Supplementary Material

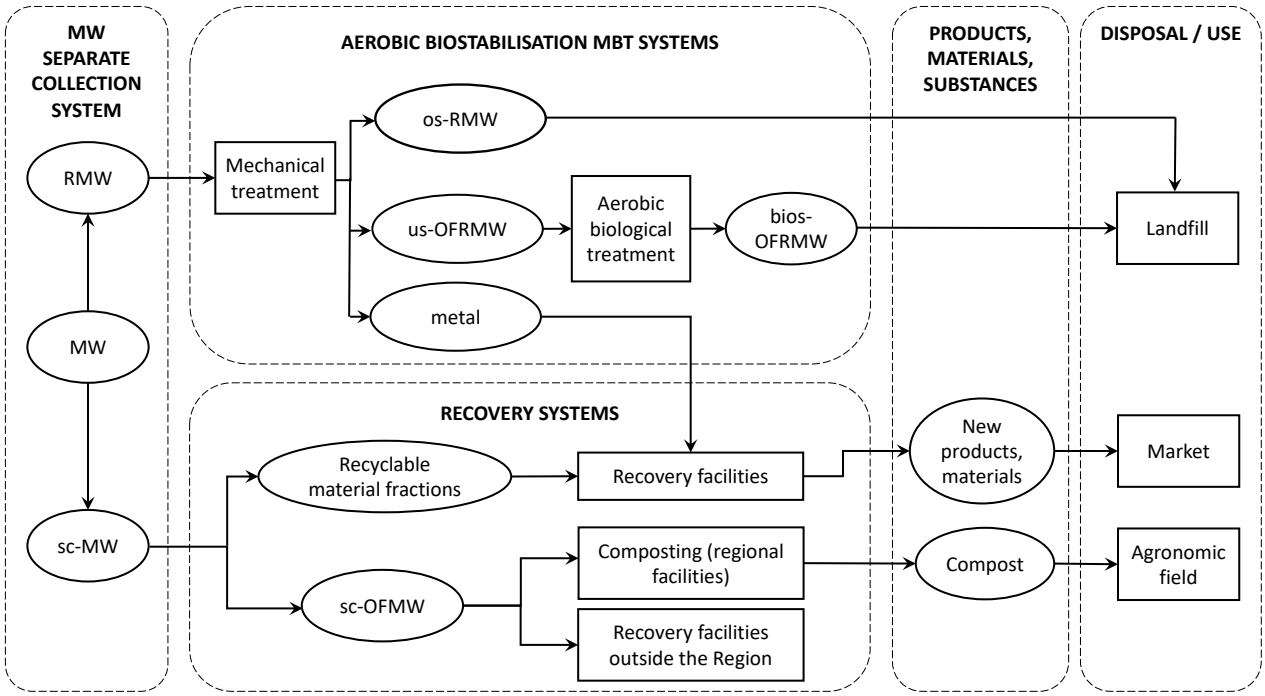

Figure S1. Synthetic representation of the overall MW management in the Marche Region.

Table S1. Representative characteristics of the aerobic biostabilisation MBT systems located in the Marche Region.

Provincial Territory	Mechanical Treatment	Aerobic Biological Treatment
PT1	Bland shredding *(to tear bags)* Sieving by rotating trommels *(screen sizes of 40 mm in the inland district and one coastal district, and of 50-80 mm in the other coastal district, with a representative provincial mean of 48 mm)*	Bio-oxidation *(in biocontainers connected to an air intake system)* Curing *(in static biocells aerated from the bottom)* [whole biostabilisation time of at least 14 days]
PT2	Shredding Magnetic separation Sieving *(screen size of 80 mm)*	Biostabilisation *(in static biocells aerated from the bottom)* [biostabilisation time of 10 days]
PT3	Bland shredding *(to tear bags)* Fast rotating shredding Magnetic separation Sieving by rotating trommel *(screen size of 45 mm)*	Initial bio-oxidation *(in slow rotating, horizontal cylinder with forced aeration)* Accelerated bio-oxidation *(in biocontainers with forced aeration)* [whole biostabilisation time of 14 days]
PT4	Bland shredding *(to tear bags)* Magnetic separation Sieving by disc screen *(screen size of 80 mm)*	Biostabilisation *(in biocells with turning cochleae and forced aeration from the bottom)* [biostabilisation time of 28-30 days]

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PT5	Bland shredding *(to tear bags)* Magnetic separation Sieving by rotating trommel *(screen size of 80 mm)*	Biostabilisation *(in biocells with turning cochleae and forced aeration from the bottom)* [biostabilisation time of 30 days]

Table S2. Sequential procedure adopted to conduct the compositional analyses of the RMW streams addressed to the provincial aerobic biostabilisation MBT systems in the Marche Region.

Step of the Procedure	Synthetic Description
Heaping and removal of possible bulky materials	The initially collected amount of RMW (about 3-4 ton) is placed on a flat, concrete surface (protected from sun, wind, and rain) to form a circular heap with a thickness of about 0.5-0.6 m. Possible bulky materials are removed and individually weighed and set aside in accordance with the following main categories: glass, inert, metal, paper/cardboard, textile, and wood.
Quartering	The heap is divided in four parts, two of them (at the opposite sides) are removed; the remaining two parts are mixed and assembled to form another circular heap. This quartering operation is repeated until a residual amount of about 200 kg of the heap is reached. The half of this last heap, accounting for around 100 kg, is used as the representative sample of RMW for the further steps.
Screening	A rectangular box sieve (typical side dimensions of 1 * 2 m) with a 20-mm mesh is used.
Manual sorting and weighing	In accordance with the material categorisation adopted by the Environmental Protection Agency of the Marche Region, the following fractions or sub-fractions are globally investigated: cardboard, diaper, glass, green waste, hazardous waste, inert, kitchen waste, metal - packaging, metal - other, paper, plastic - packaging, plastic - other, textile, waste electrical and electronic equipment, wood - packaging, wood - other, residue from sorting, and fines. Each material fraction or sub-fraction is manually sorted (with the exclusion of fines), progressively accumulated into a dedicated plastic box (with individual tare of 1.5 kg), and finally weighed (by using a proper electronic scales).
Compositional percentages by mass	In this study (see Sections 2.3 and 3.2), the following aggregations of specific sub-fractions were considered: metal (assumed as the aggregation of pertaining packaging and other metal), organic (OFRMW, assumed as the aggregation of pertaining green waste, kitchen waste, and fines), paper/cardboard (assumed as the aggregation of pertaining paper and cardboard), plastic (assumed as the aggregation of pertaining packaging and other plastic), wood (assumed as the aggregation of pertaining packaging and other wood), and other (assumed as the aggregation of inert, hazardous waste, waste electrical and electronic equipment, and residue from sorting).

Table S3. Complementary evaluation in the BIOENERGY$_{us\text{-}OFRMW}$ scenario, present time basis: resulting amounts of the sc-OFMW and related potential bioenergy recovery through AD in the provincial territories and the whole Marche Region.

Provincial Territory / Total	sc-OFMW (ton year^{-1})	Biomethane Production (Nm^3 year^{-1})	Gross Electrical Energy (GWh year^{-1})	Electrical Power (MW$_{el}$)	Net Electrical Energy (GWh year^{-1})	Gross CHP Energy Recovery (GWh year^{-1})
PT1	60,753	5,364,477	20.39	2.49	18.45	44.26
PT2	66,433	5,866,004	22.29	2.72	20.17	48.39
PT3	53,293	4,705,795	17.88	2.18	16.18	38.82
PT4	24,361	2,151,120	8.17	1.00	7.40	17.75
PT5	36,321	3,207,186	12.19	1.49	11.03	26.46
Marche Region	241,161	21,294,582	80.92	9.88	73.23	175.68

Table S4. Complementary evaluation in the BIOENERGY$_{us\text{-}OFRMW}$ scenario, present time basis: resulting aggregation of the potential bioenergy recovery through AD from the us-OFRMW (see Table 5) and sc-OFMW (see Table S3) in the whole Marche Region.

	us-OFRMW + sc-OFMW
Gross electrical energy (GWh year^{-1})	116.6
Electrical power (MW$_{el}$)	14.23
Net electrical energy (GWh year^{-1})	105.51
Gross CHP energy recovery (GWh year^{-1})	253.14

Table S5. Complementary evaluation in the BIOENERGY$_{us\text{-}OFRMW}$ scenario, present time basis: comparison of the aggregation of the potential bioenergy recovery through AD from the us-OFRMW and sc-OFMW to electrical energy productions and consumptions in the Marche Region.

Comparison to Energy Production or Consumption	us-OFRMW + sc-OFMW
Contributions on regional electrical energy production sources [55]	
Gross electrical energy (see Table S4) on:	
- regional gross electrical energy production from renewable sources (%)	6.0
- regional gross electrical energy production from bioenergy (%)	79.6
Gross CHP energy recovery (see Table S4) on regional gross CHP energy production (%)	26.2

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Alternative shares in regional electrical energy consumptions by representative sectors [55]	
Net electrical energy (see Table S4) in:	
- regional electrical energy consumption by agriculture (%)	93.2
- regional electrical energy consumption by manufacturing industry (%)	4.3
- regional electrical energy consumption by commercial sector (%)	18.7
- regional electrical energy consumption by public offices (%)	100.7
- regional electrical energy consumption by health service (%)	85.9
- regional electrical energy consumption by public lighting (%)	62.5
- regional electrical energy consumption by hospitality sector (%)	32.9
- regional electrical energy consumption by domestic sector (%)	6.8

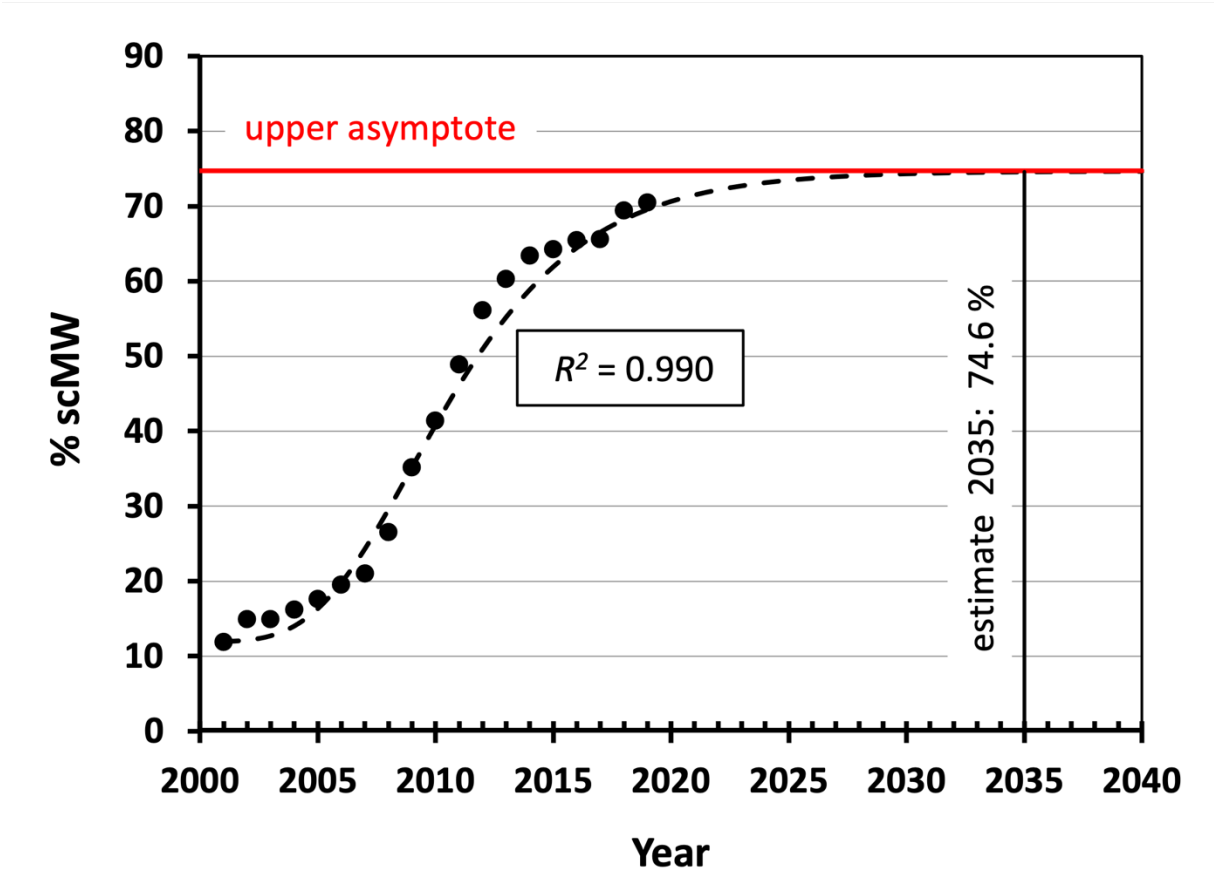

Figure S2. BIOENERGY$_{\text{us-OFRMW}}$ scenario, future time basis: resulting estimate of the level of sc-MW in the reference year 2035 based on the modified Gompertz modelling (see Section 2.4).

Table S6. Complementary evaluation in the BIOENERGY$_{us\text{-}OFRMW}$ scenario, future time basis: estimated amount of the sc-OFMW and related potential bioenergy recovery through AD in the whole Marche Region.

	sc-OFMW
Amount (ton year^{-1})	226,961
Biomethane production (Nm^3 year^{-1})	20,040,614
Gross electrical energy (GWh year^{-1})	76.15
Electrical power [MW$_{el}$]	9.29
Net electrical energy (GWh year^{-1})	68.92
Gross CHP energy recovery (GWh year^{-1})	165.34

Table S7. Complementary evaluation in the BIOENERGY$_{us\text{-}OFRMW}$ scenario, future time basis: resulting aggregation of the potential bioenergy recovery through AD from the us-OFRMW (see Table 7) and sc-OFMW (see Table S6) in the whole Marche Region.

	us-OFRMW + sc-OFMW
Gross electrical energy (GWh year^{-1})	104.61
Electrical power (MW$_{el}$)	12.76
Net electrical energy (GWh year^{-1})	94.68
Gross CHP energy recovery (GWh year^{-1})	227.14

Table S8. BIOENERGY$_{us\text{-}OFRMW}$ versus BIOENERGY-IMPACT$_{bios\text{-}OFRMW}$ scenario: expected beneficial effects of the potential bioenergy recovery through AD from the us-OFRMW on the long-term scale (from 2019 to 2035) in the whole Marche Region.

Representative yearly assumptions	
Representative gross electrical energy (GWh year^{-1}) in 2019-2035 [1]	32.07
Representative net electrical energy (GWh year^{-1}) in 2019-2035 [1]	29.02
Representative gross CHP energy recovery (GWh year^{-1}) in 2019-2035 [1]	69.63
Representative avoided CO_2 eq. diffuse emissions (ton CO_2 eq.) from the bios-OFRMW that would be alternately deposited in each year from 2019 to 2035 [2]	9586
Beneficial effects	
Long-term period (from 2019 to 2035) (year)	17
Total gross electrical energy from 2019 to 2035 (GWh)	545
Total net electrical energy from 2019 to 2035 (GWh)	494
Total gross CHP energy recovery from 2019 to 2035 (GWh)	1184
Totally avoided CO_2 eq. diffuse emissions (ton CO_2 eq.)	162,962

[1] Mean of the respective regional values at the present (2019: see Table 5) and future (2035: see Table 7) time basis; [2] Mean of the respective regional values at the present (2019: see Table 8) and future (2035: see Table 9) time basis.