

Title		
The Green Value Engineering Methodology: a sustainable-by-driven project management tool for capital projects in pro-cons 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 3X15 (kg co2eq/m)	Cables & Equipments	Cu cable FG16GH2M16 3X15
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 electrorefining process GLO
Electrorefining of copper anode to obtain high grade copper cathode	World	electrorefining of copper anode GAO
Production of copper anode (kg co2/kg)	World	leaching of copper concentrate, sulfate 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 electrorefining 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 electrorefining process Cut-off, U + Cu wire drawing
Cu bar (kg co2/kg)	World	copper production, cathode, solvent extraction and electrorefining 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, (AI Area)	aluminium production, primary, ingot (AI Area, Africa)
aluminium ingot (kg co2eq/kg)	Oceania	aluminium production, primary, ingot (AI Area, 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 CN
LIQUID ALUMINIUM (SODERBERG / PREBRIK)		
DESCRIPTION	AREA	Simapro ID
Liquid aluminium prebriks (kg co2eq/kg)	Canada	aluminium production, primary, liquid, prebriks CA
Liquid aluminium prebriks (kg co2eq/kg)	China	aluminium production, primary, liquid, prebriks CN
Liquid aluminium prebriks (kg co2eq/kg)	Africa, (AI Area)	aluminium production, primary, liquid, prebriks (AI Area, Africa)
Liquid aluminium prebriks (kg co2eq/kg)	Asia (no China), (AI Area, GCC)	Aluminium, primary, liquid (AI Area, Asia, without China and GCC) aluminium production, primary, liquid, prebriks Cut-off, U
Liquid aluminium prebriks (kg co2eq/kg)	Russia, (AI Area, GCC)	Aluminium, primary, liquid (AI Area, Russia & RER w/o EU27 & EFTA) aluminium production, primary, liquid, prebriks Cut-off, U
Liquid aluminium prebriks (kg co2eq/kg)	World	Aluminium, primary, liquid (RoW) aluminium production, primary, liquid, Soderberg Cut-off, U
Liquid aluminium prebriks (kg co2eq/kg)	World	aluminium production, primary, liquid, prebriks RoW
Liquid aluminium prebriks (kg co2eq/kg)	South America, (AI Area)	Aluminium, primary, liquid (AI Area, South America) aluminium production, primary, liquid, prebriks Cut-off, U
Liquid aluminium prebriks (kg co2eq/kg)	Russia, (AI Area)	Aluminium, primary, liquid (AI Area, Russia & RER w/o EU27 & EFTA) aluminium production, primary, liquid, prebriks Cut-off, U
Liquid aluminium prebriks (kg co2eq/kg)	Gulf Cooperation Council, (AI Area)	aluminium production, primary, liquid, prebriks (AI Area, Gulf Cooperation Council)
Liquid aluminium prebriks (kg co2eq/kg)	EU27, (AI Area, EFTA)	Aluminium, primary, liquid (AI Area, EU27 & EFTA) aluminium production, primary, liquid, prebriks Cut-off, U
Liquid aluminium prebriks (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 (kg co2eq/kg)	Europe	section bar extrusion, aluminium (RER) processing Cut-off, U
Al sheet rolling (kg co2eq/kg)	Europe	sheet rolling, aluminium RER
PRIMARY ALUMINIUM PROCESSES (STARTING FROM INGOTS)		
DESCRIPTION	AREA	Simapro ID
Al sheet (kg co2eq/kg)	EU27, (AI Area, EFTA)	Al sheet (AI Area, EU27 & EFTA)
Al bar (kg co2eq/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 (kg co2/kg)	Europe	Al bar recycled (kg co2/kg) (AI Area, EU27 & EFTA) treatment, refining, remelting of post consumer scrap aluminium, alloying & casting to secondary billet + Al bar extrusion
Al sheet recycled (kg co2/kg)	Europe	Al bar recycled (kg co2/kg) (AI Area, EU27 & EFTA) treatment, refining, remelting of post consumer scrap aluminium, alloying & casting to secondary billet + Al sheet rolling
OVERALL 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 (kg co2eq/kg)	EU27, (AI Area, EFTA)	Al sheet (AI Area, EU27 & EFTA)
Primary Al bar (kg co2eq/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 (kg co2/kg)	Europe	Al bar recycled (kg co2/kg) (AI Area, EU27 & EFTA) treatment, refining, remelting of post consumer scrap aluminium, alloying & casting to secondary billet + bar extrusion
Al sheet recycled (kg co2/kg)	Europe	Al bar recycled (kg co2/kg) (AI Area, EU27 & EFTA) treatment, refining, remelting of post consumer scrap aluminium, alloying & casting to secondary billet + Al sheet rolling
CONCRETE		
CONCRETE		
DESCRIPTION	AREA	Simapro ID
reinforced concrete slab (kg CO2eq/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 BSW
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)	World	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 polymer granulate (kg co2eq/kg)	Europe (no Switzerland)	polyethylene production, high density, granulate, recycled Europe without Switze
POLYMER PROCESSES		
DESCRIPTION	AREA	Simapro ID
PP blow moulded (kg co2eq/kg)	Europe	PP blow moulded (kg co2eq/kg)
PVC blow moulded (kg co2eq/kg)	Europe	PVC blow moulded (kg co2eq/kg)
HDPE blow moulded (kg co2eq/kg)	Europe	HDPE blow moulded (kg co2eq/kg)
HDPE calendered rigid sheet (kg co2eq/kg)	Europe	HDPE calendered (kg co2eq/kg)
PP calendered rigid sheet (kg co2eq/kg)	Europe	PP calendered (kg co2eq/kg)
PVC calendered rigid sheet (kg co2eq/kg)	Europe	PVC calendered (kg co2eq/kg)
HDPE extruded plastic pipe (kg co2eq/kg)	Europe	HDPE extrusion plastic pipe (kg co2eq/kg)
PP extruded plastic pipe (kg co2eq/kg)	Europe	PP extruded plastic pipe (kg co2eq/kg)
PVC extruded plastic pipe (kg co2eq/kg)	Europe	PVC extruded plastic pipe (kg co2eq/kg)
HDPE injection moulded (kg co2eq/kg)	Europe	HDPE injection moulded (kg co2eq/kg)
PP injection moulded (kg co2eq/kg)	Europe	PP injection moulded (kg co2eq/kg)
PVC injection moulded (kg co2eq/kg)	Europe	PVC injection moulded (kg co2eq/kg)
Synthetic rubber blow moulded	Europe	Synthetic rubber blow moulded (kg CO2/kg)
Synthetic rubber calendered	Europe	Synthetic rubber calendered (kg CO2/kg)
Synthetic rubber blow moulded	Europe	Synthetic rubber extrusion plastic pipe (kg CO2/kg)
Synthetic rubber injection moulded	Europe	Synthetic rubber injection moulded (kg CO2/kg)
PLASTIC COMPOSITES		
GLASS FIBER REINFORCED PLASTICS		
DESCRIPTION	AREA	Simapro ID
glass fiber polyester resin (kg co2eq/kg)	Europe	glass fiber reinforced plastic production, polyester resin, hand lay-up RER
glass fiber plastics polyamide (kg co2/kg)	Europe	glass fiber reinforced plastic production, polyamide, injection moulded RER
STEEL		
CAST STEEL (READY FOR MANUFACTURING)		
DESCRIPTION	AREA	Simapro ID
reinforcing steel hot rolling (kg co2 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 1.43 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 (kg co2eq/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 unalloyed steel (kg co2eq/kg)	Europe	hot rolled unalloyed steel
hot rolled primary alloyed steel (kg co2eq/kg)	Europe	hot rolled primary alloyed steel
hot rolled secondary alloyed 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 (kg co2/kg)	World	water production, decarbonized RoW
deionized water (kg co2eq/kg)	Europe (no Switzerland)	deionized water (demineralized)
ultrapure water production (kg co2/kg)	Europe	ultrapure water
water pump operation, diesel (kg co2eq/MJ)	World	water pump operation, diesel RoW
completely softened water (kg co2/kg)	Europe (no Switzerland)	water production, completely softened RER
tap water (kg co2eq/kg)	Europe (no Switzerland)	tap water production, conventional treatment Europe without Switzerland
WASTE WATER TREATMENT		
WASTE WATER TREATMENT		
DESCRIPTION	AREA	Simapro ID
Average WWTP impact from pulp and wood production (kg CO2/m3)	World	Average value between: Wastewater from hard fibreboard production (RER) and Wastewater from medium density board production (RER)
Average WWTP impact from pulp and wood production (kg CO2/m3)	World	Average value between: Wastewater from hard fibreboard production (RoW), Wastewater from medium density board production (RoW) and Wastewater from soft fibreboard production (RoW)
Average WWTP impact from biologic substances production (kg CO2/m3)	World	Average value between: Wastewater from anaerobic digestion of whey (RoW), and Wastewater from vegetable oil refinery (GLO)
Average WWTP impact from ceramic production (kg CO2/m3)	World	Average 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)
Average WWTP impact from metal production (kg CO2/m3)	World	Average value between: Wastewater from black chrome coating (RoW), Wastewater from cathode ray tube production (RoW), Wastewater from pig iron production (RoW)
Average WWTP impact from plywood/particle board production (kg CO2/m3)	World	Average value between: Wastewater from particleboard production, Wastewater from plywood production
Average WWTP impact from semiconductor production (kg CO2/m3)	World	Average value between: Wastewater from PV cell production (RoW), Wastewater from water fabrication (RoW)
Average WWTP impact from unpolluted water (kg CO2/m3)	World	Average value - Wastewater, unpolluted (RoW)
Average WWTP impact from residential/rain water (kg CO2/m3)	World	Average value between: Wastewater, from residence (RoW), Rainwater mineral oil storage
Average WWTP impact (kg CO2/m3)	World	Wastewater, average (RoW)
Average WWTP impact (kg CO2/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 fertilizer grade	Europe	purification of wet-process phosphoric acid to industrial grade, produce in 85%
Phosphoric acid produced from phosphate rock (kg co2/kg)	Europe	phosphoric acid production, dry/dihydrate process RER
sulfuric acid production from sulfur (kg co2/kg)	Europe	sulfuric acid production RER
nitric acid from ammonia oxidation (Oswald process) (kg CO2/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 (kg co2/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) (min), at plant/RER Mass
chlorine (kg co2/kg)	Europe	Chlorine, gaseous (RER) chlor-alkali electrolysis, membrane cell Cut-off, U
chlorine (kg co2/kg)	Europe	Chlorine, gaseous (RER) chlor-alkali electrolysis, diaphragm cell Cut-off, U
citric acid (kg co2/kg)	Europe	Citric acid (RER) production Cut-off, U
Lactic acid (kg co2/kg)	Europe	Lactic acid (RER) production Cut-off, U lactaldehyde with hydrogen cyanide followed by hydrolysis of lactonitrile