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GHG emission factors for waste components produced, treated and recovered in the HSY area - Background document for the calculations

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Annex 1 - Tables 1-4

Table 1. GHG emissions produced and avoided in different phases of the waste treatment and recovery chain valid for the HSY area, kg CO_2-eq./ton of waste component.

Waste component	GHG emissions produced and avoided in different phases of the waste treatment and recovery chain valid for the HSY area							Sum of the produced emissions[11] kg CO_2-eq./ton of waste component	Overall sum of the emissions= produced minus avoided[11] kg CO_2-eq./ton of waste component
	Collection and transportation[1]	Pretreament and processing[4]	Treatment	Recovery of material	Recovery of energy	Emissions avoided from virgin production[6]	Emissions avoided from energy production[9]		
Mixed waste (landfilled)	4		423				63[10]	430	370
Mixed waste (incinerated)	7				400		948	410	-540
Biowaste	9	47				37[7]		60	20
Paper	11	2		1032		1469		1050	-420
Cartons	4[2]	2			65[5]	-82[8]	-60	70	-70
Glass	[3]	[3]		570		741		570	-170
Metals	18			111		1103		130	-970
Plastics	[3]	[3]		66		144		70	-80
Wood	11	5			21		889	40	-850
Energy waste	17	12			502		1147	530	-620
Construction and demolition waste	5	67		15	12	219		100	-120
WEEE	20	36				1969		60	-1910
Hazardous waste	5				1400			1410	1410[12]
Municipal waste water sludge	5	43					102	50	-50

[1)] Includes collection and transportation of the waste component needed to deliver it to the site where recovery takes place.

[2)] Only collection of cartons included here. Transportation to the site of recovery is included in the emissions avoided from virgin production.

[3)] Included in the emissions from the recovery of material

[4)] Includes processes such as crushing, sieving, granulation, composting and anaerobic digestion.

[5)] Includes emissions from the combustion of the reject which is assumed to consist of plastics and fibres (50/50).

[6)] Including emissions from the extraction, transportation, processing and production of the virgin raw material used in the process

[7)] From peat production

[8)] The difference of emissions from core board and fluting manufacturing. For core board the data include 250 km transportation for baled cartons, pulping of fibres, manufacturing of core board and the use and production of energy. For fluting the data include forestry operations for pulp wood production (birch), manufacturing of fluting and the use and production of energy.

[9)] Including emissions from the extraction, transportation, processing and production of the fuel used in the process

[10)] Through energy recovery of the LFG

[11)] Rounded to the nearest ten

[12)] The GHG emission factor for hazardous waste is an overestimation, since no avoided emissions have been included. This factor should only be used if it is known that the waste is incinerated, i.e, it should not be used for e.g. equipment or devices, contaminated soils or metals classified as hazardous wastes.

Table 2. Definitions for the waste components included in the assessment in Julia2030 project.

Waste component	Material description
Mixed waste	Waste fraction produced in households etc. after recyclables (biowaste, paper, cartons, glass and metals) have been sorted separately.
Biowaste	Biowastes include mainly food waste from kitchens and other biobased waste (serviettes, wood-based pet litter).
Paper	Paper includes separately collected paper from households, offices etc. It is a mixture of magazines, newspapers, office paper and collected from real estates.
Cartons	Cartons include cardboard, liquid packaging board and carton from households, retail shops, offices separated at source and collected from real estates.
Glass	Glass includes separately collected bottles and other glass packages (not included in the deposit system for beverage packagings). No flat glass included. Glass is collected at regional collection points.
Metals	Metals include metal packagings (tin cans) and other small metal items (not aluminium cans included in the deposit system for beverage packagings). Metals are collected at regional collection points.
Plastics	Separately collected plastics include plastic waste from groceries, companies, offices and other facilities producing large amounts of homogenous plastics.
Wood	Non-treated wood waste.
Energy waste	Energy waste is separately collected waste, which can not be recycled but can be recovered as energy. Energy waste in HSY's operating area is primarily wood, paper, cardboard and carton packaging collected from large corporations. It may also include small amounts of separated energy waste (e.g. plastics) from local collection points.
Construction and demolition waste	Waste from construction, demolition and reparation sites.
WEEE	Waste electrical and electronic equipment belonging to the producer responsibility system
Hazardous waste	Waste classified as hazardous, which can be incinerated.
Municipal waste water sludge	Sludge from municipal wastewater treatment plants. The water treated originates mainly from municipalities (85%), the rest comes from industries (15%).

Table 3. Description of the processes included in the waste treatment and recovery chains valid for the HSY area. Data sources, modeling values and critical assumptions made for the calculations of GHG-emissions.

Waste component	Treatment	Recovery option	Avoided production	Critical assumptions	Data source
Mixed waste	Landfilling; including the machinery used at the landfill	LFG (landfill gas) is recovered as energy in a gas turbine producing electricity for HSY landfill operations	Electricity purchased by the HSY;	DOC (degradable organic carbon): 21% DOC_f (fraction DOC dissimilated): 50% OX (oxidation factor): 10% recovered CH_4: 71% CH_4-conc. in LFG: 47% LFG energy content: 12 MJ/kg Emission factor for the avoided electricity production: 94 kg CO_2-eq./GJ	IPCC 2000; Anderson 2010a; VAHTI 2010
Mixed waste		Energy recovery at an incineration plant	Energy production with coal; emission factor 117 kg CO_2-eq./GJ	Energy content: 10 GJ/t of mixed waste Emission factor for mixed waste incineration: 40 kg CO_2-eq./GJ Energy yield: 8.1 GJ/t of mixed waste	Statistics Finland 2010; Karjalainen 2009; Anderson 2010b
Biowaste	Composting	Used in a landscaping substrate (a mixture of sand, nutrients and organic material), where it replaces peat	Peat production, including emissions from the peat exploiting area and the exploiting machinery	DOC of biowaste: 65%, 3% emitted as CH_4	Leijting 1999 (peat production); Myllymaa et al. 2008
Paper	Baling, handling and loading of paper at the sorting plant	De-inking, manufacturing of de-inked pulp and use for newsprint manufacturing	Forestry operations for pulp wood production (spruce); production of TMP from virgin fibres in an integrated paper mill	Emission factor for the paper mill purchased electricity: 87 kg CO_2-eq./GJ (2006-2008 mean value)	Dahlbo et al. 2005; The emissions of the Finnish purchased electricity for life cycle assessments 2011

Cartons	Baling, handling and loading of cartons at the sorting plant	Pulping, use for core board manufacturing. The reject is used for energy recovery.	Fibres: Forestry operations for pulp wood production (birch), production of fluting from virgin fibres. Energy from the reject: Use of natural gas in an industrial co-combustion plant.	From one ton of cartons 95% used for core board manufacturing, 5% (reject) used for energy production. Raw materials used for core board manufacturing: 83% cartons, 17% virgin. Reject includes 50% fibres, 50% plastics.	Niininen 2011 (confidential); Bacher 2011; Tohka 2008
Glass	Crushing, cleaning and sorting of the separately collected glass (used for manufacturing of glass containing products)	Use in glasswool and packaging manufacturing, and in earth works.	Production of glass wool or packaging from virgin raw materials; use of gravel in earth works	One ton of glass compensates for 0.64 t of gravel. The emissions from virgin material use are estimates.	Vares & Lehtinen 2007; Uusioaines Oy 2010
Metals	Mechanical processing, including reduction of size, classification and separation of materials.	Fe: use in steel EAF production (hot-rolled coil); Cu: use in Cu-pipe production; Al: use in secondary production of Al	Fe: primary production of steel (hot-rolled coil); Cu: primary production of Cu; Al: primary production of Al	The shares of different metals in the metals fraction: 53% tin-coated steel, 24% Al, 15% stainless steel, 9% others	Kuusiola 2010; EAA 2008; Broadbent 2010; Seppälä et al. 2000; Athena 2002; Deutches Kupferinstitute 2010
Plastics	Granulating	Manufacturing of plastic profiles.	Forestry operations needed to produce logs. Use of impregnated wood.	One ton of plastics compensates for 0.83 ton of wood.	Korhonen & Dahlbo 2007
Wood	Chipping	Energy recovery in a small district heat plant.	Use of oil in a small district heat plant.	Energy yield 90%	Myllymaa et al. 2008; Alakangas 2000; Vaittinen 2009
Energy waste	Mechanical pretreatment (crushing and magnetic separation)	Energy recovery in an industrial co-combustion plant	Use of natural gas in an industrial co-combustion plant	Energy content of the energy waste 20 GJ/t, content of biobased materials 80%. The emission is an estimate based on Vesanto et al. 2007. Energy efficiency of the co-combustion facility 85%.	Myllymaa et al. 2008; Partti & Tönnes 2009; Vesanto et al. 2007

Construction and demolition waste	Concrete: crushing and magnetic separation; Tyres: crushing Other fractions, see the specific waste component in this table	Concrete and tyres: use in earth works; other fractions: see the specific waste component in this table	Concrete and tyres: use of gravel in earth works; Other fractions: see the specific waste component in this table	Fe-content of concrete: 1.5%; The shares of different metals in the C&D metals fraction: ferrous 98.5%, non-ferrous 1.5% Energy consumption of concrete crushing: 32 MJ/t crushed concrete	Joutsenoja 2010
WEEE	Manual dismantling, mechanical processing, including reduction of size, classification and separation of materials.	Metals: used for metal manufacturing (see metals component) Glass: see glass component.	Metals: production of metals from virgin raw materials (see metals component). Glass: see glass component.	The shares of different metals in the WEEE metals fraction: Fe 81%, Cu 11% and Al 8%	Ignatius et al. 2009
Hazardous waste	Incineration				Ekokem 2008
Municipal waste water sludge	Anaerobic digestion and composting	Biogas is used to produce energy for the process. Solid fraction: used in a landscaping substrate (a mixture of sand, nutrients and organic material), where it replaces peat	Electricity produced from biogas: electricity purchased by the HSY Solid fraction: Peat production, including emissions from the peat exploiting area and the exploiting machinery	Energy production: 694 MJ energy/ t of sewage sludge;.260 MJ of this is electricity Emission factor for the avoided electricity production: 94 kg CO_2-eq./GJ	Treatment plants 2011; Myllymaa et al. 2008

Table 4. Descriptions of distances and vehicles used for calculating the impacts of collecting and transporting waste components produced in the HSY area.

Waste component	Transportation distance and vehicle[1)]
All (except separately collected metals)	Collection round; the use of a compression vehicle (volume 14 t, medium load 7 t) needed to collect 1 t of waste component (LIPASTO 2009)
Mixed waste (landfilled)	-
Mixed waste (incinerated)	Mixed waste: 5 km extra transportation; compression vehicle (volume 14 t, medium load 7 t) (LIPASTO 2009) Ashes from the incineration: non-hazardous waste: 40 km semitrailer (EURO3), 70% load, 25 t (LIPASTO 2009) Hazardous waste: 70 km semitrailer (EURO3), 70% load, 25 t (LIPASTO 2009)
Biowaste	Biowaste compost: 80 km transportation; semitrailer (EURO3), 70% load, 25 t (LIPASTO 2009) Peat: 80 km transportation; semitrailer (EURO3), full load, 25 t (LIPASTO 2009)
Paper	Baled paper: 545 km transportation; 24% train (el.), 76% full trailer (LIPASTO 2002)
Cartons	Baled cartons: 250 km transportation; full trailer (EURO 3), full load, 40 t (LIPASTO 2009)
Glass	Glass: 58 km transportation, includes collection, unloading and depot driving. (Vares & Lehtinen 2007) Gravel: 30 km transportation; earth-hauling truck (EURO 3), full load, 19 t (LIPASTO 2009)
Metals	Collection round; 97.5 km, 32 t earth-hauling truck, (EURO 3), 50% load, street driving (Kuusiola 2010, LIPASTO 2009) Transportation to pretreatment; 124 km transportation; full-trailer combination truck, 70% load, 40 t (Kuusiola 2010, LIPASTO 2009)
Plastics	Plastic waste and colour agents: 80 km transportation (Korhonen & Dahlbo 2007) Logs and impregnation agents: 100 km transportation (Korhonen & Dahlbo 2007)
Wood	Wood waste: 100 km transportation, semitrailer (EURO3), 60% load, 25 t (LIPASTO 2009)
Energy waste	Energy waste: 210 km transportation, semitrailer (EURO3), 70% load, 25 t (LIPASTO 2009)
Construction and demolition waste	Crushed concrete: 20 km transportation; earth-hauling truck (EURO 3), full load, 19 t (LIPASTO 2009) Metals separated from concrete: 360 km transportation; full-trailer combination truck, 70% load, 40 t (LIPASTO 2009) Gravel: 30 km transportation; earth-hauling truck (EURO 3), full load, 19 t (LIPASTO 2009)
WEEE	Fluorescent tubes: 200 km transportation, full-trailer combination truck, 20% load, 40 t (LIPASTO 2009) Other WEEE: 150 km transportation, full-trailer combination truck, 20% load, 40 t (LIPASTO 2009)
Hazardous waste	80 km transportation; semitrailer (EURO3), 70% load, 25 t (LIPASTO 2009)
Municipal waste water sludge	Solid fraction from the digestion: 43 km transportation; semitrailer (EURO3), 60% load, 25 t (LIPASTO 2009) Peat: 80 km transportation; semitrailer (EURO3), full load, 25 t (LIPASTO 2009)

[1)] The production of fuels needed for the transportations are included.

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