

Appendix A – Life cycle inventory of the Reference cases

A1 Pulp & Paper Bio-sludge Case Study

Table 64 (A1)- Life Cycle Inventory of Reference Case for Pulp & Paper Bio-sludge Case Study

Process	Sub-process	Unit process - Input	Values	Units	Type of source	Unit process - Output	Sub-process	Values	Units	Type of source		
UPSTREAM	Land Use Change	Forest land transormation	8,46E-03	m2	Foreground	Biological sludge (3,5%, DM)	Product	9,89E-02	t wb/tADp	Foreground		
		Occupation, industrial area	1,55E-04	m2a	Foreground	Treated water stream	Product	1,79E+01	t/tADp	Background		
	Waste Water Treatament	WWT	Waste water from idustrial process	1,80E+01	t/tADp	Background						
			Urea (46%)	5,69E-01	kg/tADp	Foreground						
			Phosphoric acid (85%)	1,72E-01	kg/tADp	Foreground						
			Building construction	1,55E-04	m2/tADp	Foreground						
			Pipeline long distance	1,26E-07	km/tADp	Foreground						
			Electricity/heat	Electricity, medium voltage, Sweden country-mix	8,00E+00	kWh/tADp	Background					
	Concentrated biosludge	Biogenic residues (Mixed sludge, DM 2,39%)	Biological sludge (3,5%, DM)	9,89E-02	t wb/tADp	Foreground	Concentrated mixed sludge (DM 8%) - after gravity table	Product	1,08E-01	t wb/tADp	Foreground	
			Fiber sludge stream (DM 1,65%)	3,15E-01	t wb/tADp	Foreground						
		Gravity table	Steel, low-alloyed	9,05E-05	kg/tADp	Background						
		Electricity/heat	Electricity, medium voltage, Sweden country-mix	3,31E+00	kWh/tADp	Background						
	MAIN STREAM	Dewatering	Concentrated sludge	Concentrated mixed sludge (DM 8%) - after gravity table	1,08E-01	t wb/tADp	Foreground	SOLIDS (30% DM) - after screw press	Product	2,74E-02	t wb/tADp	Foreground
			Chiemicals	Iron sulfate (40%)	6,54E-01	kg db/tADp	Foreground	Waste water in output from wire screw press	Product	8,08E-02	t wb/tADp	Calculated
Polyacrylamide				3,85E-02	kg db/tADp	Foreground						
Screw press			Steel, low-alloyed	7,96E-05	kg/tADp	Background						
			Electricity, medium voltage, Sweden country-mix	1,08E+00	kWh/tADp	Background						
Biomass boiler Kyaerner BFB "Hybex" [132MW, 50kg/s (Smurfit Kappa Pitea, Technical Presentation, 2016)]		Feedstock to biomass boiler	SOLIDS (30% DM) - after screw press	2,74E-02	t wb/tADp	Foreground	Energy-Heat-Steam (Available thermal power)	Product	1,00E+02	MJ/tADp	Calculated	
		Acid neutralizer	Sodium hydroxide in 50% solution state	5,55E-01	kg/t ADp	Background	NMVOC, non-methane volatile organic compounds, unspecified origin	Emission to Air	3,76E-05	kg/tADp	Background	
		NOx removal	Ammonia, liquid	1,71E-02	kg/t ADp	Background	Particulates, > 10 um	Emission to Air	4,14E-05	kg/tADp	Background	
		Flou Gas Cleaning	Water, deionised	4,25E-01	t /tADp	Background	Water	Emission to Air	2,96E-03	m3/tADP	Background	
		Biomass boiler	Steel, low-alloyed	3,92E-05	kg/t ADp	Calculated	Water	Emission to Water	2,67E-03	m3/tADP	Background	
		Electricity/heat	Electricity, medium voltage, Sweden country-mix	4,22E+00	kWh/tADp	Background	Ash from paper production sludge	Waste to treatment	6,85E-03	t/tADp	Background	
Electric power production by Steam Turbine		Energy-Heat-Steam	Energy-Heat-Steam (Available thermal power)	1,00E+02	MJ/tADp	Calculated	Electric power production	Product	5,56E+00	kWh/tADp	Background	
		Steam Turbine	Steel, low-alloyed	8,46E-04	kg/t ADp	Background	Heat, central or small-scale, natural gas	Product	5,17E+00	kWh/tADp	Background	

A2 Virgin Olive Pomace Case Study

Table 65 (A2) - Life Cycle Inventory of Reference Case for Virgin Olive Pomace Case Study

	Process	Sub-process	Unit process - Input	Values	Units	Type of source	Unit process - Output	Sub-process	Values	Units	Type of source
UPSTREAM	Preconditioning	Biogenic residue	Virgin olive pomace (ar, DM 19,36%)	1,00E+00	t OP	Foreground	Pre-conditioned olive pomace (destoned and diluted) DM 3,26%	Product	3,55E+00	t wb/tOP	Calculated
		Destoning	Steel, low-alloyed	6,94E-03	kg/tOP	Background	Olive's stones recovered	Product	8,05E-02	t wb/tOP	Background
		Dilution	Tap water	2,63E+00	kg/Top	Background					
		Electricity/heat	Electricity, medium voltage, Italy country-mix	6,34E+00	kWh/top	Background/Foreground					
MAIN STREAM	Anaerobic digestion	Feedstock	Pre-conditioned olive pomace (destoned and diluted) DM 3,26%	3,55E+00	twb/tOP	Calculated	Biogas from anaerobic digestion	Products	1,07E+01	Nm3/tOP	Background
		Biogas production process	Biogas anaerobic digestion of manure	1,07E+01	Nmc/tOP	Background	Digestate	Products	4,87E+03	kg/tOP	Background
		Landfarming	Treatment of refinery sludge by landfarming	4,87E+03	kg/tOP	Background					
		IRON SPONGE BED technology for H2S Gas Cleaning	Iron pellet	1,61E-04	kgFe2O3/tOP	Calculated					
	Silica sand		6,05E-05	kgSiO2/tOP	Calculated						
	Oxygen, liquid		4,84E-05	kgO2/tOP	Calculated						
	DOWNSTREAM	Electricity production from biogas	Feedstock	Biogas from anaerobic digestion	1,07E+01	m3/tOP	Background	Electricity, HV by heat and power co-generation, biogas, gas engine-100%	Product	2,72E+02	kWh el/tOP
Gas engine			Electricity, high voltage (IT) heat and power co-generation, biogas, gas engine/m3 BIOGAS	1,07E+01	m3/tOP	Background	Heat, central or small-scale, natural gas	Avoided product - Scenario 100%	4,67E+02	kWh th/tOP	Background
			Avoided product - Scenario 80%	3,73E+02	kWh th/tOP	Background					
Transformation from High to Medium Voltage		Electricity High Voltage	ELECTRICITY, HIGH VOLTAGE BY HEAT AND POWER CO-GENERATION, BIOGAS, GAS ENGINE	2,72E+02	kWh/tADp	Background	Electricity MV from heat and power co-generation	Product	2,70E+02	kWh/tOP	Background
		Electricity transforation	Electricity voltage transformation from high to medium voltage (IT)	2,72E+02	kWh/tADp	Background					

A3 Fruit & Vegetable (Orange Peels) Case Study

Table 66 (A3) - Life Cycle Inventory of Reference Case for Fruit & Vegetable (Orange Peels) Case Study

	Process	Sub-process	Unit process-Input	Values	Units	Source	Unit process-Output	Sub-process	Values	Units	Source
UPSTREAM	Preconditioning	Biogenic residue	Virgin orange peels (ar, DM 20%)	1,00E+00	t ORP	Foreground	Pre-conditioned orange peels (grinded and diluted) DM 10%	Product	2,00E+00	t wb/tORP	Foreground/Calculated
		Grinding	Steel, low-alloyed	2,89E-02	kg/tORP	Background					
		Dilution	Tap water	1,00E+00	kg/tORP	Calculated					
		Electricity/heat	Electricity, medium voltage, Italy country-mix	3,33E-01	kWh/tORP	Background/Foreground					
MAIN STREAM	Anaerobic digestion	Feedstock	Pre-conditioned orange peels (grinded and diluted) DM 10%	2,00E+00	twb/tORP	Foreground/Calculated	Biogas from anaerobic digestion	Products	5,74E+01	Nm3/tORP	Background
		Biogas production process	Biogas anaerobic digestion of manure /kWh	5,74E+01	Nmc/tORP	Background	Digestate	Products	2,74E+03	kg/tORP	Background
		Landfarming	Treatment of refinery sludge by landfarming	2,74E+03	kg/tOP	Background					
		IRON SPONGE BED technology for H2S Gas Cleaning	Iron pellet	6,78E+00	kgFe2O3/tORP	Calculated					
			Silica sand	2,55E+00	kgSiO2/tORP	Calculated					
			Oxygen, liquid	2,04E+00	kgO2/tORP	Calculated					
		DOWNSTREAM	Electricity production from biogas	Feedstock	Biogas from anaerobic digestion	5,74E+01	m3/tOP	Background	Electricity, HV by heat and power co-generation, biogas, gas engine-100%	Product	1,17E+03
Gas engine	Electricity, high voltage (IT) heat and power co-generation, biogas, gas engine/m3 BIOGAS			5,74E+01	m3/tOP	Background	Heat, central or small-scale, natural gas	Avoided product - Scenario 100%	2,01E+03	kWh th/tOP	Background
								Avoided product - Scenario 54%	1,09E+03	kWh th/tORP	Background
Transformation from High to Medium Voltage	Electricity High Voltage		ELECTRICITY, HIGH VOLTAGE BY HEAT AND POWER CO-GENERATION, BIOGAS, GAS ENGINE	1,17E+03	kWh/tADp	Background	Electricity MV from heat and power co-generation	Product	1,16E+03	kWh/tADp	Background
	Electricity transforation		Electricity voltage transformation from high to medium voltage (IT)	1,17E+03	kWh/tADp	Background					

Appendix C – Analysis of the substances and process distribution in the single impact categories

Table 67 (C1) - Pulp & Paper Bio-sludge F-CUBED Production System

Substances	Compartment	Units	Total	Upstream processes				Main stream processes				Downstream processes			Filtrate (liquid fraction) processing		
				Biological sludge	Treated water stream	Enhanced Bio-sludge	Waste water from decanter-centrifuge	TORWASH effluent	Dewatering PRESS CAKE (Solids)	Dewatering FILTRATE (Liquid fraction)	PELLETIZING phase	Biomass boiler (combustion)	Electricity production system	Anaerobic digestion	Digestate	ELECTRICITY generation from biogas (HV)	ELECTRICITY voltage transformation (MV)
Ozone depletion																	
Total of all compartments		kg CFC-11 eq	4,88E-06	6,61E-07	-	6,33E-07	3,33E-08	6,45E-07	6,53E-07	-	7,45E-07	8,85E-07	5,60E-07	-8,48E-08	-	-1,74E-07	3,27E-07
Remaining substances		kg CFC-11 eq	1,31E-07	6,76E-08	-	6,44E-08	3,39E-09	6,48E-08	6,52E-08	-	7,61E-08	9,07E-08	-6,81E-08	-1,66E-08	-	-1,14E-07	-1,02E-07
Ethane, 1,2-dichloro-1,1,2,2-tetrafluoro-, CFC-114	Air	kg CFC-11 eq	2,90E-06	3,27E-07	-	3,15E-07	1,66E-08	3,24E-07	3,32E-07	-	3,54E-07	3,92E-07	3,85E-07	-4,99E-09	-	-3,71E-09	4,59E-07
Methane, bromotrifluoro-, Halon 1301	Air	kg CFC-11 eq	1,52E-06	2,37E-07	-	2,25E-07	1,18E-08	2,26E-07	2,27E-07	-	2,80E-07	3,61E-07	2,04E-07	-6,00E-08	-	-1,05E-07	-9,08E-08
Methane, dichlorodifluoro-, CFC-12	Air	kg CFC-11 eq	1,73E-07	2,28E-08	-	2,19E-08	1,15E-09	2,25E-08	2,30E-08	-	2,64E-08	3,05E-08	2,91E-08	-1,55E-09	-	-1,68E-09	-1,13E-09
Methane, tetrachloro-, CFC-10	Air	kg CFC-11 eq	1,67E-07	7,20E-09	-	6,86E-09	3,61E-10	6,92E-09	6,94E-09	-	8,04E-09	9,89E-09	9,50E-09	-1,66E-09	-	5,08E-08	6,21E-08
Process contribution (%)				13,54%	0,00%	12,97%	0,68%	13,20%	13,38%	0,00%	15,25%	18,12%	11,46%	-1,74%	0,00%	-3,55%	6,69%
Sum					27,19%				41,83%			29,58%			1,40%		
Human toxicity																	
Total of all compartments		kg 1,4-DB eq	1,46E+01	1,12E+00	-	1,07E+00	5,61E-02	1,08E+00	1,09E+00	-	1,50E+00	2,93E+00	2,71E+00	-4,44E-01	-	1,42E+00	2,07E+00
Remaining substances		kg 1,4-DB eq	1,07E+00	1,28E-01	-	1,22E-01	6,42E-03	1,23E-01	1,24E-01	-	1,67E-01	2,53E-01	2,37E-01	-7,78E-02	-	-2,10E-02	5,92E-03
Antimony	Air	kg 1,4-DB eq	2,45E-01	1,18E-02	-	1,12E-02	5,89E-04	1,13E-02	1,13E-02	-	3,94E-02	7,61E-02	7,55E-02	-4,57E-03	-	4,96E-03	7,89E-03
Arsenic	Air	kg 1,4-DB eq	7,72E-01	1,10E-01	-	1,05E-01	5,52E-03	1,06E-01	1,07E-01	-	1,23E-01	1,52E-01	1,40E-01	-4,36E-02	-	-2,82E-02	-3,82E-03
Lead	Air	kg 1,4-DB eq	7,14E-01	8,38E-02	-	7,99E-02	4,20E-03	8,05E-02	8,13E-02	-	1,06E-01	1,78E-01	1,69E-01	-3,44E-02	-	-2,38E-02	-1,10E-02
Manganese	Air	kg 1,4-DB eq	2,28E-01	4,51E-03	-	4,33E-03	2,28E-04	4,44E-03	4,52E-03	-	1,99E-02	9,13E-02	9,11E-02	-4,85E-04	-	1,67E-03	6,09E-03
Mercury	Air	kg 1,4-DB eq	7,58E-01	3,48E-02	-	3,33E-02	1,75E-03	3,40E-02	3,48E-02	-	4,55E-02	7,76E-02	7,12E-02	-5,95E-03	-	1,92E-01	2,39E-01
Vanadium	Air	kg 1,4-DB eq	5,32E-01	8,47E-02	-	8,05E-02	4,24E-03	8,06E-02	8,07E-02	-	8,30E-02	8,61E-02	8,57E-02	-2,00E-02	-	-1,59E-02	-1,77E-02
Arsenic	Water	kg 1,4-DB eq	3,06E+00	1,60E-01	-	1,53E-01	8,04E-03	1,55E-01	1,56E-01	-	1,88E-01	8,33E-01	8,16E-01	-4,89E-02	-	2,59E-01	3,81E-01
Barium	Water	kg 1,4-DB eq	5,21E-01	1,07E-01	-	1,02E-01	5,37E-03	1,03E-01	1,03E-01	-	1,18E-01	1,40E-01	5,74E-02	-4,48E-02	-	-8,76E-02	-8,22E-02
Lead	Water	kg 1,4-DB eq	3,62E-01	3,11E-02	-	2,96E-02	1,56E-03	2,98E-02	3,01E-02	-	3,40E-02	4,16E-02	3,80E-02	-1,63E-02	-	6,29E-02	7,95E-02
Manganese	Water	kg 1,4-DB eq	5,66E+00	3,41E-01	-	3,25E-01	1,71E-02	3,30E-01	3,34E-01	-	5,50E-01	8,54E-01	7,86E-01	-1,39E-01	-	9,54E-01	1,30E+00
Molybdenum	Water	kg 1,4-DB eq	4,47E-01	1,20E-02	-	1,15E-02	6,06E-04	1,17E-02	1,18E-02	-	1,48E-02	1,34E-01	1,33E-01	-4,59E-03	-	5,30E-02	6,91E-02
Zinc	Water	kg 1,4-DB eq	2,38E-01	8,97E-03	-	8,55E-03	4,50E-04	8,62E-03	8,70E-03	-	1,10E-02	1,59E-02	1,47E-02	-4,32E-03	-	7,42E-02	9,07E-02
Process contribution (%)				7,66%	0,00%	7,30%	0,38%	7,38%	7,45%	0,00%	10,28%	20,09%	18,59%	-3,04%	0,00%	9,76%	14,15%
Sum					15,34%				25,11%			38,69%			20,86%		
Freshwater ecotoxicity																	
Total of all compartments		kg 1,4-DB eq	1,67E+00	1,44E-01	-	1,37E-01	7,22E-03	1,39E-01	1,41E-01	-	1,64E-01	2,21E-01	1,93E-01	-6,61E-02	-	2,57E-01	3,32E-01
Remaining substances		kg 1,4-DB eq	6,12E-02	1,15E-02	-	1,09E-02	5,75E-04	1,10E-02	1,10E-02	-	1,29E-02	1,71E-02	5,89E-03	-4,74E-03	-	-8,06E-03	-6,89E-03
Cypermethrin	Soil	kg 1,4-DB eq	-3,47E-02	4,83E-05	-	4,60E-05	2,42E-06	4,62E-05	4,63E-05	-	7,92E-05	1,16E-04	1,16E-04	-1,12E-02	-	-1,09E-02	-1,31E-02
Copper	Water	kg 1,4-DB eq	1,36E+00	1,12E-01	-	1,07E-01	5,63E-03	1,08E-01	1,10E-01	-	1,26E-01	1,62E-01	1,47E-01	-4,40E-02	-	2,33E-01	2,95E-01
Manganese	Water	kg 1,4-DB eq	3,56E-02	2,15E-03	-	2,05E-03	1,08E-04	2,08E-03	2,11E-03	-	3,47E-03	5,38E-03	4,95E-03	-8,73E-04	-	6,01E-03	8,20E-03
Nickel	Water	kg 1,4-DB eq	1,53E-01	1,08E-02	-	1,03E-02	5,40E-04	1,04E-02	1,05E-02	-	1,38E-02	2,69E-02	2,55E-02	-3,97E-03	-	2,06E-02	2,75E-02
Vanadium	Water	kg 1,4-DB eq	4,02E-02	5,33E-03	-	5,07E-03	2,67E-04	5,09E-03	5,11E-03	-	5,47E-03	5,97E-03	5,82E-03	-3,93E-04	-	8,37E-04	1,61E-03
Zinc	Water	kg 1,4-DB eq	4,90E-02	1,80E-03	-	1,72E-03	9,04E-05	1,73E-03	1,75E-03	-	2,24E-03	3,25E-03	3,00E-03	-8,95E-04	-	1,54E-02	1,89E-02
Process contribution (%)				8,62%	0,00%	8,22%	0,43%	8,31%	8,44%	0,00%	9,81%	13,26%	11,55%	-3,96%	0,00%	15,43%	19,89%
Sum					17,27%				26,56%			24,81%			31,36%		
Water depletion																	
Total of all compartments		m3	1,45E+00	1,88E-01	-	1,79E-01	9,43E-03	1,87E-01	1,88E-01	-	1,90E-01	2,06E-01	2,04E-01	-4,91E-02	-	3,64E-02	1,16E-01
Remaining substances		m3	3,09E-01	2,39E-02	-	2,27E-02	1,20E-03	2,37E-02	2,41E-02	-	4,69E-02	7,64E-02	6,86E-02	-1,54E-02	-	1,44E-02	2,25E-02
Water, cooling, unspecified natural origin, RER	Raw	m3	3,68E-01	5,99E-02	-	5,69E-02	3,00E-03	5,71E-02	5,71E-02	-	5,79E-02	5,90E-02	5,87E-02	-1,46E-02	-	-1,24E-02	-1,45E-02
Water, cooling, unspecified natural origin, SE	Raw	m3	1,98E+00	2,33E-01	-	2,25E-01	1,18E-02	2,31E-01	2,36E-01	-	2,37E-01	2,39E-01	2,38E-01	-1,08E-04	-	-2,22E-04	3,29E-01
Water, river, Europe without Switzerland	Raw	m3	2,90E-02	2,20E-04	-	2,11E-04	1,11E-05	2,21E-04	2,23E-04	-	5,52E-03	5,62E-03	5,61E-03	-4,13E-05	-	4,30E-04	5,38E-04
Water, turbine use, unspecified natural origin, SE	Raw	m3	1,00E+03	1,18E+02	-	1,13E+02	5,97E+00	1,17E+02	1,19E+02	-	1,20E+02	1,20E+02	1,20E+02	-5,14E-02	-	-1,17E-01	1,70E+02
Water, RER	Water	m3	-2,34E-01	-3,77E-02	-	-3,59E-02	-1,89E-03	-3,59E-02	-3,60E-02	-	-3,69E-02	-3,81E-02	-3,78E-02	9,30E-03	-	7,78E-03	8,91E-03
Water, SE	Water	m3	-1,01E+03	-1,18E+02	-	-1,14E+02	-5,98E+00	-1,17E+02	-1,20E+02	-	-1,20E+02	-1,21E+02	-1,20E+02	5,15E-02	-	1,17E-01	-1,71E+02
Process contribution (%)				12,91%	0,00%	12,31%	0,65%	12,83%	12,91%	0,00%	13,10%	14,19%	14,02%	-3,37%	0,00%	2,50%	7,95%
Sum					25,87%				38,83%			28,21%			7,08%		
Agricultural land occupation																	
Total of all compartments		m2a	6,36E+01	9,31E-01	-	8,95E-01	4,71E-02	9,20E-01	9,38E-01	-	1,07E+01	2,17E+01	2,17E+01	-2,49E-01	-	2,37E+00	3,65E+00
Remaining substances		m2a	1,01E+00	7,00E-03	-	6,67E-03	3,51E-04	6,73E-03	6,78E-03	-	1,45E-01	3,14E-01	3,13E-01	-1,27E-01	-	1,54E-01	1,86E-01
Occupation, forest, intensive	Raw	m2a	5,78E+01	9,22E-01	-	8,87E-01	4,67E-02	9,11E-01	9,30E-01	-	1,05E+01	2,14E+01	2,14E+01	-5,47E-02	-	4,58E-02	8,67E-01
Occupation, grassland, natural, for livestock grazing	Raw	m2a	1,68E+00	5,88E-04	-	5,64E-04	2,97E-05	5,79E-04	5,89E-04	-	1,63E-03	2,94E-03	2,81E-03	-2,40E-02	-	7,69E-01	9,22E-01
Occupation, pasture, man made	Raw	m2a	3,05E+00	1,22E-03	-	1,17E-03	6,17E-05	1,20E-03	1,22E-03	-	3,14E-03	5,59E-03	5,34E-03	-4,34E-02	-	1,40E+00	1,68E+00
Process contribution (%)				1,46%	0,00%	1,41%	0,07%	1,45%	1,48%	0,00%	16,79%	34,15%	34,12%	-0,39%	0,00%	3,72%	5,74%
Sum					2,95%				19,71%			68,27%			9,07%		

Table 68 (C2) - Virgin Olive Pomace F-CUBED Production System

Substances	Compartment	Units	Total	Upstream processes		Main stream processes				Downstream processes		Filtrate (liquid fraction) processing		
				Pre-conditioning	TORWASH effluent	Dewatering PRESS CAKE (Solids)	Dewatering FILTRATE (Liquid fraction)	PELLETIZING phase	ELECTRICITY generation from pellets (HV)	ELECTRICITY voltage transformation (MV)	Anaerobic digestion	Digestate	ELECTRICITY generation from biogas (HV)	ELECTRICITY voltage transformation (MV)
Ozone depletion														
Total of all compartments		kg CFC-11 eq	-6,50E-05	4,01E-07	1,12E-06	1,33E-06	-	2,97E-06	-8,26E-05	1,09E-05	2,81E-09	-	-1,31E-05	1,40E-05
Remaining substances		kg CFC-11 eq	7,81E-07	5,15E-08	1,44E-07	1,71E-07	-	2,57E-07	-1,10E-06	1,07E-06	7,92E-11	-	-2,23E-07	4,10E-07
Ethane, 1,1,2-trichloro-1,2,2-trifluoro-, CFC-113	Air	kg CFC-11 eq	3,77E-06	1,20E-09	3,35E-09	3,97E-09	-	9,35E-09	1,72E-06	1,97E-06	5,63E-12	-	-1,10E-09	7,15E-08
Ethane, 1,2-dichloro-1,1,2,2-tetrafluoro-, CFC-114	Air	kg CFC-11 eq	1,28E-05	4,35E-08	1,22E-07	1,44E-07	-	5,55E-07	-1,36E-06	1,04E-05	1,68E-10	-	-2,63E-07	3,14E-06
Methane, bromochlorodifluoro-, Halon 1211	Air	kg CFC-11 eq	-9,01E-06	2,43E-07	6,81E-07	8,04E-07	-	9,73E-07	-4,14E-05	2,44E-05	9,38E-11	-	-6,91E-06	1,22E-05
Methane, bromotrifluoro-, Halon 1301	Air	kg CFC-11 eq	-7,62E-05	5,83E-08	1,63E-07	1,95E-07	-	1,14E-06	-4,04E-05	-2,77E-05	2,43E-09	-	-6,65E-06	-2,96E-06
Methane, tetrachloro-, CFC-10	Air	kg CFC-11 eq	2,94E-06	3,56E-09	9,99E-09	1,19E-08	-	3,15E-08	-5,79E-08	8,69E-07	3,53E-11	-	9,02E-07	1,17E-06
Process contribution (%)				-0,62%	-1,73%	-2,05%	0,00%	-4,56%	127,09%	-16,78%	0,00%	0,00%	20,21%	-21,56%
Sum				-0,62%		-8,34%			110,31%				-1,36%	
Freshwater eutrophication														
Total of all compartments		kg P eq	3,49E-01	7,89E-04	2,21E-03	2,64E-03	-	9,86E-03	-2,04E-02	1,84E-01	5,31E-06	-	5,53E-02	1,15E-01
Remaining substances		kg P eq	1,09E-03	1,59E-06	4,48E-06	5,33E-06	-	2,88E-05	2,36E-05	3,15E-04	3,01E-08	-	3,12E-04	3,96E-04
Phosphate	Water	kg P eq	3,32E-01	7,83E-04	2,19E-03	2,62E-03	-	9,23E-03	-2,76E-02	1,76E-01	5,26E-06	-	5,50E-02	1,14E-01
Phosphorus	Soil	kg P eq	1,64E-02	4,91E-06	1,38E-05	1,63E-05	-	6,01E-04	7,18E-03	8,26E-03	1,27E-08	-	-1,08E-05	3,05E-04
Process contribution (%)				0,23%	0,63%	0,75%	0,00%	2,82%	-5,84%	52,75%	0,00%	0,00%	15,82%	32,83%
Sum				0,23%		4,21%			46,91%				48,66%	
Human toxicity														
Total of all compartments		kg 1,4-DB eq	1,50E+02	5,80E-01	1,62E+00	1,96E+00	-	9,33E+00	-2,78E+01	1,13E+02	5,79E-03	-	5,25E+00	4,61E+01
Remaining substances		kg 1,4-DB eq	6,35E+00	5,95E-02	1,65E-01	2,02E-01	-	1,15E+00	-5,32E+00	5,16E+00	1,55E-03	-	9,42E-01	3,99E+00
Antimony	Air	kg 1,4-DB eq	3,16E+00	1,50E-03	4,21E-03	5,44E-03	-	5,01E-01	1,04E+00	1,38E+00	3,40E-05	-	6,35E-02	1,61E-01
Lead	Air	kg 1,4-DB eq	2,74E+00	1,57E-02	4,36E-02	5,38E-02	-	4,94E-01	-3,12E-01	2,08E+00	5,08E-04	-	-1,68E-01	5,28E-01
Manganese	Air	kg 1,4-DB eq	4,85E+00	1,60E-03	4,46E-03	5,33E-03	-	2,80E-01	2,05E+00	2,39E+00	9,78E-06	-	9,32E-03	1,09E-01
Mercury	Air	kg 1,4-DB eq	3,64E+00	9,53E-03	3,16E-02	4,90E-02	-	2,40E-01	-9,62E-01	1,41E+00	1,26E-04	-	1,09E+00	1,78E+00
Vanadium	Air	kg 1,4-DB eq	3,65E+00	1,22E-02	3,41E-02	4,04E-02	-	8,05E-02	2,33E-02	2,65E+00	2,32E-05	-	2,34E-02	7,87E-01
Cadmium	Soil	kg 1,4-DB eq	2,72E+00	1,10E-03	3,09E-03	3,68E-03	-	9,55E-02	1,01E+00	1,27E+00	2,41E-05	-	1,31E-01	2,06E-01
Arsenic	Water	kg 1,4-DB eq	2,47E+01	8,18E-02	2,29E-01	2,74E-01	-	8,42E-01	-3,67E+00	1,75E+01	5,71E-04	-	1,64E+00	7,78E+00
Barium	Water	kg 1,4-DB eq	-4,53E+01	2,33E-02	6,41E-02	7,91E-02	-	3,40E-01	-2,22E+01	-1,79E+01	4,53E-04	-	-3,52E+00	-2,27E+00
Manganese	Water	kg 1,4-DB eq	1,38E+02	3,53E-01	9,86E-01	1,18E+00	-	5,05E+00	1,33E+00	9,24E+01	2,36E-03	-	5,14E+00	3,16E+01
Selenium	Water	kg 1,4-DB eq	5,67E+00	2,07E-02	5,79E-02	6,91E-02	-	2,58E-01	-7,93E-01	4,66E+00	1,33E-04	-	-9,73E-02	1,49E+00
Process contribution (%)			1,80E+01	0,39%	1,08%	1,31%	0,00%	6,21%	-18,49%	75,28%	0,00%	0,00%	3,50%	30,73%
Sum				0,39%		8,60%			56,79%				34,23%	
Photochemical oxidant formation														
Total of all compartments		kg NMVOC	1,02E+00	6,43E-03	1,80E-02	2,16E-02	-	1,26E-01	-5,51E-01	1,07E+00	2,16E-04	-	-7,60E-02	3,96E-01
Remaining substances		kg NMVOC	-2,63E-03	1,15E-04	3,13E-04	3,97E-04	-	4,11E-03	-2,24E-02	4,35E-03	5,60E-06	-	1,37E-03	9,15E-03
Butane	Air	kg NMVOC	-3,28E-02	1,45E-05	4,07E-05	4,82E-05	-	7,24E-05	-1,63E-02	-1,24E-02	1,52E-07	-	-2,70E-03	-1,56E-03
Carbon monoxide, biogenic	Air	kg NMVOC	4,72E-02	1,58E-05	4,43E-05	5,25E-05	-	2,94E-03	1,78E-02	2,16E-02	5,64E-08	-	1,86E-03	2,94E-03
Ethane	Air	kg NMVOC	-4,91E-02	2,84E-05	7,95E-05	9,41E-05	-	1,27E-04	-2,54E-02	-1,78E-02	5,05E-08	-	-4,20E-03	-1,98E-03
Methane, fossil	Air	kg NMVOC	-7,70E-02	6,51E-05	1,82E-04	2,19E-04	-	4,20E-04	-4,31E-02	-2,58E-02	2,38E-07	-	-7,02E-03	-1,98E-03
Nitrogen oxides	Air	kg NMVOC	1,44E+00	4,92E-03	1,38E-02	1,65E-02	-	9,32E-02	-1,39E-01	1,11E+00	1,82E-04	-	-1,31E-02	3,49E-01
NMVOC, non-methane volatile organic compounds, unsp	Air	kg NMVOC	-3,32E-01	6,42E-04	1,79E-03	2,21E-03	-	1,93E-02	-2,41E-01	-8,03E-02	2,52E-05	-	-4,08E-02	5,91E-03
Pentane	Air	kg NMVOC	-1,54E-02	1,76E-05	4,92E-05	5,82E-05	-	6,12E-04	-9,23E-03	-4,56E-03	2,13E-07	-	-1,85E-03	-4,91E-04
Propane	Air	kg NMVOC	-2,88E-02	1,14E-05	3,19E-05	3,78E-05	-	5,44E-05	-1,41E-02	-1,11E-02	8,62E-08	-	-2,33E-03	-1,44E-03
Sulfur dioxide	Air	kg NMVOC	1,07E-01	5,94E-04	1,67E-03	1,98E-03	-	4,41E-03	-4,24E-02	1,05E-01	3,06E-06	-	-3,88E-03	3,90E-02
Toluene	Air	kg NMVOC	-3,64E-02	4,80E-06	1,35E-05	1,61E-05	-	9,92E-04	-1,62E-02	-1,50E-02	6,22E-08	-	-3,33E-03	-2,99E-03
Process contribution (%)				0,63%	1,77%	2,12%	0,00%	12,44%	-54,28%	105,78%	0,02%	0,00%	-7,48%	39,00%
Sum				0,63%		16,33%			51,50%				31,53%	

Table 69 (C3) - Fruit & Vegetable (Orange Peels) F-CUBED Production System

Substances	Compartment Units	Total	Upstream processes		Main stream processes			Downstream processes			Filtrate (liquid fraction) processing		
			Pre-conditioning	TORWASH effluent	Dewatering PRESS CAKE (Solids)	Dewatering FILTRATE (Liquid fraction)	PELLETIZING phase	ELECTRICITY generation from pellets (HV)	ELECTRICITY voltage transformation (MV)	Anaerobic digestion	Digestate	ELECTRICITY generation from biogas (HV)	ELECTRICITY voltage transformation (MV)
Freshwater eutrophication													
Total of all compartments	kg P eq	1,31E+00	6,94E-04	4,87E-03	6,18E-03	-	2,47E-02	-8,11E-04	2,87E-01	2,05E-04	-	3,15E-01	6,71E-01
Remaining substances	kg P eq	4,29E-03	1,95E-07	1,78E-06	2,30E-06	-	6,25E-05	6,72E-05	1,34E-04	4,43E-07	-	1,97E-03	2,05E-03
Phosphate	Water kg P eq	1,28E+00	6,92E-04	4,85E-03	6,15E-03	-	2,31E-02	-1,21E-02	2,75E-01	2,04E-04	-	3,13E-01	6,68E-01
Phosphorus	Soil kg P eq	2,60E-02	2,16E-06	1,48E-05	1,87E-05	-	1,52E-03	1,12E-02	1,21E-02	1,12E-07	-	-2,31E-05	1,16E-03
Process contribution (%)			0,05%	0,37%	0,47%	-	1,88%	-0,06%	21,95%	0,02%	-	24,04%	51,28%
Sum			0,05%		2,73%			21,88%				75,34%	
Human toxicity													
Total of all compartments	kg 1,4-DB eq	6,56E+02	6,03E-01	4,29E+00	5,48E+00	-	2,43E+01	-9,84E-01	2,38E+02	6,19E-02	-	4,48E+01	3,40E+02
Remaining substances	kg 1,4-DB eq	7,49E+01	5,12E-02	3,28E-01	4,31E-01	-	4,38E+00	6,90E+00	2,31E+01	4,19E-03	-	9,78E+00	2,99E+01
Arsenic	Air kg 1,4-DB eq	1,33E+01	2,62E-02	1,76E-01	2,27E-01	-	9,69E-01	-2,07E+00	5,65E+00	-7,20E-04	-	-6,30E-01	8,93E+00
Lead	Air kg 1,4-DB eq	1,53E+01	1,97E-02	1,25E-01	1,65E-01	-	1,29E+00	1,21E+00	6,47E+00	-2,67E-04	-	-2,63E-01	6,25E+00
Mercury	Air kg 1,4-DB eq	2,17E+01	9,12E-03	2,07E-01	2,74E-01	-	7,62E-01	-8,84E-02	3,37E+00	3,86E-03	-	6,46E+00	1,07E+01
Arsenic	Water kg 1,4-DB eq	1,29E+02	1,11E-01	7,60E-01	9,67E-01	-	2,42E+00	-1,90E+00	4,59E+01	8,69E-03	-	1,05E+01	6,97E+01
Barium	Water kg 1,4-DB eq	-5,52E+01	2,51E-02	1,44E-01	1,93E-01	-	8,57E-01	-2,12E+01	-1,47E+01	-4,26E-04	-	-1,42E+01	-6,22E+00
Manganese	Water kg 1,4-DB eq	4,33E+02	3,36E-01	2,37E+00	3,00E+00	-	1,29E+01	1,65E+01	1,57E+02	4,49E-02	-	3,34E+01	2,07E+02
Selenium	Water kg 1,4-DB eq	2,47E+01	2,52E-02	1,78E-01	2,25E-01	-	7,08E-01	-3,09E-01	1,07E+01	1,65E-03	-	-2,32E-01	1,34E+01
Process contribution (%)			0,09%	0,65%	0,84%	-	3,70%	-0,15%	36,21%	0,01%	-	6,83%	51,83%
Sum			0,09%		5,19%			36,06%				58,66%	
Freshwater ecotoxicity													
Total of all compartments	kg 1,4-DB eq	2,91E+01	5,23E-02	3,01E-01	4,03E-01	-	1,45E+00	-5,83E+00	3,95E+00	5,05E-03	-	8,34E+00	2,04E+01
Remaining substances	kg 1,4-DB eq	2,44E-01	7,08E-04	4,38E-03	5,76E-03	-	3,70E-02	-1,42E-01	8,75E-02	-6,05E-04	-	-1,65E-02	2,67E-01
Beryllium	Water kg 1,4-DB eq	4,64E-01	6,29E-04	4,09E-03	5,29E-03	-	1,86E-02	-2,57E-02	2,03E-01	2,18E-05	-	-1,23E-02	2,70E-01
Bromine	Water kg 1,4-DB eq	-7,85E+00	2,04E-04	1,46E-03	1,93E-03	-	1,31E-02	-2,37E+00	-2,28E+00	-3,63E-05	-	-1,66E+00	-1,55E+00
Cobalt	Water kg 1,4-DB eq	5,55E-01	6,17E-04	3,58E-03	4,74E-03	-	1,77E-02	-1,73E-02	1,77E-01	6,51E-05	-	6,44E-02	3,04E-01
Copper	Water kg 1,4-DB eq	2,37E+01	3,81E-02	2,10E-01	2,84E-01	-	9,90E-01	-2,86E+00	1,91E+00	4,19E-03	-	8,59E+00	1,45E+01
Manganese	Water kg 1,4-DB eq	2,73E+00	2,12E-03	1,49E-02	1,89E-02	-	8,13E-02	1,04E-01	9,89E-01	2,83E-04	-	2,10E-01	1,31E+00
Nickel	Water kg 1,4-DB eq	7,24E+00	7,28E-03	4,51E-02	5,90E-02	-	2,10E-01	-1,53E-01	2,40E+00	8,17E-04	-	7,59E-01	3,91E+00
Silver	Water kg 1,4-DB eq	-9,00E-01	6,95E-04	3,23E-03	4,64E-03	-	2,22E-02	-3,45E-01	-2,61E-01	-4,72E-05	-	-2,14E-01	-1,11E-01
Vanadium	Water kg 1,4-DB eq	1,23E+00	1,18E-03	9,07E-03	1,16E-02	-	2,82E-02	-9,25E-03	4,90E-01	5,52E-05	-	3,90E-02	6,57E-01
Zinc	Water kg 1,4-DB eq	1,74E+00	7,98E-04	5,00E-03	6,55E-03	-	2,88E-02	-1,51E-02	2,40E-01	3,10E-04	-	5,77E-01	8,93E-01
Process contribution (%)			0,18%	1,03%	1,38%	-	4,97%	-20,03%	13,56%	0,02%	-	28,65%	70,23%
Sum			0,18%		7,39%			-6,46%				98,89%	
Climate change													
Total of all compartments	kg CO2 eq	-1,30E+03	1,67E+00	1,13E+01	1,46E+01	-	4,65E+01	-9,26E+02	-2,04E+02	9,20E-02	-	-5,70E+02	3,23E+02
Remaining substances	kg CO2 eq	1,70E+00	1,57E-02	1,05E-01	1,33E-01	-	2,50E-01	-3,10E-02	8,77E-01	3,69E-04	-	-3,88E-01	7,36E-01
Carbon dioxide, fossil	Air kg CO2 eq	-1,22E+03	1,54E+00	1,04E+01	1,34E+01	-	4,22E+01	-8,24E+02	-1,54E+02	5,96E-02	-	-5,70E+02	2,59E+02
Carbon dioxide, land transformation	Air kg CO2 eq	2,56E+01	1,51E-02	9,88E-02	1,26E-01	-	3,12E-01	4,07E-01	7,24E+00	-1,21E-04	-	4,48E+00	1,29E+01
Dinitrogen monoxide	Air kg CO2 eq	1,09E+02	2,02E-02	1,38E-01	1,76E-01	-	1,67E+00	2,01E+00	1,09E+01	1,82E-02	-	4,13E+01	5,23E+01
Methane, biogenic	Air kg CO2 eq	5,61E+01	2,25E-03	1,61E-02	2,05E-02	-	1,40E-01	1,72E-01	1,17E+00	1,16E-02	-	2,67E+01	2,79E+01
Methane, fossil	Air kg CO2 eq	-2,72E+02	7,88E-02	5,28E-01	7,06E-01	-	1,97E+00	-1,04E+02	-7,00E+01	2,28E-03	-	-7,17E+01	-2,96E+01
Process contribution (%)			0,13%	0,87%	1,12%	0,00%	3,57%	-71,10%	-15,68%	0,01%	0,00%	-43,75%	24,84%
Sum			0,13%		5,56%			-86,79%				-18,90%	