

Title The Green Value Engineering Methodology: a sustainability-driven project management tool for capital projects in pro-ess industry		
Description Supporting information: Attachment A. Simapro Impact Reference List		
The following table lists the inventories used to generate an impact database to perform quick estimates of embodied or generated GWP impacts for Green Value Engineering assessment phase of technical alternatives.		
GREEN VALUE ENGINEERING DATABASE INVENTORY		
EMBEDDED CO2		
COPPER		
COPPER CABLES		
DESCRIPTION	AREA	Simapro ID
Cu cable FG16GH2M16 3X6 [kg co2eq/m]	Cables & Equipments	Cu cable FG16GH2M16 3X6
Cu cable FG16GH2M16 3X10 [kg co2eq/m]	Cables & Equipments	Cu cable FG16GH2M16 3X10
Cu cable FG16GH2M16 3X16 [kg co2eq/m]	Cables & Equipments	Cu cable FG16GH2M16 3X16
Cu cable FG16GH2M16 3X25 [kg co2eq/m]	Cables & Equipments	Cu cable FG16GH2M16 3X25
Cu cable FG16GH2M16 3X35 [kg co2eq/m]	Cables & Equipments	Cu cable FG16GH2M16 3X35
COPPER BARS		
DESCRIPTION	AREA	Simapro ID
copper refining from copper ore [kg co2/kg]	World	copper production, cathode, solvent extraction and electrowinning process GLO
electrorefining of copper anode to obtain high grade copper cathode	World	electrorefining of copper anode GLO
production of copper anode [kg co2/kg]	World	leaching of copper concentrate, sulfates ore RoW
COPPER PROCESSES		
DESCRIPTION	AREA	Simapro ID
Cu sheet [kg co2/kg]	Europe	Cu sheet (Copper, cathode (GLO)) copper production, cathode, solvent extraction and electrowinning process Cut-off, U + copper sheet rolling
Cu wire drawn [kg co2/kg]	Europe	Cu wire drawn (Copper, cathode (GLO)) copper production, cathode, solvent extraction and electrowinning process Cut-off, U + Cu wire drawing
Cu bar [kg CO2/kg]	World	copper production, cathode, solvent extraction and electrowinning process GLO
ALUMINIUM		
ALUMINIUM INGOT		
DESCRIPTION	AREA	Simapro ID
aluminium ingot [kg co2eq/kg]	EU27, (AI Area, EFTA	aluminium, primary, ingot (AI Area, EU27 & EFTA) production, cut off U
aluminium ingot [kg co2eq/kg]	World	aluminium production, primary, ingot RoW
aluminium ingot [kg co2eq/kg]	Asia (no China), (AI Area, GCC	aluminium production, primary, ingot (AI Area, Asia, without China and GCC
aluminium ingot [kg co2eq/kg]	Africa	aluminium production, primary, ingot (AI Area, Africa
aluminium ingot [kg co2eq/kg]	Oceania	aluminium production, primary, ingot UN-OCEANIA
aluminium ingot [kg co2eq/kg]	Gulf Cooperation Council, (AI Area	aluminium production, primary, ingot (AI Area, Gulf Cooperation Council
aluminium ingot [kg co2eq/kg]	Canada	aluminium production, primary, ingot CA
aluminium ingot [kg co2eq/kg]	South America, (AI Area	aluminium production, primary, ingot (AI Area, South America
aluminium ingot [kg co2eq/kg]	Russia, (AI Area	aluminium production, primary, ingot (AI Area, Russia & RER w/o EU27 & EFTA
aluminium ingot [kg co2eq/kg]	China	aluminium production, primary, ingot CH
LIQUID ALUMINIUM (SODERBERG / PREBAKE)		
DESCRIPTION	AREA	Simapro ID
Liquid aluminium prebake [kg co2eq/kg]	Canada	aluminium production, primary, liquid, prebake CA
Liquid aluminium prebake [kg co2eq/kg]	China	aluminium production, primary, liquid, prebake CH
Liquid aluminium prebake [kg co2eq/kg]	Africa, (AI Area	aluminium production, primary, liquid, prebake (AI Area, Africa
Liquid aluminium prebake [kg co2eq/kg]	Alasino China), (AI Area, GCC	Aluminium, primary, liquid (AI Area, Asia, without China and GCC) aluminium production, primary, liquid, prebake Cut-off, U
Liquid aluminium soderberg [kg co2eq/kg]	Alasino China), (AI Area, GCC	Aluminium, primary, liquid (AI Area, Asia, without China and GCC) aluminium production, primary, liquid, Soderberg Cut-off, U
Liquid aluminium soderberg [kg co2eq/kg]	Russia, (AI Area	Aluminium, primary, liquid (AI Area, Russia & RER w/o EU27 & EFTA) aluminium production, primary, liquid, Soderberg Cut-off, U
Liquid aluminium soderberg [kg co2eq/kg]	World	Aluminium, primary, liquid (RoW) aluminium production, primary, liquid, Soderberg Cut-off, U
Liquid aluminium prebake [kg co2eq/kg]	World	aluminium production, primary, liquid, prebake RoW
Liquid aluminium prebake [kg co2eq/kg]	South America, (AI Area	Aluminium, primary, liquid (AI Area, South America) aluminium production, primary, liquid, prebake Cut-off, U
Liquid aluminium prebake [kg co2eq/kg]	Russia, (AI Area	Aluminium, primary, liquid (AI Area, Russia & RER w/o EU27 & EFTA) aluminium production, primary, liquid, prebake Cut-off, U
Liquid aluminium prebake [kg co2eq/kg]	Gulf Cooperation Council, (AI Area	aluminium production, primary, liquid, prebake (AI Area, Gulf Cooperation Council
Liquid aluminium prebake [kg co2eq/kg]	EU27, (AI Area, EFTA	Aluminium, primary, liquid (AI Area, EU27 & EFTA) aluminium production, primary, liquid, prebake Cut-off, U
Liquid aluminium soderberg [kg co2eq/kg]	EU27, (AI Area, EFTA	aluminium production, primary, liquid, Soderberg (AI Area, EU27 & EFTA
PRIMARY ALUMINIUM PROCESSES		
DESCRIPTION	AREA	Simapro ID
Al bar extrusion [kgco2eq/kg]	Europe	Section bar extrusion, aluminium (RER) processing Cut-off, U
Al sheet rolling [kgco2eq/kg]	Europe	sheet rolling, aluminium RER
PRIMARY ALUMINIUM PROCESSES (STARTING FROM INGOTS)		
DESCRIPTION	AREA	Simapro ID
Al sheet [kgco2eq/kg]	EU27, (AI Area, EFTA	Al sheet (AI Area, EU27 & EFTA)
Al bar [kgco2eq/kg]	EU27, (AI Area, EFTA	Al bar (AI Area, EU27 & EFTA)
RECYCLED ALUMINIUM		
DESCRIPTION	AREA	Simapro ID
cast aluminium billet [kg co2eq/kg]	Europe	treatment of aluminium scrap, post-consumer, prepared for recycling, at refiner
RECYCLED ALUMINIUM PROCESSES		
DESCRIPTION	AREA	Simapro ID
Al bar recycled [kgco2/kg]	Europe	Al bar riciclat [kgco2/kg] (AI Area, EU27 & EFTA) treatment, refining, remelting of post consumer scrap aluminium, alloying e casting to secondary billet + Al bar extrusion)
Al sheet recycled [kgco2/kg]	Europe	Al bar riciclat [kgco2/kg] (AI Area, EU27 & EFTA) treatment, refining, remelting of post consumer scrap aluminium, alloying e casting to secondary billet + Al sheet rolling)
OVERAL PROCESSED ALUMINIUM		
DESCRIPTION	AREA	Simapro ID
aluminium ingot [kg co2eq/kg]	EU27, (AI Area, EFTA	aluminium, primary, ingot (AI Area, EU27 & EFTA) production, cut off U
Primary Al sheet [kgco2eq/kg]	EU27, (AI Area, EFTA	Al sheet (AI Area, EU27 & EFTA)
Primary Al bar [kgco2eq/kg]	EU27, (AI Area, EFTA	Al bar (AI Area, EU27 & EFTA)
cast aluminium billet (secondary) [kg co2eq/kg]	Europe	treatment of aluminium scrap, post-consumer, prepared for recycling, at refiner
Al bar recycled [kgco2/kg]	Europe	Al bar riciclat [kgco2/kg] (AI Area, EU27 & EFTA) treatment, refining, remelting of post consumer scrap aluminium, alloying e casting to secondary billet + bar extrusion)
Al sheet recycled [kgco2/kg]	Europe	Al bar riciclat [kgco2/kg] (AI Area, EU27 & EFTA) treatment, refining, remelting of post consumer scrap aluminium, alloying e casting to secondary billet + Al sheet rolling)
CONCRETE		
CONCRETE		
DESCRIPTION	AREA	Simapro ID
reinforced concrete slab [kgCO2eq/m3]	World	Concrete slab production
concrete block [kg co2eq/kg]	World	concrete block production RoW, cut off U
concrete mix [kg co2 eq/m3]	World	Concrete, 20MPa (RoW) concrete production 20MPa Cut-off, U
concrete Portland [kg co2 eq/m3]	World	concrete production, 20MPa, ready-mix, with Portland cement RoW
concrete [kg co2 eq/m3]	World	concrete production, 20MPa, ready-mix, with cement, alternative constituents 21-35%
concrete for building [kg co2 eq/m3]	Switzerland	concrete production, for building construction, with cement CEM I/B CH
concrete for civil engineers [kg co2 eq/m3]	Switzerland	concrete production, for civil engineering, with cement CEM I CH
fiber reinforced concrete [kg co2 eq/m3]	Brazil	fiber-reinforced concrete, steel
POLYMERS		
POLYMER GRANULATES		
DESCRIPTION	AREA	Simapro ID
PVC polymer granulate [kg co2eq/kg]	Europe	polyvinylchloride production, emulsion polymerisation RER
PP polymer granulate [kg co2eq/kg]	Europe	polypropylene production, granulate RER
HDPE polymer granulate [kg co2eq/kg]	Europe	polyethylene production, high density, granulate RER
recycled HDPE granulate [kg co2eq/kg]	(Europe (no Switzerland)	polyethylene production, high density, granulate, recycled Europe without Switze
POLYMER PROCESSES		
DESCRIPTION	AREA	Simapro ID
PP blow molded [kg co2eq/kg]	Europe	PP blow molded [kg co2eq/kg]
PVC blow molded [kg co2eq/kg]	Europe	PVC blow molded [kg co2eq/kg]
HDPE blow molded [kgco2eq/kg]	Europe	HDPE blow molded [kgco2eq/kg]
HDPE calendared rigid sheet [kgco2eq/kg]	Europe	HDPE calendared [kgco2eq/kg]
PP calendared rigid sheet [kgco2eq/kg]	Europe	PP calendared [kgco2eq/kg]
PVC calendared rigid sheet [kgco2eq/kg]	Europe	PVC calendared [kgco2eq/kg]
HDPE extruded plastic pipe [kgco2eq/kg]	Europe	HDPE extrusion plastic pipe [kgco2eq/kg]
PP extruded plastic pipe [kgco2eq/kg]	Europe	PP extruded plastic pipe [kgco2eq/kg]
PVC extruded plastic pipe [kgco2eq/kg]	Europe	PVC extruded plastic pipe [kgco2eq/kg]
HDPE injection molded [kgco2eq/kg]	Europe	HDPE injection molded [kgco2eq/kg]
PP injection molded [kgco2eq/kg]	Europe	PP injection molded [kgco2eq/kg]
PVC injection molded [kgco2eq/kg]	Europe	PVC injection molded [kgco2eq/kg]
Synthetic rubber blow molded	Europe	Synthetic rubber blow molded [kg CO2/kg]
Synthetic rubber calendared	Europe	Synthetic rubber calendared [kg CO2/kg]
Synthetic rubber blow molded	Europe	Synthetic rubber injection plastic pipe [kg CO2/kg]
Synthetic rubber blow molded	Europe	Synthetic rubber injection molded [kg CO2/kg]
PLSTIC COMPOSITES		
GLASS FIBER REINFORCED PLASTICS		
DESCRIPTION	AREA	Simapro ID
glass fiber Polyester resin [kgco2eq/kg]	Europe	glass fiber reinforced plastic production, polyester resin, hand lay-up RER
glass fiber plastics potting [kg co2/kg]	Europe	glass fiber reinforced plastic production, polyamide, injection molded RER
STEEL		
CAST STEEL (READY FOR MANUFACTURING)		
DESCRIPTION	AREA	Simapro ID
reinforcing steel hot rolling [kgco2 eq/kg]	Europe (no Austria)	reinforcing steel production Europe without Austria
stainless steel [kg co2 eq/kg]	Europe (no Austria)	steel production, electric, chromium steel 18/8 RER
secondary low alloyed steel [kg co2 eq/kg]	Europe (no Switzerland and Austria)	steel production, electric, low alloyed Europe without Switzerland and Austria
primary low alloyed steel [kgco2eq/kg]	Europe	steel production, converter, low alloyed RER
steel unalloyed [kg co2 eq/kg]	Europe	steel production, converter, unalloyed RER
STEEL SHEET		
DESCRIPTION	AREA	Simapro ID
steel sheet [kg co2eq/kg]	Europe	primary low alloyed Steel sheet
steel sheet [kg co2eq/kg]	Europe (no Switzerland and Austria)	secondary low alloyed Steel sheet
steel sheet [kg co2eq/kg]	Europe	unalloyed steel sheet
steel sheet [kg co2eq/kg]	Europe (no Austria)	stainless steel sheet
STEEL SECTION BAR		
DESCRIPTION	AREA	Simapro ID
steel section bar [kg co2 eq/kg]	Europe	primary low alloyed Steel section bar
steel section bar [kg co2 eq/kg]	Europe (no Switzerland and Austria)	secondary low alloyed Steel section bar
steel section bar [kg co2 eq/kg]	Europe	steel section bar unalloyed
steel section bar [kg co2 eq/kg]	Europe (no Austria)	stainless steel section bar
PIPE DRAWN STEEL		
DESCRIPTION	AREA	Simapro ID
pipe steel drawn [kg co2eq/kg]	Europe	pipe drawn unalloyed steel
pipe steel drawn [kg co2eq/kg]	Europe (no Switzerland and Austria)	pipe drawn secondary low alloyed steel
pipe steel drawn [kg co2eq/kg]	Europe	pipe drawn primary low alloyed steel
pipe steel drawn [kg co2eq/kg]	Europe (no Austria)	pipe drawn stainless steel
HOT ROLLED STEEL FOR BEAMS		
DESCRIPTION	AREA	Simapro ID
hot rolled un-alloyed steel [kg co2eq/kg]	Europe	hot rolled un-alloyed steel
hot rolled primary alloyed steel [kg co2eq/kg]	Europe	hot rolled primary alloyed steel
hot rolled stainless steel [kg co2eq/kg]	Europe (no Switzerland and Austria)	hot rolled secondary alloyed steel
hot rolled secondary alloyed steel [kg co2eq/kg]	Europe (no Austria)	hot rolled stainless steel
FORGED STEEL		
DESCRIPTION	AREA	Simapro ID
forged primary alloyed steel [kg co2eq/kg]	Europe	forged primary alloyed steel
forged secondary alloyed steel [kg co2eq/kg]	Europe (no Switzerland and Austria)	forged secondary alloyed steel
forged unalloyed steel [kg co2eq/kg]	Europe	forged unalloyed steel
forged stainless steel [kg co2eq/kg]	Europe (no Austria)	forged stainless steel
GENERATED CO2 (UTILITIES)		
WATER		
WATER		
DESCRIPTION	AREA	Simapro ID
decarbonized water [kgco2/kg]	World	water production, decarbonised RoW
desminerized water [kgco2eq/kg]	Europe (no Switzerland)	desminerized water (demineralised)
ultrapure water production [kgco2/kg]	Europe	ultrapure water
water pump operation, diesel [kg co2eq/MJ]	World	water pump operation, diesel RoW
completely softened water [kgco2/kg]	Europe (no Switzerland)	water production, completely softened RER
tap water [kgco2eq/kg]	Europe (no Switzerland)	tap water production, conventional treatment Europe without Switzerland
WASTE WATER TREATMENT		
WASTE WATER TREATMENT		
DESCRIPTION	AREA	Simapro ID
Averaged WWT impact from pulp and wood production [kgCO2/m3]	Europe	Averaged value between: Wastewater from hard fibreboard production (RER) and Wastewater from medium density board production (RER)
Averaged WWT impact from pulp and wood production [kgCO2/m3]	World	Averaged value between: Wastewater from hard fibreboard production (RoW), Wastewater from medium density board production (RoW) and Wastewater from soft fibreboard production (RoW)
Averaged WWT impact from biologic substances production [kgCO2/m3]	World	Averaged value between: Wastewater from anaerobic digestion of whey (RoW), and Wastewater from vegetable oil refinery (GLO)
Averaged WWT impact from ceramic production [kgCO2/m3]	World	Averaged value between: Wastewater from ceramic production (RoW), Wastewater from concrete production (RoW), Wastewater from glass production (RoW) and Wastewater from ground granulated blast furnace slag production (RoW)
Averaged WWT impact from metals production [kgCO2/m3]	World	Average value between: Wastewater from black chrome coating (RoW), Wastewater from cathode ray tube production (RoW), Wastewater from pig iron production (RoW)
Averaged WWT impact from plywood [kgCO2/m3]	World	Averaged value between: Wastewater from particleboard production, Wastewater from plywood production
Averaged WWT impact from semiconductor production [kgCO2/m3]	World	Averaged value between: Wastewater from PV cell production (RoW), Wastewater from water fabrication (RoW)
Averaged WWT impact from unpolluted water [kgCO2/m3]	World	Averaged value - Wastewater, unpolluted (RoW)
Averaged WWT impact from rain water [kgCO2/m3]	World	Averaged value between: Wastewater, from residence (RoW), Rainwater mineral oil storage
Averaged WWT impact [kgCO2/m3]	World	Wastewater, average (RoW)
Averaged WWT impact [kgCO2/m3]	Europe (no Switzerland)	Wastewater, average (Europe without Switzerland)
ELECTRICITY AND STEAM		
ELECTRICITY AND STEAM		
DESCRIPTION	AREA	Simapro ID
Electricity mix medium voltage [kg CO2/ MJ]	Italy	electricity voltage transformation from high to medium voltage IT
Electricity production from natural gas, combined cycle [kg CO2/MJ]	Italy	electricity production, natural gas, combined cycle power plant IT
Steam production, in chemical industry [kg CO2/kg]	Italy	steam production, in chemical industry RER
CHEMICALS		
CHEMICALS		
DESCRIPTION	AREA	Simapro ID
Phosphoric acid production (industrial grade), obtained from fertiliser grade	Europe	purification of wet-process phosphoric acid to industrial grade, product in 85%
Phosphoric acid produced from phosphate rock [kgco2/kg]	Europe	phosphoric acid production, dihydrate process RER
sulfuric acid production from sulfur [kg co2/kg]	Europe	sulfuric acid production RER
nitric acid from ammonia oxidation (Oswald process) [kgCO2/kg]	Europe (no Russia)	Nitric acid, without water, in 50% solution state (RER w/o RU) nitric acid production, product in 50% solution state Cut-off, U
hydrochloric acid production from Mannheim process [kg co2/kg]	Europe	Mannheim process RER
hydrochloric acid production [kg co2/kg]	Europe	hydrochloric acid production, from the reaction of hydrogen with chlorine RER
Ethanol from ethylene hydration [kgco2/kg]	Europe	Ethanol, without water, in 99.7% solution state, from ethylene (RER) ethylene hydration Cut-off, U
Soap from coconut or palm oil [kg co2/kg]	Europe	Soap (RER) production Cut-off, U
sodium hydroxide	Europe	Sodium hydroxide (50% NaOH) (mix), at plant/RER Mass
chlorine [kgco2/kg]	Europe	Chlorine, gaseous (RER) chlor-alkali electrolysis, membrane cell Cut-off, U
chlorine [kgco2/kg]	Europe	Chlorine, gaseous (RER) chlor-alkali electrolysis, diaphragm cell Cut-off, U
Chloric acid [kg co2/kg]	Europe	Chloric acid (RER) production Cut-off, U
Lactic acid [kg co2/kg]	Europe	Lactic acid (RER) production Cut-off, U (acetaldehyde with hydrogen cyanide followed by hydrolysis of lactonitrile)