Combined Use of an Information System and LCA Approach to Assess the Performances of a Solid Waste Management System

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ANNEX A: data from the information system W-MySir

Table 1. Generation of different waste streams (identified by the EWC) generated by Procida municipality in 2011 and 2021. **Bold** indicates waste types included in the analysis. Source: W-MySir, 2022.

		MASS (kg)	
EWC	DESCRIPTION	Year 2011	Year 2021
80111*	Waste paint and varnish containing organic solvents or other dangerous substances	-	955
80318	Waste printing toner other than those mentioned in 08 03 17	-	120
150101	**Paper and cardboard packaging**	**267590**	**268450**
150102	**Plastic packaging**	**83160**	**-**
150104	**Metallic packaging**	**12580**	**-**
150106	**Mixed packaging**	**-**	**378036**
150107	**Glass packaging**	**214700**	**500980**
150110*	Packaging containing residues of or contaminated by dangerous substances	-	1240
160103	End-of-life tyres	-	250
161002	Aqueous liquid wastes other than those mentioned in 16 10 01	31540	30820
170107	Mixtures of concrete, bricks, tiles and ceramics other than those mentioned in 17 01 06	119340	-
170301*	Bituminous mixtures containing coal tar	-	1660
170904	Mixed construction and demolition wastes other than those mentioned in 17 09 01, 17 09 02 and 17 09 03	-	24000
200101	**Paper and cardboard**	**88660**	**278580**
200108	**Biodegradable kitchen and canteen waste**	**875090**	**1545160**
200110	Clothes	-	39880
200111	Textiles	27440	31560
200121*	Fluorescent tubes and other mercury-containing waste	-	158
200123*	Discarded equipment containing chlorofluorocarbons	-	51400
200125	Edible oil and fat	1550	1280
200132	Medicines other than those mentioned in 20 01 31	-	400
200133*	Batteries and accumulators included in 16 06 01, 16 06 02 or 16 06 03 and unsorted batteries and accumulators containing these batteries	-	360
200135*	Discarded electrical and electronic equipment other than those mentioned in 20 01 21 and 20 01 23 containing hazardous components	-	24440
200138	Wood other than that mentioned in 20 01 37	173940	-
200136	Discarded electrical and electronic equipment other than those mentioned in 20 01 21, 20 01 23 and 20 01 35	-	51360

200140	**Metals**	**165940**	**-**
200201	**Biodegradable waste**	**-**	**884080**
200203	Other non-biodegradable wastes	6420	1400
200301	**Mixed municipal waste**	**3932620**	**1946110**
200307	Bulky waste	118830	725229
	TOTAL	6119400	6787908

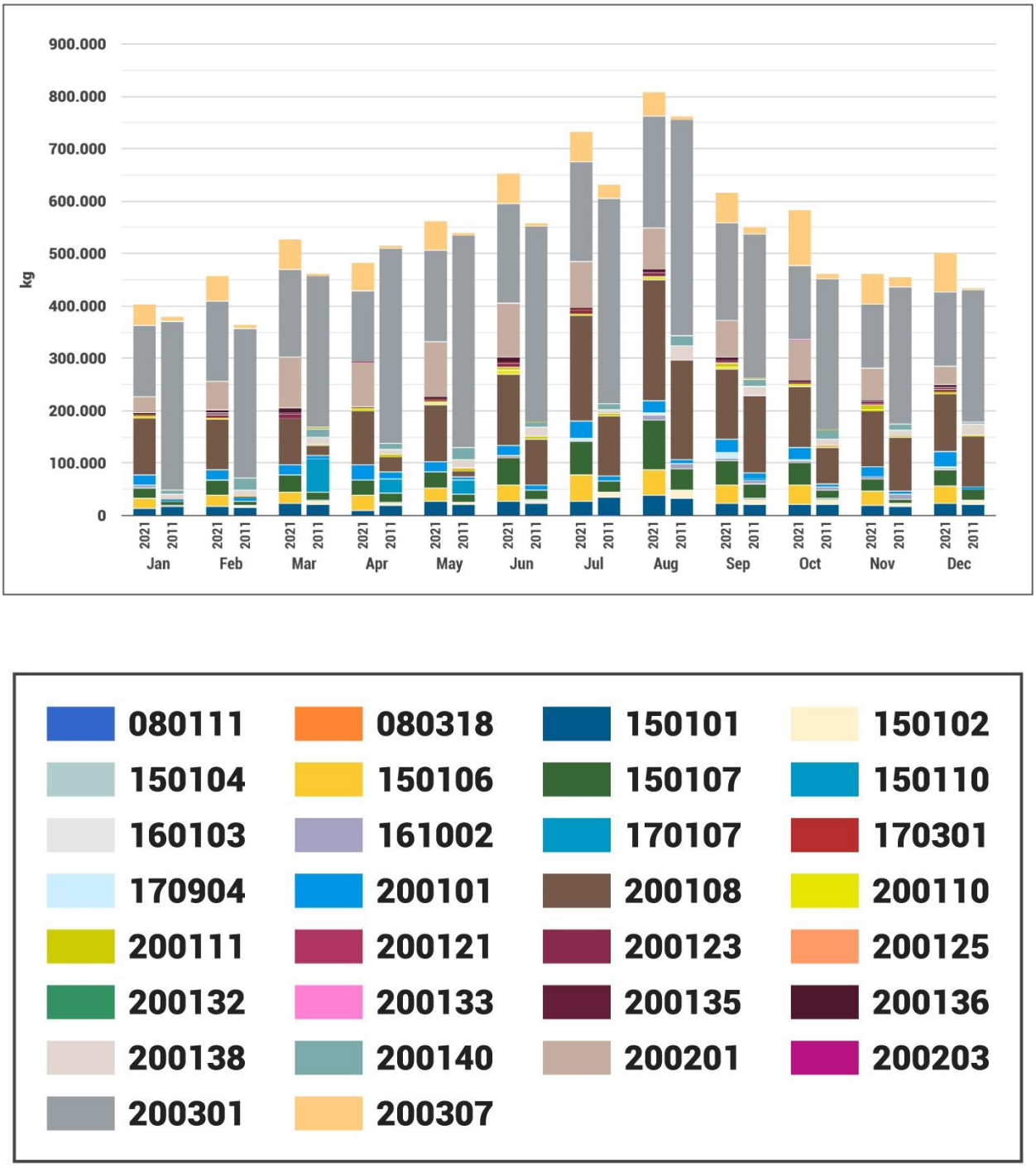


Figure 1. Monthly generation of different waste streams (identified by the EWC) generated by Procida municipality in 2011 and 2021. The grey bar indicated the unsorted municipal waste. Source: W-MySir, 2022.

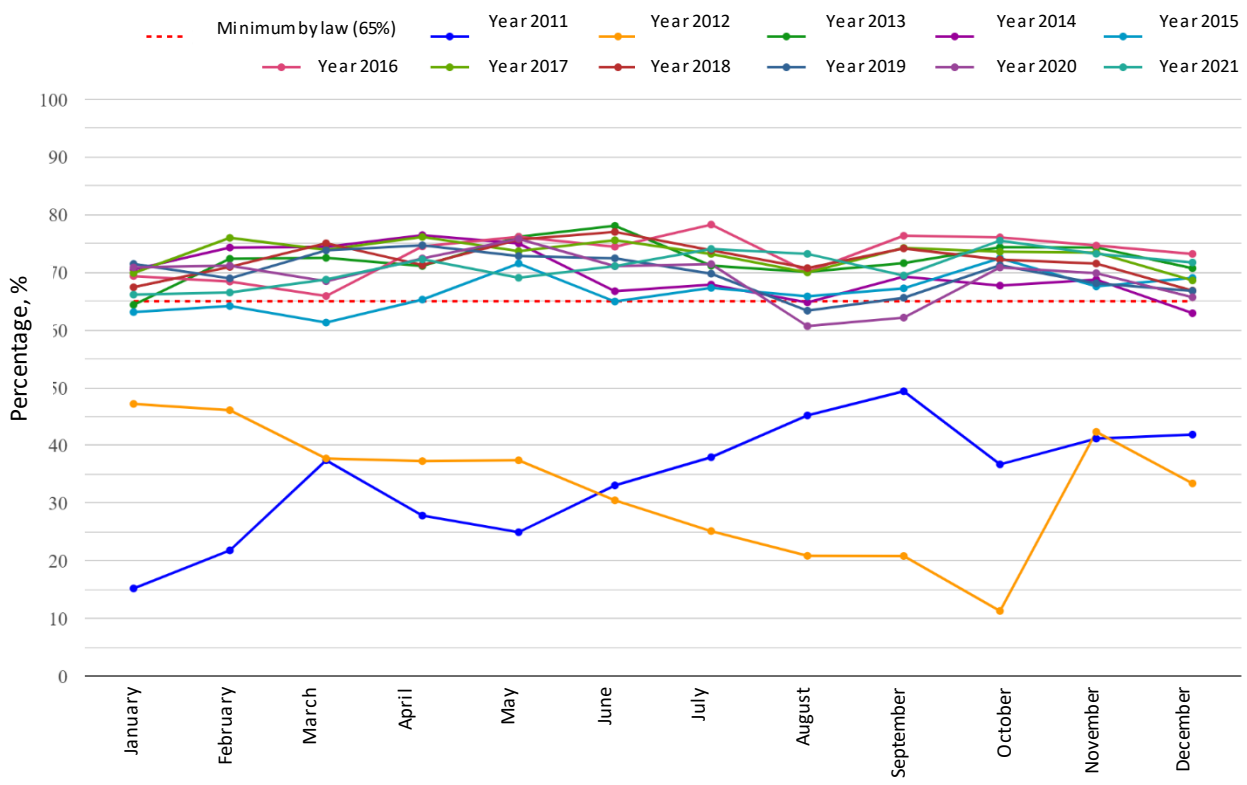


Figure 2. Shares of separate collection defined for Procida management scheme from 2011 to 2021, on monthly basis. Source: W-MySir, 2022.

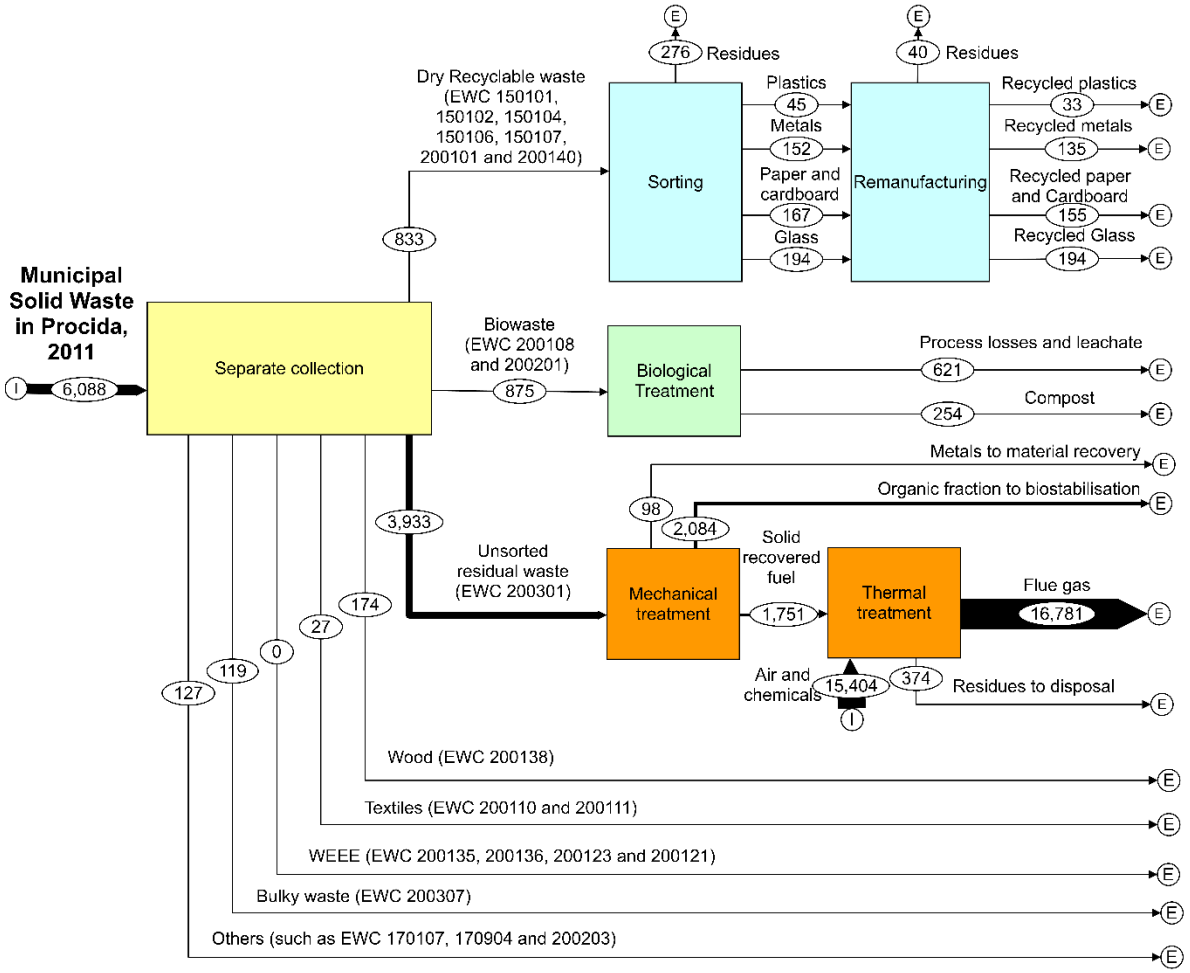


Figure 3. Quantified flow sheet of MSW management in Procida in 2011. Dashed lines indicate the boundary of activities included in the LCA. Data Source: W-MySir, 2022, coupled with data from scientific literature and specific parameters for each process unit, as detailed in section 2.2 of the manuscript.

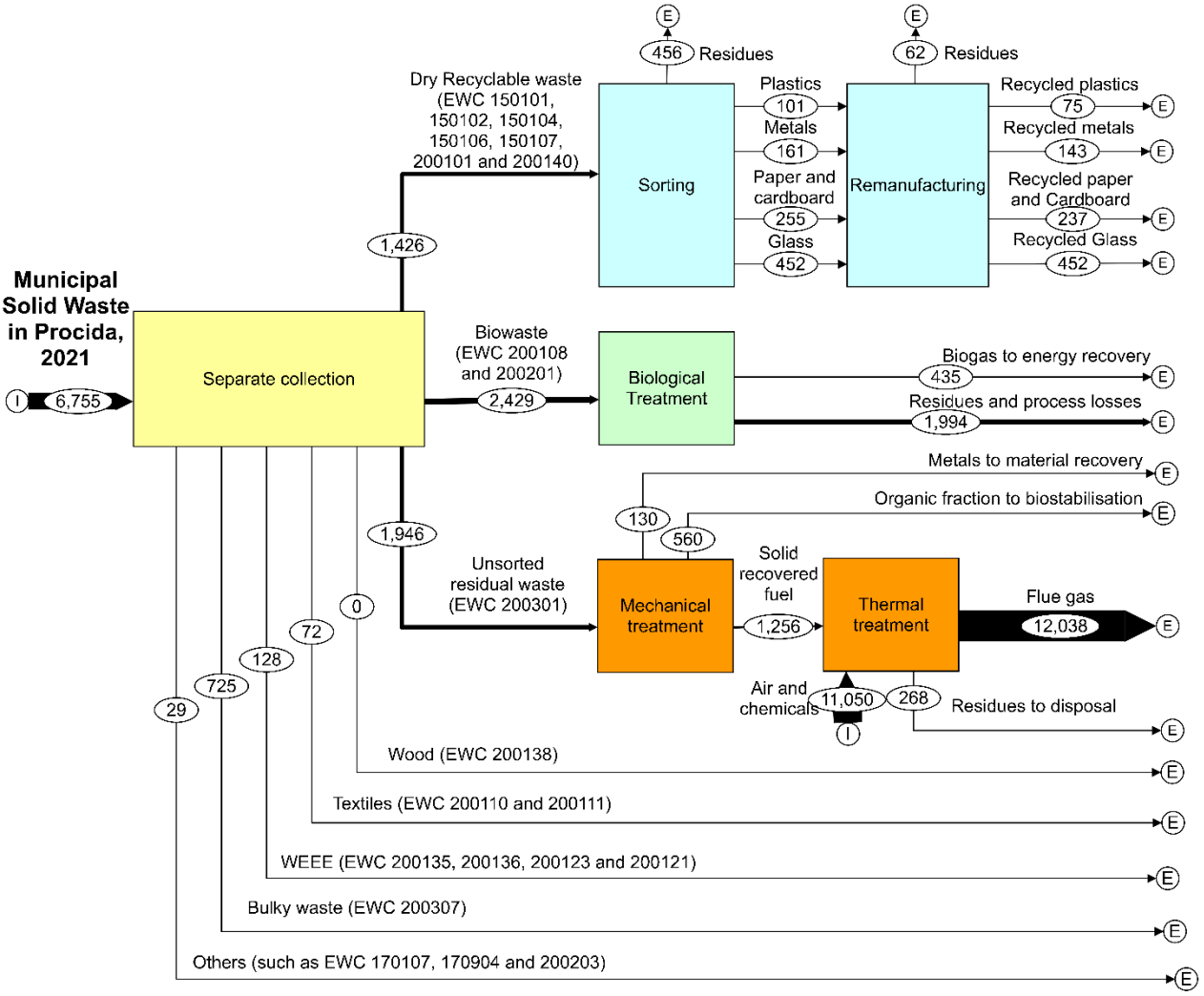


Figure 4. Quantified flow sheet of MSW management in Procida in 2021. Dashed lines indicate the boundary of activities included in the LCA. Data Source: W-MySir, 2022, coupled with data from scientific literature and specific parameters for each process unit, as detailed in section 2.2 of the manuscript.

ANNEX B: Life Cycle Inventory data

Biowaste

Table 2. Ultimate analysis of the biowaste taken into account for 2011 and 2021 scenarios.

	2011 and 2021
	$\%_{mass}$
Carbon	15.49
Hydrogen	2.51
Nitrogen	0.76
Chlorine	0.2
Sulphur	0.03
Oxygen (by diff.)	13.62
Moisture	62.5
Ash	4.89

Unsorted residual waste

Table 3. Direct burdens related to mechanical treatment of unsorted residual waste, aimed at producing SRF. Data Source: Arena et al., 2003; Ardolino et al., 2017.

	2011	**2021**
URW IN, kg	**1000**	**1000**
Polyethylene film, g	160	160
Ferrous wire, g	300	300
Electric Energy, kWh	14	14
Diesel, MJ	10	10
OUTPUT STREAMS		
Solid Recovered fuel to WtE, kg	445	645
Metals to recycling, kg	25	67
Organic fraction to biostabilisation, kg	530	288

Table 4. Compositions, carbon contents and low heating values of solid recovered fuels for 2011 and 2021 scenarios. Data Source: W-MySir, 2022

	2011	**2021**
	$\%_{mass}$	**$\%_{mass}$**
Plastics	36	49.6

Paper	35	42.1
Metals	1	1.2
Glass	15	2.2
Biowaste	13	4.9
C content	34%	42%
Biogenic C	40%	34%
Fossil C	60%	66%
***Low Heating value**, MJ/t_{SRF}*	11,600	15,400

Table 5. Direct burdens related to biostabilisation of organic fraction deriving from mechanical treatment of unsorted residual waste. Data Source: Arena et al., 2003; Ardolino et al., 2017.

	2011 and 2021
Organic fractions IN, kg	**1000**
DIRECT BURDENS	
Consumptions	
Water, kg	176
Electric energy, kWh	18
Air emissions	
H_2S, mg	5153
NH_3, mg	5582
Mercaptans, mg	859
Aldehydes, mg	859
Ketones, mg	1975
Amine, mg	859
Fat volatile acides, mg	1116
Dusts, mg	11765
Heavy metals, mg	6269
Hg, mg	859
VOC, g	161
Residues	
Stabilised organic fraction to disposal, kg	290
Leachate to treatment, kg	75

ANNEX C: Life Cycle Impact assessment and Interpretation

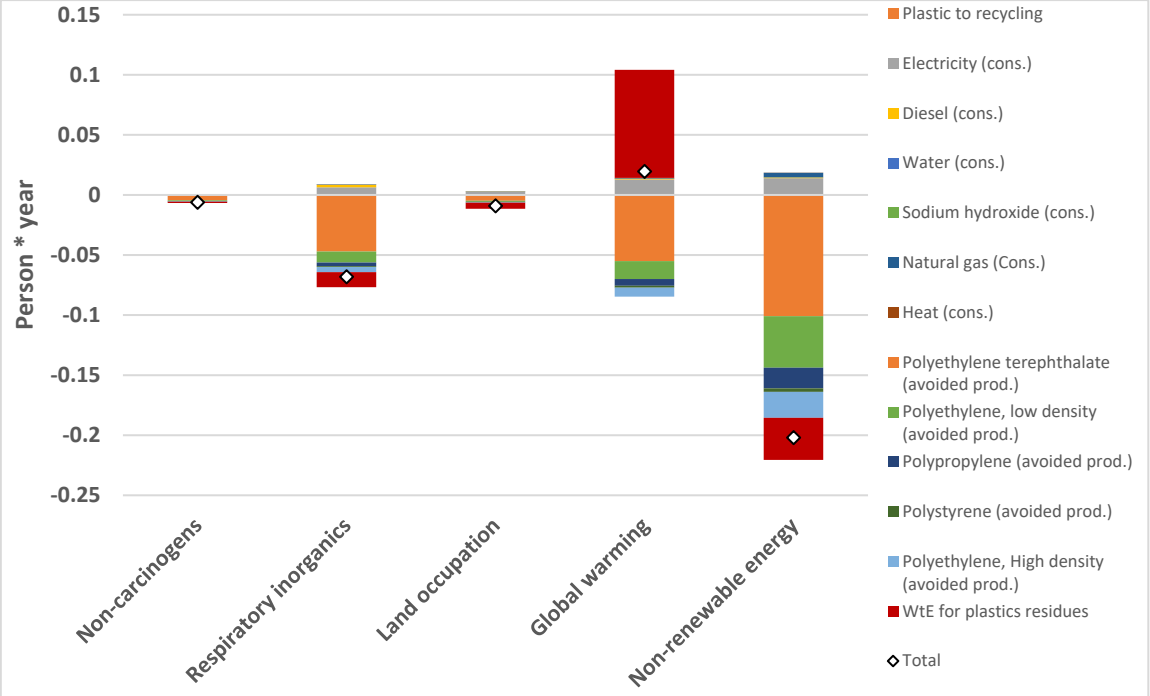


Figure 5. Contributional analysis for recycling chain of plastic packaging waste in 2021 (EWC 150102 and EWC 150106). Data refer to 1 ton of mixed plastics in input to sorting stages.

Table 6. Composition of the Italian electricity mixes "Italy, 2011" and "Italy, 2020", utilised in the base case scenarios, and that of "Italy, 2030", utilised for the sensitivity analysis scenario. Data from: IEA, (2022); EC, (2016).

Electricity mix	**Italy, 2011**	**Italy, 2020**	**Italy, 2030**
Energy source (%)			
Non-renewable	***70%***	***57%***	***49%***
Coal and lignite	16%	5%	3%
Oil	7%	3%	3%
Gas	47%	49%	43%
Nuclear	-	-	-
Renewable	***30%***	***43%***	***51%***
Wind	3%	7%	14%
Hydro	18%	17%	16%
Biomass and waste	4%	8%	8%
Solar and geothermal	5%	11%	13%

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