content in tapping and lack of need for further reduction as up to 0.24 % C in C22 is permitted.
Net (Input - Output)						0	0	155	155	
Hot rolling	Cast steel	kg								Estimate for C22 based on empirical values for carbon content in tapping and lack of need for further reduction as up to 0.24 % C in C22 is permitted.
	Hydrogen	GJ								German Federal Environmental Agency (LBA) Calculation based on ecoinvent transport data and estimate from "Hydrogen in climate protection"
	Electricity (renewable)	kWh								German Federal Environmental Agency LBA (assuming current distribution of wind and PV) Assumption regeneratively produced
	Oxygen (renewable)	m3								
	Steel Scrap	kg								Estimate for C22 based on empirical values for carbon content in tapping and lack of need for further reduction as up to 0.24 % C in C22 is permitted.
Hot rolled steel	kg									
Net (Input - Output)						0	0	170	170	
						Scope 1	Scope 2	Scope 3	Scope 1-3	
						16	0	154	170	

Threshold Value Calculation Aid

Qualitätsstahl / Quality steel

Bau- und Betonstahl / structural and reinforcing steel

Schwellenwerte aller Klassifizierungsstufen / Threshold of all classification

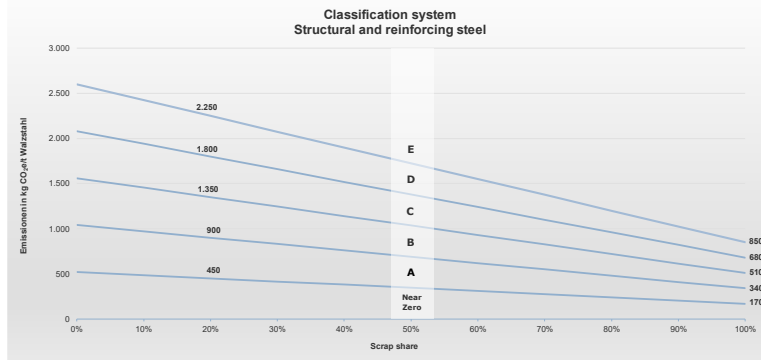
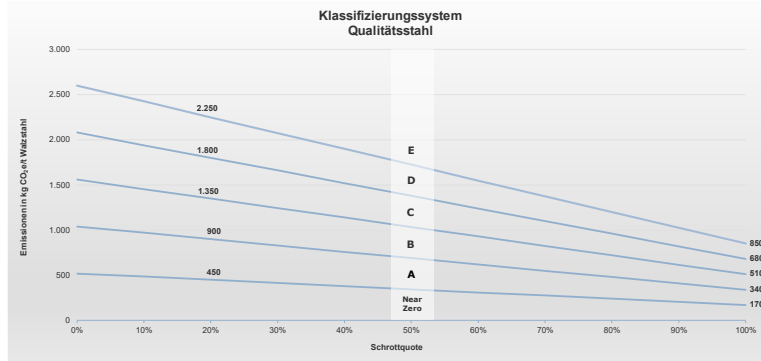
Schwelle Near Zero	
0%	520
10%	485
20%	450
30%	415
40%	380
50%	345
60%	310
70%	275
80%	240
90%	205
100%	170

Schwelle A	
0%	1.040
10%	970
20%	900
30%	830
40%	760
50%	690
60%	620
70%	550
80%	480
90%	410
100%	340

Schwelle B	
0%	1.560
10%	1.455
20%	1.350
30%	1.245
40%	1.140
50%	1.035
60%	930
70%	825
80%	720
90%	615
100%	510

Schwelle C	
0%	2.080
10%	1.940
20%	1.800
30%	1.660
40%	1.520
50%	1.380
60%	1.240
70%	1.100
80%	960
90%	820
100%	680

Schwelle D	
0%	2.600
10%	2.425
20%	2.250
30%	2.075
40%	1.900
50%	1.725
60%	1.550
70%	1.375
80%	1.200
90%	1.025
100%	850



Allgemeine Geradengleichung / General equation

$E = m \cdot (100 - x) + s$
 E = Emissionen in kg CO₂e/t Walzstahl - emissions in kg CO₂e/t hot rolled steel
 m = Steigung der Geraden - slope of the line
 x = Schrottquote - scrap share
 s = Emissionen in kg CO₂e/t Walzstahl der Referenzanlage bei 100% Schrottquote - Emissions in kg CO₂e/t Walzstahl der Referenzanlage bei 100% Schrottquote

Hertellung Klassifizierungsschwelle Near Zero / Derivation of the threshold for Near Zero

330 IEA-Ansatz Emissionen in kg CO₂e/t Walzstahl Referenzanlage 20 % Schrottquote - IEA-approach emissions in kg CO₂e/t hot rolled steel reference plant 20% scrap
50 IEA-Ansatz Emissionen in kg CO₂e/t Walzstahl Referenzanlage 100 % Schrottquote - IEA-approach emissions in kg CO₂e/t hot rolled steel reference plant 100% scrap
+120 Aufschlag in kg CO₂e/t Walzstahl Referenzanlage 20 % Schrottquote - surcharge in kg CO₂e/t hot rolled steel reference plant 20% scrap share
+120 Aufschlag in kg CO₂e/t Walzstahl Referenzanlage 100 % Schrottquote - surcharge in kg CO₂e/t hot rolled steel reference plant 100% scrap share

Schwellenwerte aller Klassifizierungsstufen / Threshold of all classification

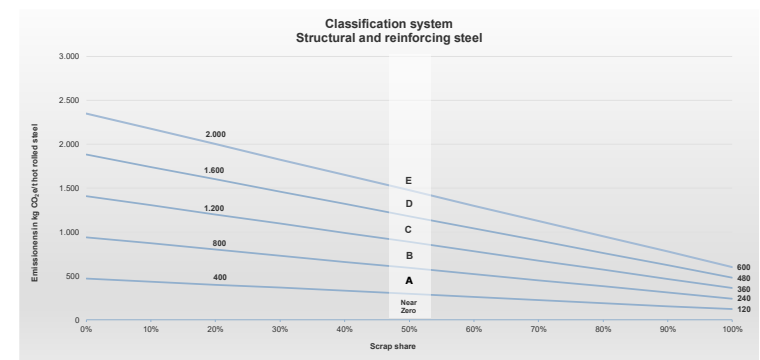
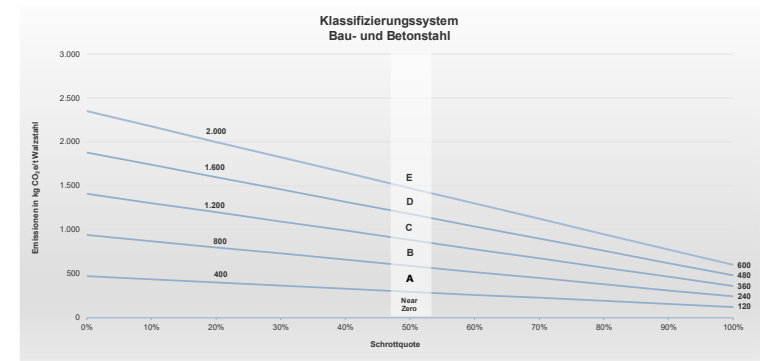
Schwelle / Threshold Near Zero	
0%	470
10%	435
20%	400
30%	365
40%	330
50%	295
60%	260
70%	225
80%	190
90%	155
100%	120

Schwelle / Threshold A	
0%	940
10%	870
20%	800
30%	730
40%	660
50%	590
60%	520
70%	450
80%	380
90%	310
100%	240

Schwelle / Threshold B	
0%	1.410
10%	1.305
20%	1.200
30%	1.095
40%	990
50%	885
60%	780
70%	675
80%	570
90%	465
100%	360

Schwelle / Threshold C	
0%	1.880
10%	1.740
20%	1.600
30%	1.460
40%	1.320
50%	1.180
60%	1.040
70%	900
80%	760
90%	620
100%	480

Schwelle / Threshold D	
0%	2.350
10%	2.175
20%	2.000
30%	1.825
40%	1.650
50%	1.475
60%	1.300
70%	1.125
80%	950
90%	775
100%	600



Allgemeine Geradengleichung / General equation

$E = m \cdot (100 - x) + s$
 E = Emissionen in kg CO₂e/t Walzstahl - emissions in kg CO₂e/t hot rolled steel
 m = Steigung der Geraden - slope of the line
 x = Schrottquote - scrap share
 s = Emissionen in kg CO₂e/t Walzstahl der Referenzanlage bei 100% Schrottquote - Emissions in kg CO₂e/t Walzstahl der Referenzanlage bei 100% Schrottquote

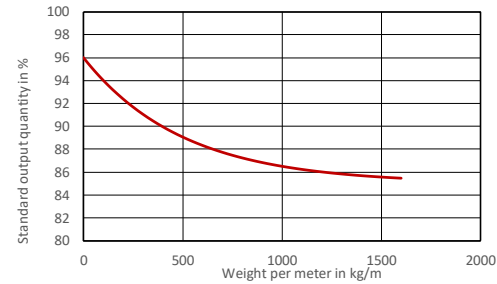
Hertellung Klassifizierungsschwelle Near Zero / Derivation of the threshold for Near Zero

330 IEA-Ansatz Emissionen in kg CO₂e/t Walzstahl Referenzanlage 20 % Schrottquote - IEA-approach emissions in kg CO₂e/t hot rolled steel reference plant 20% scrap
50 IEA-Ansatz Emissionen in kg CO₂e/t Walzstahl Referenzanlage 100 % Schrottquote - IEA-approach emissions in kg CO₂e/t hot rolled steel reference plant 100% scrap
+70 Aufschlag in kg CO₂e/t Walzstahl Referenzanlage 20 % Schrottquote - surcharge in kg CO₂e/t hot rolled steel reference plant 20% scrap share
+70 Aufschlag in kg CO₂e/t Walzstahl Referenzanlage 100 % Schrottquote - surcharge in kg CO₂e/t hot rolled steel reference plant 100% scrap share

Rolling Mill Excess Input

Weight per meter in kg/m	Bar diameter in mm	Sheet thickness in mm (2 m wide)	Standard output quantity in %	Excess input
1	12,8		96,0	1,050
2	18,1		96,0	1,050
4	25,6		95,9	1,050
8	36,1	0,51	95,8	1,050
12	44,3	0,77	95,7	1,050
16	51,1	1,03	95,7	1,050
20	57,1	1,28	95,6	1,050
24	62,6	1,54	95,5	1,050
28	67,6	1,79	95,4	1,050
32	72,3	2,05	95,3	1,050
36	76,7	2,31	95,2	1,050
40	80,8	2,56	95,2	1,051
44	84,7	2,82	95,1	1,052
48	88,5	3,08	95,0	1,053
52	92,1	3,33	94,9	1,054
56	95,6	3,59	94,8	1,054
60	99,0	3,85	94,8	1,055
70	106,9	4,49	94,6	1,057
80	114,3	5,13	94,4	1,060
90	121,2	5,77	94,2	1,062
100	127,8	6,41	94,0	1,064
110	134,0	7,05	93,8	1,066
120	140,0	7,69	93,7	1,068
130	145,7	8,33	93,5	1,070
140	151,2	8,97	93,3	1,072
150	156,5	9,62	93,1	1,074
200	180,7	12,82	92,4	1,083
250	202,0	16,03	91,7	1,091
300		19,23	91,0	1,098
350		22,44	90,5	1,105
400		25,64	89,9	1,112
450		28,85	89,5	1,118
500		32,05	89,0	1,123
550		35,26	88,7	1,128
600		38,46	88,3	1,132
650		41,67	88,0	1,136
700		44,87	87,7	1,140
750		48,08	87,5	1,143
800		51,28	87,2	1,147
850		54,49	87,0	1,149
900		57,69	86,8	1,152
950		60,90	86,6	1,154
1.000		64,10	86,5	1,156
1.050		67,31	86,3	1,158
1.100		70,51	86,2	1,160
1.150		73,72	86,1	1,161
1.200		76,92	86,0	1,163
1.250		80,13	85,9	1,164
1.300		83,33	85,8	1,165
1.350		86,54	85,7	1,166
1.400		89,74	85,7	1,167
1.450		92,95	85,6	1,168
1.500		96,15	85,5	1,169
1.550		99,36	85,5	1,170
1.600		102,56	85,4	1,170

max. output quantity in % 96
 min. output quantity in % 85
 Standardization in kg/m 500



List of Alloying Agents

Element	No.	Name (dt.)	Name (engl.)	Verbindungen/Stoffe (dt.)	Composition (engl.)
B	5	Bor	Boron	Ferro-Bor	Ferro boron
C	6	Kohlenstoff*	Carbon	Braunkohlenfeinstaub C-Fülldraht Petrolkoks Steinkohle	pulverized lignite petroleum coke hard coal
N	7	Stickstoff	Nitrogen	Salpetersäure Stickstoff Kalkstickstoff	Nitric acid Nitrogen Calciumcyanamid
Al	13	Aluminum	Aluminum	Primäraluminium Sekundäraluminium Aluminiumchlorid Aluminiumsulfat Aluminium	Primary aluminium Secondary aluminium Aluminium chloride Aluminium sulphate Aluminium
Si	14	Silizium	Silicon	Siliziummetall Calciumsilizid Ferroilizium	Silicon metal Calcium Silicide Ferro silicum
P	15	Phosphor	Phosphorus	Ferro-Phosphor	Ferro phosphorus
S	16	Schwefel	Sulphur	Aluminiumsulfat Ammoniumsulfat Eisendisulfid (Pyrit) Eisensulfat Natriumsulfat Schwefel	Aluminium sulphate Ammonium sulphate Pyrite Ferrous sulphate Sodium sulphate Sulfur
Ca	20	Kalzium**	Calcium	Branntkalk (CaO) Calciumchlorid Dolomit Dolomitkalk Kalziumkarbonat Kalkstein CaSi-Draht Ferro-Kalzium Kalzium-Silizium	(quick)lime Calcium chloride dolomite domitic lime Calciumcarbonat Lime stone CaSi-Wire Ferro calcium Silico calcium
Ti	22	Titan	Titanium	Titanium metal Ferro-Titanium Titanschwamm Titandioxid	Titanium metal Ferro titanium Titanschwamm Titanium dioxide
V	23	Vanadium	Vanadium	Vanadiumnitrid Ferro-Vanadium	Ferro vanadium
Cr	24	Chrom	Chromium	Ferrochrom high-carbon (carbure) Ferrochrom low-carbon (affine) Charge chrome Ferrochrom	Ferrochrome high-carbon (carbure) Ferrochrome low-carbon (affine) Charge chrome Ferro chrome
Mn	25	Mangan	Manganese	Ferro-Mangan Mangan Silizium-Mangan	Ferro-Mangan high-carbon (carbure) Ferro-Mangan low-carbon (affine) Ferro manganese Manganese Silico Manganese
Co	27	Kobalt	Cobalt		
Ni	28	Nickel	Nickel	Ferro-Nickel Nickel	Ferro nickel Nickel
Cu	29	Kupfer	Copper	Kupfer	Copper
Se	34	Selen	Selenium	Ferro-Selen Selenoxid	Ferro Selenium Selenium Dioxide
Nb	41	Niob	Niobium	Ferro-Niob	Ferro Niobium
Mo	42	Molybdän	Molybdenum	Molybdän(VI)-oxid Ferro-Molybdän	Molybdenum oxides Ferro molybdenum
Te	52	Tellur	Tellurium	Mangantellurid Telluride Tellur Sulfide	Manganese telluride Telluride Tellurium Sulfide
W	74	Wolfram	Tungsten	Wolfram Metal Ferro-Wolfram	Tungsten metal Ferro tungsten
Pb	82	Blei	Lead	Primärblei Sekundärblei	Primary lead Secondary lead
Bi	83	Wismut	Bismuth	Wismut	Bismuth

* Note: When using carbon compounds, special case 2 in chapter 8.1.2 of the Rulebook must be observed.

** Note: When using calcium compounds, special case 1 in chapter 8.1.2 of the Rulebook must be considered.

Standard Emission Factors Scope 3

	Unit	kg CO ₂ /unit	Ecointvent source Source Scope 3 emissions factor	Region	Ecointvent Version	Source Scope 3 emissions factor (not Ecointvent)
Acetylen	kg	Not publicly available	market for acetylene	RER	3.9.1 Allocation at the point of substitution IPCC 2021 (GWP100)	
Aluminium	kg	Not publicly available	market for aluminium, cast alloy	GLO	3.9.1 Allocation at the point of substitution IPCC 2021 (GWP100)	
Aluminium (primary)	kg	Not publicly available	market for aluminium, primary, magnet	EU Area, EULET & EFTA	3.9.1 Allocation at the point of substitution IPCC 2021 (GWP100)	
Aluminium chloride	kg	Not publicly available	market for aluminium chloride	GLO	3.9.1 Allocation at the point of substitution IPCC 2021 (GWP100)	
Aluminium sulfate	kg	Not publicly available	market for aluminium sulfate, powder	RER	3.9.1 Allocation at the point of substitution IPCC 2021 (GWP100)	
Ammonium sulfate	kg	Not publicly available	market for ammonium sulfate	RER	3.9.1 Allocation at the point of substitution IPCC 2021 (GWP100)	
Anthracite	kg	Not publicly available	market for hard coal	Europe, without Russia and Turkey	3.9.1 Allocation at the point of substitution IPCC 2021 (GWP100)	
Argon	kg	Not publicly available	market for argon, liquid	RER	3.9.1 Allocation at the point of substitution IPCC 2021 (GWP100)	
BF injection coal	kg	Not publicly available	market for hard coal	Europe, without Russia and Turkey	3.9.1 Allocation at the point of substitution IPCC 2021 (GWP100)	
Biochar	kg	0,1297				Own calculation based on assumed transportation routes and emission factors from Ecointvent 3.9.1
Calcium carbonate	kg	Not publicly available	market for calcium carbonate, precipitated	RER	3.9.1 Allocation at the point of substitution IPCC 2021 (GWP100)	
Calcium chloride	kg	Not publicly available	market for calcium chloride	RER	3.9.1 Allocation at the point of substitution IPCC 2021 (GWP100)	
Calciumcyanamid	kg	Not publicly available	Proxy: market for calcium carbide, technical grade	RER	3.9.1 Allocation at the point of substitution IPCC 2021 (GWP100)	
Calcium silicide	kg	Not publicly available	Proxy: market for silicon, metallurgical grade	GLO	3.9.1 Allocation at the point of substitution IPCC 2021 (GWP100)	
CAS-Wire	kg	Not publicly available	Proxy: market for silicon, metallurgical grade	GLO	3.9.1 Allocation at the point of substitution IPCC 2021 (GWP100)	
Cobalt	kg	Not publicly available	market for cobalt	GLO	3.9.1 Allocation at the point of substitution IPCC 2021 (GWP100)	
Coke	kg	Not publicly available	market for coke	GLO (Conversion to kg using the calorific value given there)	3.9.1 Allocation at the point of substitution IPCC 2021 (GWP100)	
Coking coal	kg	Not publicly available	market for hard coal	Europe, without Russia and Turkey	3.9.1 Allocation at the point of substitution IPCC 2021 (GWP100)	
Copper	kg	Not publicly available	market for copper, anode	GLO	3.9.1 Allocation at the point of substitution IPCC 2021 (GWP100)	
C-Fülldraht	kg	Not publicly available	Proxy: market for petroleum coke	GLO	3.9.1 Allocation at the point of substitution IPCC 2021 (GWP100)	
Diesel	kg	Not publicly available	market for diesel, low-sulfur	Europe without Switzerland	3.9.1 Allocation at the point of substitution IPCC 2021 (GWP100)	
Dolomite	kg	Not publicly available	market for dolomite	RER	3.9.1 Allocation at the point of substitution IPCC 2021 (GWP100)	
Dolomitic lime	kg	Not publicly available	market for quicklime, milled, packed	RER	3.9.1 Allocation at the point of substitution IPCC 2021 (GWP100)	
DRB	kg	Not publicly available	market for sponge iron	GLO	3.9.1 Allocation at the point of substitution IPCC 2021 (GWP100)	
EAF coal	kg	Not publicly available	market for hard coal	Europe, without Russia and Turkey	3.9.1 Allocation at the point of substitution IPCC 2021 (GWP100)	
Ferro calcium	kg	Not publicly available	Proxy: market for calcium carbide, technical grade	RER	3.9.1 Allocation at the point of substitution IPCC 2021 (GWP100)	
Ferrocromium, high-carbon, 65% Cr	kg	Not publicly available	market for ferrocromium, high-carbon, 65% Cr	GLO	3.9.1 Allocation at the point of substitution IPCC 2021 (GWP100)	
Ferrocromium, high-carbon, 68% Cr	kg	Not publicly available	market for ferrocromium, high-carbon, 68% Cr	GLO	3.9.1 Allocation at the point of substitution IPCC 2021 (GWP100)	
Ferromanganese	kg	Not publicly available	market for ferromanganese, high-coal, 74.5% Mn	GLO	3.9.1 Allocation at the point of substitution IPCC 2021 (GWP100)	
Ferro molybdenum	kg	Not publicly available	Proxy: market for molybdenum	GLO	3.9.1 Allocation at the point of substitution IPCC 2021 (GWP100)	
Ferro nickel	kg	Not publicly available	market for ferro-nickel	GLO	3.9.1 Allocation at the point of substitution IPCC 2021 (GWP100)	
Ferro niobium	kg	Not publicly available	market for ferro-niobium, 95% Nb	GLO	3.9.1 Allocation at the point of substitution IPCC 2021 (GWP100)	
Ferro phosphorus	kg	Not publicly available	Proxy: market for phosphorus, white, liquid	GLO	3.9.1 Allocation at the point of substitution IPCC 2021 (GWP100)	
Ferro selenium	kg	Not publicly available	Proxy: market for selenium	GLO	3.9.1 Allocation at the point of substitution IPCC 2021 (GWP100)	
Ferrosilicon	kg	Not publicly available	market for ferrosilicon	GLO	3.9.1 Allocation at the point of substitution IPCC 2021 (GWP100)	
Ferrous sulfate	kg	Not publicly available	market for iron sulfate	RER	3.9.1 Allocation at the point of substitution IPCC 2021 (GWP100)	
Ferro titanium	kg	Not publicly available	Proxy: market for titanium sponge	GLO	3.9.1 Allocation at the point of substitution IPCC 2021 (GWP100)	
Ferro tungsten	kg	Not publicly available	Proxy: market for tungsten concentrate	GLO	3.9.1 Allocation at the point of substitution IPCC 2021 (GWP100)	
Ferro vanadium	kg	Not publicly available	market for ferro-vanadium	GLO	3.9.1 Allocation at the point of substitution IPCC 2021 (GWP100)	Workshop
Fuel oil (light)	kg	Not publicly available	market for light fuel oil	Europe without Switzerland	3.9.1 Allocation at the point of substitution IPCC 2021 (GWP100)	
Fuel oil (heavy)	kg	Not publicly available	market for heavy fuel oil	Europe without Switzerland	3.9.1 Allocation at the point of substitution IPCC 2021 (GWP100)	
Granulated BF slag	kg dry	Not publicly available	Not publicly available			
Graphite electrodes	kg	Not publicly available	market for graphite, battery grade	GLO	3.9.1 Allocation at the point of substitution IPCC 2021 (GWP100)	
Hard coal	kg	Not publicly available	market for hard coal	Europe, without Russia and Turkey	3.9.1 Allocation at the point of substitution IPCC 2021 (GWP100)	
Hot metal	kg	Not publicly available	Not publicly available			
Hydrogen	GJ	10,62				Own calculation based on Ecointvent 3.9.1 Transport data and estimate from "Hydrogen in climate protection"
Lead	kg	Not publicly available	market for lead	GLO	3.9.1 Allocation at the point of substitution IPCC 2021 (GWP100)	
(Quick) Lime	kg	Not publicly available	market for quicklime, milled, packed	RER	3.9.1 Allocation at the point of substitution IPCC 2021 (GWP100)	
Limestone	kg	Not publicly available	market for limestone, crushed, washed	ROW	3.9.1 Allocation at the point of substitution IPCC 2021 (GWP100)	
Liquid to cast/ Liquid steel	kg	Not publicly available	Not publicly available			
Lump ore BF	kg	Not publicly available	market for iron ore, crude ore, 63% Fe	GLO	3.9.1 Allocation at the point of substitution IPCC 2021 (GWP100)	
Manganese	kg	Not publicly available	market for manganese	GLO	3.9.1 Allocation at the point of substitution IPCC 2021 (GWP100)	
Manganese telluride	kg	Not publicly available	market for manganese telluride	GLO	3.9.1 Allocation at the point of substitution IPCC 2021 (GWP100)	
Molybdenum oxide	kg	Not publicly available	market for molybdenum trioxide	GLO	3.9.1 Allocation at the point of substitution IPCC 2021 (GWP100)	Nuas P. Eckelman MJ (2014) Life Cycle Assessment of Metals: A Scientific Synthesis. <i>PLoS ONE</i> 9(7): e101298. doi:10.1371/journal.pone.0101298
Natural-Gas	GJ	11,30				Federal Environment Agency (UBA)
Nickel	kg	Not publicly available	market for nickel, class 1	GLO	3.9.1 Allocation at the point of substitution IPCC 2021 (GWP100)	
Nitric Acid	kg	Not publicly available	market for nitric acid, without water, in 50% solution state	RER w/o RU	3.9.1 Allocation at the point of substitution IPCC 2021 (GWP100)	
Nitrogen	kg	Not publicly available	market for nitrogen, liquid	RER	3.9.1 Allocation at the point of substitution IPCC 2021 (GWP100)	
Oilvine	kg	Not publicly available	market for silica sand	GLO	3.9.1 Allocation at the point of substitution IPCC 2021 (GWP100)	
Oxygen	m ³	Not publicly available	market for oxygen, liquid, Umrechnung mit Dichte von 1,429 kg/m ³	RER	3.9.1 Allocation at the point of substitution IPCC 2021 (GWP100)	
Oxygen (renewable)	m ³	0,0002				Own Assumption for regeneratively produced oxygen
Pallets BF	kg	Not publicly available	market for iron pellet	GLO	3.9.1 Allocation at the point of substitution IPCC 2021 (GWP100)	
Petroleum coke	kg	Not publicly available	market for petroleum coke	GLO	3.9.1 Allocation at the point of substitution IPCC 2021 (GWP100)	
Pig iron	kg	Not publicly available	market for pig iron	RER	3.9.1 Allocation at the point of substitution IPCC 2021 (GWP100)	
Pulverized lignite	kg	Not publicly available	market for lignite	RER	3.9.1 Allocation at the point of substitution IPCC 2021 (GWP100)	
Pyrite	kg	Not publicly available	not available			
Scrap	kg	Not publicly available	market for scrap steel, Europe without Switzerland & Transport über	Europe without Switzerland	3.9.1 Allocation at the point of substitution IPCC 2021 (GWP100)	
Scrap (BS1)	kg	Not publicly available	market for scrap steel, Europe without Switzerland & Transport über	Europe without Switzerland	3.9.1 Allocation at the point of substitution IPCC 2021 (GWP100)	
Selenium dioxide	kg	Not publicly available	Proxy: market for selenium	GLO	3.9.1 Allocation at the point of substitution IPCC 2021 (GWP100)	
Silico manganese	kg	Not publicly available	Proxy: market for ferromanganese, high-coal, 74.5% Mn	GLO	3.9.1 Allocation at the point of substitution IPCC 2021 (GWP100)	
Silicon metal	kg	Not publicly available	Proxy: market for silicon, metallurgical grade	GLO	3.9.1 Allocation at the point of substitution IPCC 2021 (GWP100)	
Sinter	kg	Not publicly available	market for iron sinter	GLO	3.9.1 Allocation at the point of substitution IPCC 2021 (GWP100)	
Sinter fines	kg	Not publicly available	market for iron ore, crude ore, 63% Fe	GLO	3.9.1 Allocation at the point of substitution IPCC 2021 (GWP100)	
Sodium sulfate	kg	Not publicly available	market for sodium sulfate, anhydrite	RER	3.9.1 Allocation at the point of substitution IPCC 2021 (GWP100)	
Sulfur	kg	Not publicly available	market for sulfur	GLO	3.9.1 Allocation at the point of substitution IPCC 2021 (GWP100)	
Telluride	kg	Not publicly available	Not publicly available			
Titanium sulfide	kg	Not publicly available	market for titanium	GLO	3.9.1 Allocation at the point of substitution IPCC 2021 (GWP100)	Nuas P. Eckelman MJ (2014) Life Cycle Assessment of Metals: A Scientific Synthesis. <i>PLoS ONE</i> 9(7): e101298. doi:10.1371/journal.pone.0101298
Titanium metal	kg	Not publicly available	market for titanium	GLO	3.9.1 Allocation at the point of substitution IPCC 2021 (GWP100)	Nuas P. Eckelman MJ (2014) Life Cycle Assessment of Metals: A Scientific Synthesis. <i>PLoS ONE</i> 9(7): e101298. doi:10.1371/journal.pone.0101298
Titanium sponge	kg	Not publicly available	market for titanium sponge	GLO	3.9.1 Allocation at the point of substitution IPCC 2021 (GWP100)	
Tungsten metal	kg	Not publicly available	market for tungsten concentrate	GLO	3.9.1 Allocation at the point of substitution IPCC 2021 (GWP100)	
Transport						
Lorry unspecified	tkm	Not publicly available	market for transport, freight, lorry, unspecified	RER	3.9.1 Allocation at the point of substitution IPCC 2021 (GWP100)	
Sea, bulk carrier	tkm	Not publicly available	market for transport, freight, sea, bulk carrier for dry goods	GLO	3.9.1 Allocation at the point of substitution IPCC 2021 (GWP100)	
Sea, container ship	tkm	Not publicly available	market for transport, freight, sea, container ship	GLO	3.9.1 Allocation at the point of substitution IPCC 2021 (GWP100)	
Tanker for liquified products	tkm	Not publicly available	market for transport, freight, sea, tanker for liquid goods other than	GLO	3.9.1 Allocation at the point of substitution IPCC 2021 (GWP100)	
Freight train	tkm	Not publicly available	market for transport, freight, train	Europe without Switzerland	3.9.1 Allocation at the point of substitution IPCC 2021 (GWP100)	
Inland waterways, barge	tkm	Not publicly available	market for transport, freight, inland waterways, barge	RER	3.9.1 Allocation at the point of substitution IPCC 2021 (GWP100)	
Inland waterways, barge tanker	tkm	Not publicly available	market for transport, freight, inland waterways, barge tanker	RER	3.9.1 Allocation at the point of substitution IPCC 2021 (GWP100)	
Für Berechnung Gutschriften granuliertes BFsBF/SAF Slag	kg	0,10				Outcome of the stakeholderprocess, German Federal Ministry for Economic Affairs and Climate Action (BMWi)



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