



Output 6.2

Market Analysis of Italy and Spain

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1. MARKET ANALYSIS ITALY

In Italy, there are 60,244,639 inhabitants (2019). Table 1 and Figure 1 show the percentage of separate waste collection in Italy which is 61.28% with differences between North (69.60%), South (50.63%) and center (57.78%).

Table 1: Production and separate collection of urban waste - 2019 (ISPRA).

	Population (n.inh.)	RD(t)	RU(t)	RD (%)	Per-capita RD (kg/inh.*year)	Per-capita RU (kg/inh.*year)
ITALY	60.244.639	18.397.318,69	30.023.033,33	61,28	305,38	498,35
North	27.774.970	10.021.294,61	14.398.682,47	69,60	360,80	518,40
Center	11.986.958	3.761.965,27	6.510.345,53	57,78	313,84	543,12
South	20.482.711	4.614.058,82	9.114.005,34	50,63	225,27	444,96

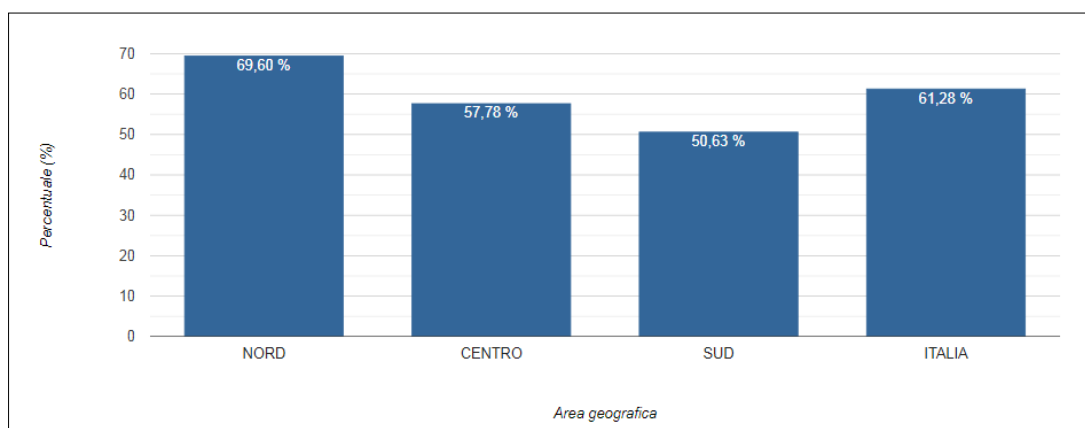


Figure 1: Separate collection waste in Italy - 2019 (ISPRA).

In particular, Table 2 shows the separate collection for each category. In Italy the organic fraction is present in greater quantity (7.300.051,270 ton). However, Table 3 shows that Lombardia is the region with the highest quantity of organic fraction collected (1.270.557,969 ton), while Basilicata (35.383,910 ton) is third from the last, before Molise (23.347,540 ton) and Valle d'Aosta (17.147,493 ton).

Table 2: Separate collection by fraction.

	ITALY	North	Center	South
Other waste RD (t)	302.817,197	136.965,594	78.223,355	87.628,248
Bulky waste (t)	865.049,701	502.689,283	142.104,534	220.255,884
Paper and cardboard (t)	3.523.659,101	1.800.936,164	843.476,046	879.246,891
Organic Fraction (t)	7.300.051,270	3.787.896,946	1.488.951,546	2.023.202,778
Wood (t)	930.449,964	685.390,874	146.024,102	99.034,988
Metals (t)	357.636,099	230.988,544	61.784,738	64.862,817
Plastic (t)	1.508.204,497	802.609,506	277.916,537	427.678,454
WEEE (t)	279.767,348	155.815,293	57.063,258	66.888,797
Selettiva (t)	53.139,104	36.876,386	9.668,218	6.594,500
Textile (t)	157.703,026	80.085,666	35.418,404	42.198,956
Glass (t)	2.237.970,966	1.223.574,494	451.399,242	562.997,230
Construction and demolition waste (t)	429.747,720	289.465,099	74.096,596	66.186,026
Road cleaning and recovery (t)	451.122,702	288.000,760	95.838,697	67.283,246

Table 3: National production - Organic fraction -2019 (ISPRA).

REGION	ORGANIC FRACTION (t)
Piemonte	460.141,291
Valle d'Aosta	17.147,493
Lombardia	1.270.557,969
Trentino-Alto Adige	141.671,845
Veneto	767.965,933
Friuli-Venezia Giulia	167.759,387
Liguria	136.669,082
Emilia-Romagna	825.983,946
Toscana	550.489,325
Umbria	125.679,759
Marche	247.930,931
Lazio	564.851,531
Abruzzo	162.309,970
Molise	23.347,540
Campania	625.212,017
Puglia	382.605,760
Basilicata	35.383,910
Calabria	163.023,731
Sicilia	389.576,476
Sardegna	241.743,374

The Basilicata Region has a number of inhabitants equal to 555.934 and there are 131 municipalities. The selective waste collection in Basilicata in 2019 amounted to 49,37% of the total. In particular, 38,70% of separate waste collection is in the province of Matera, while 56,80% is in the province of Potenza (ISPRA, 2019).

Table 4: Production and separate collection of urban waste by province - Basilicata - 2019 (ISPRA).

	Istat	Population (n.inh.)	RD(t)	RU(t)	RD (%)	Per-capita RD (kg/inh.*year)	Per-capita RU (kg/inh.*year)
Basilicata	17	556.934	97.369,856	197.213,762	49,37%	174,83	354,11
Potenza	17076	360.936	66.041,999	116.261,955	56,80 %	182,97	322,11
Matera	17077	195.998	31.327,857	80.951,807	38,70 %	159,84	413,02

The following table shows the quantities (tons) of sorted waste for each type (ISPRA, 2019).

Figure 2 shows that the organic fraction represents the type of waste produced and collected in greater quantities (35.384 t).

Table 5: Separate collection by fraction on a provincial and regional scale-2019 (ISPRA).

	Region	Province	
	Basilicata	Potenza	Matera
Istat	17	17076	17077
Other waste RD (t)	3.315,490	2.660,065	655,422
Bulky waste (t)	1.957,410	1.113,784	843,630
Paper and cardboard (t)	25.587,832	17.422,986	8.164,847
Organic Fraction (t)	35.383,910	23.655,860	11.728,050
Wood (t)	2.941,682	1.786,998	1.154,683
Metals (t)	2.449,359	1.807,114	642,245
Plastic (t)	6.499,217	4.072,855	2.426,362
WEEE (t)	1.620,575	1.189,259	431,316
Selettiva (t)	96,341	72,899	23,442
Textile (t)	2.166,045	1.562,747	603,299
Glass (t)	14.567,748	9.955,177	4.612,571
Construction and demolition waste (t)	493,315	451,325	41,990
Road cleaning and recovery (t)	290,930	290,930	-

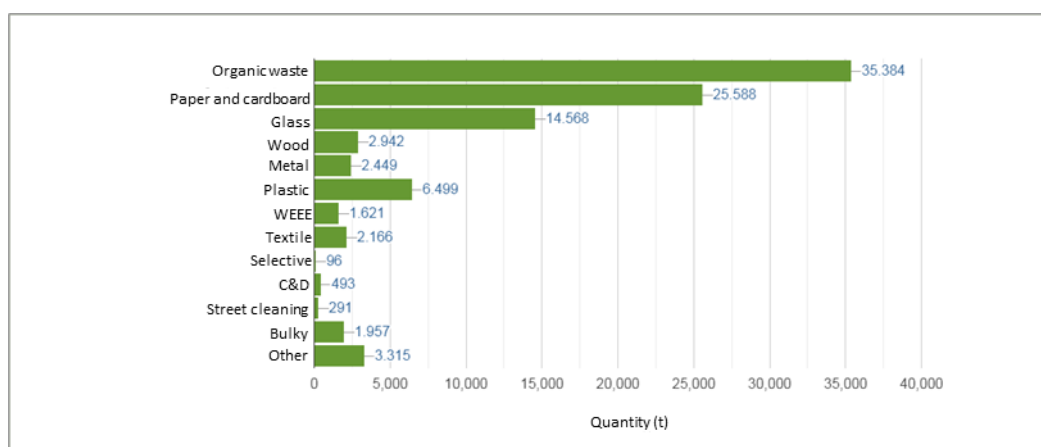


Figure 2: Collection by fraction in the Basilicata region, year 2019.

In Italy, currently, there are 281 composting plants, which allow 1.719.534 tons of organic waste to be treated (Table 6).

Table 6: Composting plants in Italy - 2019 (ISPRA).

Geographic area	N. plants	Organic fraction (t)	Green (t)	Tot. RU (t)	Sludge (t)	Other (t)	Total (t)
North	172	462.491,0	1.083.583,1	1.546.074,1	243.141,0	253.672,0	2.042.887,1
Center	42	295.129,0	194.564,0	489.693,0	56.125,0	59.060,0	604.878,0
South	67	961.914,0	143.269,0	1.105.183,0	147.899,0	38.178,0	1.291.260,0
ITALY	281	1.719.534,0	1.421.416,1	3.140.950,1	447.165,0	350.910,0	3.939.025,1

The composting plants in Italy are mainly located in Lombardia (64), Veneto (45) and Sicilia (21), while in Basilicata there are no composting plants for the treatment of the organic fraction (Figure 3 and Figure 4).



Figure 3: Location of municipal waste treatment plants - Italy, Composting plants, year 2019.

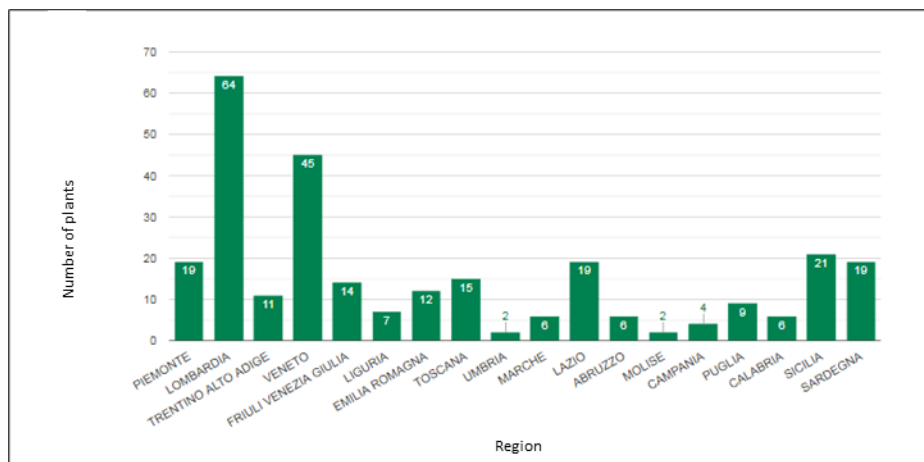


Figure 4: Number of composting plants by region, year 2019.

Figure 5 and Table 7 show the composting plants present in southern Italy (67), of which 21 in Sicilia and 19 in Sardegna. However, even if the FORSU represents most of the waste produced in the region, Basilicata currently has no composting plants operating in the area, as shown in the following figure.

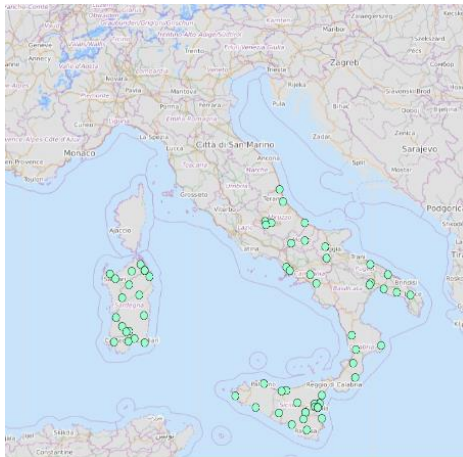


Figure 5: Location of municipal waste treatment plants - South, Composting plants, year 2019.

Table 7: Municipal waste management by region - Composting plants - South - 2019 (ISPRA).

Geographic area	N. plants	Organic fraction (t)	Green (t)	Tot. RU (t)	Sludge (t)	Other (t)	Total (t)
Abruzzo	6	131.989,0	12.355,0	144.344,0	28.132,0	2.984,0	175.460,0
Molise	2	15.230,0	1.561,0	16.791,0	1.236,0	105,0	18.132,0
Campania	4	57.415,0	7.263,0	64.678,0	12.501,0	10.022,0	87.201,0
Puglia	9	276.943,0	25.151,0	302.094,0	9.688,0	7.339,0	319.121,0
Calabria	6	60.289,0	24.693,0	84.982,0	0,0	48,0	85.030,0
Sicilia	21	236.969,0	33.839,0	270.808,0	96.274,0	12.624,0	379.706,0
Sardegna	19	183.079,0	38.407,0	221.486,0	68,0	5.056,0	226.610,0
SOUTH	67	961.914,0	143.269,0	1.105.183,0	147.899,0	38.178,0	1.291.260,0

In Basilicata region there are 2 TMB plants, 1 incineration plant and 1 co-incineration plant and finally 5 landfills (Figure 6).

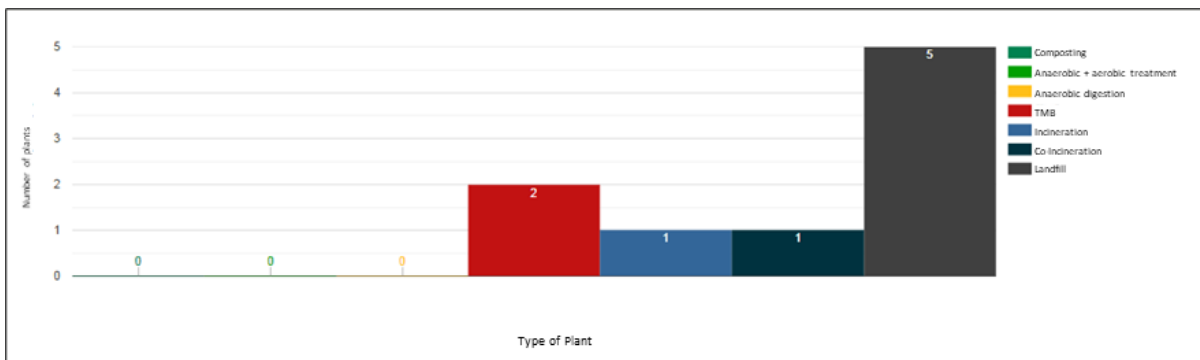


Figure 6: Number of plants in the Basilicata region, by type - 2019 (ISPRA).

Community composting is regulated by the D.M. (Ministerial Decree) of 29 December 2016, n. 266 "Regulation containing the operating criteria and simplified authorization procedures for the composting of organic waste communities", consisting of 10 articles.

In art. 1 defines the simplified authorization procedures and the operational criteria for community composting activities that do not exceed 130 tons/year (*Article 183, paragraph 1, Legislative Decree 152/2006*), for higher capacities the provisions of which to art. 208 and 214 of Legislative Decree 152/2006. In **art. 2** some useful definitions are reported such as the difference between static equipment and electromechanical equipment, i.e. the former allows aerobic decomposition by natural aeration, in the second case the aeration takes place by induction. The table shows a classification of composters according to the treatment capacity.

Table 8: Classification of community composting equipment by size.

Size	T/year maximum	Equipment
T1	10	Small
T2	60	Medium
T3	130	Big

For composters of small size (T1) the equipment is of the static or electromechanical type, while in the case of medium size (T2) or large (T3) the equipment is of the electromechanical type. The materials and waste admissible in the equipment are identified in **Article 4** (Table 9)

Table 9: Materials and waste admissible (All.3).

Type of waste	CER Cod
Biodegradable waste from kitchens and canteen	20 01 08
Biodegradable waste produced by gardens and parks	20 02 01
Sawdust, shavings, cuttings, wood	03 01 05
Bark and wood waste from paper processing if not added	03 03 01
Filter material deriving from periodic maintenance of the biofilter in service of the equipment	15 02 03
paper and cardboard packaging	15 01 01

wooden packaging	15 01 03
paper and cardboard	20 01 01

Article 5 defines the installation requirements and conditions, i.e. the equipment must be placed close to the conferring users or at most within 1 km of distance from them and the waste is delivered autonomously. **Article 6** shows the characteristics of the compost produced (Table 10), which is used for the fertilization of the users' land. Compost that doesn't meet these requirements is considered urban waste.

Table 10: Characteristics of the compost produced (All.6).

Parameter	Values
Moisture	30% - 50%
Temperature	T.amb +2°C
pH	6 - 8.5
extraneous fractions	< 2%
dangerous fractions	absent

The Italian Composting Association (AIC) reports the presence of community composting plants with different treatment capacities in some municipalities of the Basilicata Region. In particular, composters have been installed in the municipalities of San Chirico Raparo, Castelgrande, Paterno, Vietri di Potenza, Salandra, San Mauro Forte and Gorgoglione with the characteristics shown in Table 11 (*Source: AIC*).

Table 11: Community composting plants in Basilicata Region.

Municipality	Inhabitants	Numbers	Potential	Firm
San Chirico Raparo (PZ)	966	1	60	Crtech Group
Castelgrande (PZ)	876	1	50	Crtech Group
Paterno (PZ)	3.224	2	150	Crtech Group
Vietri di Potenza (PZ)	2.773	1	80	Crtech Group
Salandra (MT)	2.653	1	110	Comar
San Mauro Forte (MT)	1.405	1	110	Comar
Gorgoglione (MT)	911	1	110	Comar

In the municipalities listed above, there is a percentage of variable separate waste collection (Table 12), from a minimum of 1.87% in the case of San Chirico Raparo to a maximum value in the case of the aggregation of municipalities - Accettura, Calciano, Garaguso, Salandra and San Mauro Forte (76.89%).

Table 12: Production and separate collection of urban waste in the municipalities of the province of Potenza - 2019 (ISPRA).

Municipality	Population (n.inh.)	RD(t)	RU(t)	RD (%)	Per-capita RD (kg/inh.*year)	Per-capita RU (kg/inh.*year)
--------------	---------------------	-------	-------	--------	------------------------------	------------------------------

San Chirico Raparo (PZ)	966	5,700	305,190	1,87 %	5,90	315,93
Castelgrande (PZ)	876	89,280	224,180	39,83 %	101,92	255,91
Paterno (PZ)	3.224	259,293	750,873	34,53 %	80,43	232,90
Vietri di Potenza (PZ)	2.773	408,240	610,980	66,82 %	147,22	220,33
Salandra (MT)	2.653	1.598,59	2.078,97	76,89%	213,5	277,7
San Mauro Forte (MT)	1.402					
Gorgoglione (MT)	911	61,49	340,6	18,04%	67,5	374,2

2. Actual implementation

2.1. H&CC systems description

2.1.1. Comparison and applications of different community composting technology in Italy

In Italy there are two main types of applications for Community Composting, as reported in the National Legislation (Ministerial Decree n. 266 of 29/12/2016): static or electromechanical composters. In the static systems the handling of the waste is performed manually by the responsible of the process who decide when to move the material based on the specific condition analysed. In the electromechanical systems, the waste is mixed mechanically and automatically at least 3 times a day (Oddo & Sagnotti, 2017).

Static composting can be performed up to a maximum of 10 tons/y, usually it is applied for home composting, but there are examples of community composters too. In this case the composters are divided into 2 chambers with a different function:

- The first one is open to the community and it is used for the loading of organic waste by citizens.
- The second one is dedicated to the maturation of the compost and it is closed to citizens with special padlocks.

The two chambers usually alternate in their function every 6 months.

The composters are usually made up of wooden slats and each chamber has two openable lids with a handle to facilitate opening and special padlocks for when the chambers are locked (Progetto COMLOC, 2017).

Electromechanical composters can be applied up to a maximum capacity of 130 t/y for community composting (Ministerial Decree n. 266 of 29/12/2016). These machines were initially only of foreign construction, while now there are also Italian producers. The system is usually composed of:

- A waste delivery area for both organic waste and structuring material, sometimes equipped with a shredder (optional).
- One or more chambers (typically cylindrical in shape) where the waste and the structuring undergo the first stage of composting. The advancement of the mass is ensured by the presence of mechanical arms (reels) or by the rotation of the entire chamber.
- A forced ventilation system, typically composed of a fan that extracts the air from the chambers, consequently the composter does not emit odors because in continuous small air depression.
- An odor abatement system (biofilter) that could be generated in the case of activation of anaerobic processes due to poor management of the machinery. The biofilter can be composed of activated carbon or tree bark.
- An area where maturation ends, for example in heaps (Progetto COMLOC, 2017).
- A control display

In addition, all the composters are generally equipped with temperature sensors for the monitoring of the process and the possibility of remote control.

Considering the monitoring of the process, specific items has been developed. Among those, the “Compostino”, developed by the ENEA research centre (<https://www.enea.it/it/seguici/pubblicazioni/opuscoli/flyer/compostino>) can be installed in almost all kind of electromechanical composters. The system is composed of different modules:

1. Central module "compostino", based on Arduino Mega, receives via radio (NRF24L01) the data of the various sensors, performs hourly averages, and optionally:

- a) saves on SD
- b) sends to remote server via Wifi or GPRS
- c) displays on LCD screen o Touch Screen
- d) exchange via Bluetooth with smartphone
- e) exchange data with PC via serial USB2.

2. Air analysis module: with sensors for CO₂, CH₄, NH₃, H₂S, O₂, temperature, air humidity and hot wire anemometer. It is equipped with an optional fan for air intake if the measurement is carried out on heaps. Based on the Arduino nano, it sends the data via radio to the central module or exchanges them via Bluetooth with a smartphone.

3. Composter analysis module: based on Arduino Nano, measures the temperature and humidity (capacitive sensor) and sends the data to the central module

4. Heap module: based on Arduino Nano, measures the heap temperature and humidity through a tip to be introduced into the mass.

Finally, the following optionals are usually provided by the producers of electromechanical composters:

- Access control system via badge
- Waste weighing system with automatic structuring agent dosage
- Loading hopper or lifting bins
- Waste shredder or final screen
- Training course for operators

In Italy different applications has been applied and, even if there are some examples of community composting with static machines, the main commercialized systems are electromechanical. In the following table (

Table 13) a summary of the main applications of electromechanical composting in Italy from 2009 to 2019 are reported.

Most of the applications are managed by the municipality and the composter can be placed or inside the municipality, for example in the Municipal pitch or outside the centre of the town in specific Ecological centre. There are also different examples where the composter is not managed by the municipality but is applied to a specific facility like for example a school canteen or a company or a restaurant. In Table 14 the different applications are grouped based on the client, responsible for the management of the syste

Table 13: Application of community composting in Italy, from 2009 to 2019

Producer/distributing company	Year of installation	Capacity (t/y)	Number	Municipality	Client
Ecopans	2014	5	1	Tignale (BS)	Center for the elderly of Tignale
Ecopans	2017	10	1	Rogno (BG)	Elementary School of Rogno
Ecopans	2017	10	1	Cividale del Friuli (UD)	Center for the elderly
Ecopans	2017	30	1	Varese Ligure (SP)	Ecological island
Ecopans	2017	30	1	San Felice del Molise (CB)	Ecological island
Ecopans	2018	60	1	Mafalda (CB)	Ecological island
Ecopans	2019	130	1	San Martino in Pensilis (CB)	Ecological island
Ecopans	2019	60	1	Isola d'Asti (AT)	Self-composting center
Ecopans	2019	80	1	Berceto (PR)	Ecological island
Ecopans	2019	60	1	Riparbella (PI)	Ecological island
Achab Group	2016	22	1	Frigento (AV)	Anpas
Achab Group	2014	62	1	Casalbuono (SA)	Municipality of Casalbuono
Achab Group	2017	62	2	Caserta (CE)	CO.GE.PI
Achab Group	2016	62	1	Frigento (AV)	Municipality of Frigento
Achab Group	2013	62	1	Moio della Civitella (SA)	Ecological island
Achab Group	2016	33	1	Torrioni (AV)	Municipality of Torrioni
Achab Group	2012	33	1	Pieve di Cento	Kindergarten school Pieve di Cento
Achab Group	2019	5	1	Fiorano Modenese	
Achab Group	2011	33	1	Casaccia (RM)	Municipal pitch
Achab Group	2013	62	1	Arce (FR)	Municipal pitch
Achab Group	2014	33	1	Rieti (RT)	Prison
Achab Group	2016	62	1	Bassiano (LT)	Municipal pitch
Achab Group	2016	5	3	Bassano Romano (VT)	School canteen
Achab Group	2016	25	1	Oriolo Romano (VT)	Municipal pitch
Achab Group	2016	62	1	Ponza (LT)	Municipal pitch
Achab Group	2016	5	1	Monte Compatri (RM)	School canteen
Achab Group	2016	22	1	Monte Compatri (RM)	School canteen

Achab Group	2017	22	1	Montelibretti (RM)	Military Veterinary Hospital
Achab Group	2015	22	1	Cesano (RM)	Enea
Achab Group	2014	22	1	Montalto Ligure (IM)	Municipal pitch
Achab Group	2014	22	1	Cogoleto (GE)	School canteen
Achab Group	2015	33	1	Cogorno (GE)	Gal Genovese (School canteen)
Achab Group	2015	33	1	Genova (GE)	Gal Genovese (School canteen)
Achab Group	2015	33	1	Ne (GE)	Gal Genovese (Municipal pitch)
Achab Group	2015	33	1	Seborga (IM)	Municipal pitch
Achab Group	2017	130	1	Gambatesa (CB)	Municipal eco-center
Achab Group	2014	5	1	Ronsecco (VC)	Municipal rest home
Achab Group	2015	22	1	Rongio Superiore (BI)	Delivery pitch
Achab Group	2015	130	1	Sant'Agata di Puglia (FG)	Municipal pitch
Achab Group	2015	62	2	Miggiano (LE)	Municipal pitch
Achab Group	2015	62	2	Anzano di Puglia (FG)	Municipal pitch
Achab Group	2015	130	1	Ugento (LE)	Municipal pitch
Achab Group	2015	130	1	Lizzanello (LE)	Municipal pitch
Achab Group	2015	130	1	Montesano Salentino (LE)	Municipal pitch
Achab Group	2015	62	1	Fondachelli Fantina (ME)	Municipal pitch
Achab Group	2013	5	1	Iar (AO)	Agricultural Centre of the Ollignan Foundation
Crtech Group		5	11	Lecce (LE)	Ministry of Education
Crtech Group		25	1	Alliste (LE)	Municipality of Alliste
Crtech Group		150	1	Castri di Lecce (LE)	Municipality of Castri di Lecce
Crtech Group		150	1	Caprarica di Lecce (LE)	Municipality of Caprarica di Lecce
Crtech Group		150	1	Castrignano dei Greci (LE)	Municipality of Castrignano dei Greci
Crtech Group		150	1	Monteparano (TA)	Municipality of Monteparano
Crtech Group		150	1	Melpignano (LE)	Municipality of Melpignano
Crtech Group		150	1	Cursi (LE)	Municipality of Cursi
Crtech Group		150	1	Ortelle (LE)	Municipality of Ortelle
Crtech Group		150	1	Nociglia (LE)	Municipality of Nociglia
Crtech Group		150	1	Carpignano Salentino (LE)	Municipality of Carpignano Salentino
Crtech Group		50	2	Biccari (FG)	Municipality of Biccari
Crtech Group		150	1	Deliceto (FG)	Municipality of Deliceto
Crtech Group		50	1	Jenne (RM)	Municipality of Jenne

Crtech Group		50	1	Tivoli (RM)	Municipality of Tivoli
Crtech Group		50	1	San Chirico Raparo (PZ)	Municipality of San Chirico Raparo
Crtech Group		50	1	Castelgrande (PZ)	Municipality of Castelgrande
Crtech Group		150	2	Paterno (PZ)	Municipality of Paterno
Crtech Group		80	1	Vietri di Potenza (PZ)	Municipality of Vietri di Potenza
Crtech Group		150	1	San Cassiano – Badia (BZ)	Municipality of San Cassiano
Crtech Group		25	1	Rometta (ME)	Municipality of Rometta
Crtech Group		10	1	Lascari (PA)	Municipality of Lascari
DBM/Joraform		20	1	Levata di Curtatone (MN)	Kindergarten school Corte Verde
DBM/Joraform		20	1	Taurianova (RC)	Reuse Center
DBM/Joraform		20	1	Spezzano Albanese (CS)	Municipality of Spezzano Albanese
DBM/Joraform		20	1	Ginestra (PZ)	
DBM/Joraform		20	1	Cuccaro Vetere (SA)	
DBM/Joraform		20	1	Formicola (CE)	
DBM/Joraform		20	1	Acquapendente (VT)	
DBM/Joraform		20	1	Roma (RM)	
DBM/Joraform		20	1	Pigna (IM)	
DBM/Joraform		20	1	Bra (CN)	
DBM/Joraform		20	1	Favignana (TR)	
Dizioinoxa	2015	125	1	Zagarise (CZ)	Municipality of Zagarise
Dizioinoxa	2016	125	1	Roseto Valforte (FG)	Municipality of Roseto Valforte
Dizioinoxa	2016	125	1	Orsara (FG)	Municipality of Orsara
Satriani		20	1	Lecce (LE)	
Satriani		140	1	Arnesano (LE)	
Satriani		180	1	San Marco la Catola (FG)	
Satriani		5	1	Foggia (FG)	
Satriani		18	2	Concerviano (RI)	
Satriani		30	1	Trevignano Romano	
Satriani		30	1	Roma (RM)	
Satriani		30	1	Potenza (PZ)	
Comar	2009	5.5	1	Siena (SI)	Casabianca Farm
Comar	2010	5.5	1	Castiglione del Lago (PG)	Badiaccia Camping Village
Comar	2010	5.5	1	Tuoro sul Trasimeno (PG)	Hotel Restaurant Volante Inn

Comar	2011	22	1	Vinovo (TO)	Municipality of Vinovo
Comar	2012	5.5	1	Viterbo (VT)	Agricultural University
Comar	2012	5.5	1	Neviano (LE)	Municipality of Neviano
Comar	2012	5.5	1	Molfetta (BA)	Bari University
Comar	2012	5.5	1	Modugno (BA)	Omnitech
Comar	2012	5.5	1	Molfetta (BA)	Company Primavita
Comar	2013	5.5	1	Vieste (FG)	Residence Villa Carabella
Comar	2013	25	1	Vasto (CH)	Region Abruzzo
Comar	2013	5.5	1	Casaccia (RM)	Sede Enea
Comar	2013	25	1	Santu Lussurgiu (OR)	Municipality of Santu Lussurgiu
Comar	2014	110	1	Salandra (MT)	Municipality of Salandra
Comar	2014	110	1	San Mauro Forte (MT)	Municipality of San Mauro Forte
Comar	2014	110	1	Gorgoglione (MT)	Municipality of Gorgoglione
Comar	2014	5.5	1	Frattamaggiore (NA)	Omnitech
Comar	2014	25	1	Dolceacqua (IM)	Municipality of Dolceacqua
Comar	2014	5.5	2	San Vito dei Normanni (BR)	Municipality of San Vito Normanni
Comar	2014	5.5	1	Rossano (CS)	Municipality of Rossano
Comar	2014	25	1	Rossano (CS)	Municipality of Rossano
Comar	2014	5.5	1	Vieste (FG)	Chianca Island Tourist Village
Comar	2014	25	1	Casarza Ligure (GE)	Municipality of Casarza Ligure
Comar	2014	25	1	Rocchetta di Vara (SP)	Municipality of Rocchetta di Vara
Comar	2014	5.5	1	Cori (LT)	Municipality of Cori
Comar	2015	25	1	Alessandria (AL)	Alexandrian Basin Consortium
Comar	2015	5.5	1	Gressoney Saint Jean (AO)	Knubel S.A.S di M. Squinobal & Co.
Comar	2016	5.5	2	Palombara Sabina (RM)	Municipality of Palombara Sabina
Comar	2016	200	1	Canale Monterano (RM)	Municipality of Canale Monterano
Comar	2016	12	1	Amatrice (RI)	Municipality of Amatrice
Comar	2016	25	1	Perinaldo (IM)	Municipality of Perinaldo
Comar	2016	35	1	Ospedaletti (IM)	Municipality of Ospedaletti
Comar	2016	40	1	Molini di Triora (IM)	Municipality of Molini di Triora
Comar	2016	12	1	Bajardo (IM)	Municipality of Bajardo
Comar	2016	20	1	Ceriana (IM)	Municipality of Ceriana
Comar	2016	25	1	Davagna (SP)	Municipality of Davagna

Comar	2017	25	1	Follo (SP)	Municipality of Follo
Comar	2017	80	1	Camposso (IM)	Municipality of Camposso

Table 14: Number of applications for each category of client

Clients	Number of applications
Retirement home	3
School / School Canteen	9
University	2
Private/Public company	8
Ministry/Region	2
Restaurant/Hotel/Residence	4
Farm	2
Hospital	1
Prison	1
Municipality	78

2.1.2 Municipalities and applications

As shown in

Table 13 and Table 14, numerous applications of community composting are already in place in Italy. In Figure 7 the distribution of the applications is represented, and it can be noticed that the majority of the composters are located in the centre and in the south Regions. This is probably due to the absence of an adequate distributions of centralized plant for the organic fraction of waste.



Figure 7: Community composting applications in Italy

In the following table the specific characteristics of the municipalities where the composters are placed are summarized.

Table 15: Municipalities where community composting is applied

Municipality	Population	Area	Population density	Altitude	Number of composters	Capacity
	Inhab.	km2	Inhab. /km2	m		
Vasto (CH)	40489	71.34	568	144	1	25
San Chirico Raparo (PZ)	956	84.07	11	780	1	50
Castelgrande (PZ)	864	34.9	25	950	1	50
Paterno (PZ)	3202	40.74	79	634	2	150
Vietri di Potenza (PZ)	2751	52.24	53	405	1	80
Ginestra (PZ)	721	13.32	54	564	1	20
Potenza (PZ)	66393	175.43	378	819	1	30
Salandra (MT)	2641	77.44	34	552	1	110
San Mauro Forte (MT)	1377	87.06	16	540	1	110

Gorgoglione (MT)	903	34.93	26	800	1	110
Taurianova (RC)	15118	48.54	311	210	1	20
Spezzano Albanese (CS)	6833	32.26	212	320	1	20
Zagarise (CZ)	1526	49.33	31	581	1	125
Rossano (CS)	75126	346.55	217	210	2	30.5
Frigento (AV)	3521	38.04	93	911	2	84
Casalbuono (SA)	1124	34.82	32	661	1	62
Caserta (CE)	73984	54.07	1368	68	2	124
Moio della Civitella (SA)	1861	17.19	108	515	1	62
Torrioni (AV)	473	4.22	112	645	1	33
Cuccaro Vetere (SA)	556	17.66	31	629	1	20
Formicola (CE)	1412	15.68	90	196	1	20
Frattamaggiore (NA)	28735	5.39	5333	44	1	5.5
Berceto (PR)	2008	131.7	15	808	1	80
Pieve di Cento	7113	15.94	446	18	1	33
Fiorano Modenese	17135	26.23	653	115	1	5
Cividale del Friuli (UD)	11117	50.65	220	135	1	10
Arce (FR)	5492	39.52	139	247	1	62
Rieti (RT)	46604	206.46	226	405	1	33
Bassiano (LT)	1459	32.4	45	562	1	62
Bassano Romano (VT)	4583	37.55	122	360	3	15
Oriolo Romano (VT)	369	19.31	191	420	1	25
Ponza (LT)	3309	10.16	326	10	1	62
Monte Compatri (RM)	11802	24.57	480	576	2	27
Montelibretti (RM)	5171	45.43	114	232	1	22
Jenne (RM)	341	31.45	11	834	1	50
Tivoli (RM)	54366	68.64	792	235	1	50
Acquapendente (VT)	5369	131.6	41	420	1	20
Roma (RM)	2808293	1287.4	2181	20	2	50
Concerviano (RI)	270	21.39	13	560	2	18
Trevignano Romano	5641	38.99	145	220	1	30
Viterbo (VT)	65911	406.23	162	326	1	5.5
Cori (LT)	10575	85.31	124	384	1	5.5
Palombara Sabina (RM)	12688	75.8	167	372	2	11
Canale Monterano (RM)	413	36.92	112	378	1	200
Amatrice (RI)	2358	174.38	14	955	1	12

Varese Ligure (SP)	189	137.59	14	353	1	30
Montalto Ligure (IM)	491	30	16	315	1	22
Cogoleto (GE)	8944	20.72	432	4	1	22
Cogorno (GE)	5697	9.08	627	38	1	33
Genova (GE)	565752	240.29	2354	19	1	33
Ne (GE)	2188	63.52	34	68	1	33
Seborga (IM)	280	4.87	57	500	1	33
Pigna (IM)	768	53.23	14	280	1	20
Dolceacqua (IM)	2032	20.28	100	51	1	25
Casarza Ligure (GE)	6698	27.82	241	34	1	25
Rocchetta di Vara (SP)	680	32.66	21	220	1	25
Perinaldo (IM)	815	20.3	40	572	1	25
Ospedaletti (IM)	3116	5.45	572	5	1	35
Molini di Triora (IM)	592	58.05	10	460	1	40
Bajardo (IM)	335	24.32	14	900	1	12
Ceriana (IM)	1128	31.79	35	369	1	20
Davagna (SP)	1847	20.53	90	552	1	25
Follo (SP)	6282	23.27	270	30	1	25
Camporosso (IM)	5491	17.94	306	25	1	80
Tignale (BS)	1209	45.86	26	555	1	5
Rogno (BG)	3779	15.81	239	215	1	10
Levata di Curtatone (MN)	14904	67.47	221	26	1	20
San Felice del Molise (CB)	591	24.37	24	548	1	30
Mafalda (CB)	1138	32.51	35	459	1	60
San Martino in Pensilis (CB)	4684	100.65	47	281	1	130
Gambatesa (CB)	1348	43.68	31	468	1	130
Isola d'Asti (AT)	2026	13.5	150	136	1	60
Ronsecco (VC)	535	24.48	22	145	1	5
Rongio Superiore (BI)	2027	27.07	75	341	1	22
Bra (CN)	29592	59.53	497	290	1	20
Vinovo (TO)	15102	17.69	854	232	1	22
Alessandria (AL)	92876	203.57	456	95	1	25
Sant'Agata di Puglia (FG)	1882	116.13	16	794	1	130
Miggiano (LE)	3411	7.8	437	107	2	124
Anzano di Puglia (FG)	1169	11.01	106	760	2	124
Alliste (LE)	6533	23.53	278	54	1	25
Arnesano (LE)	3995	13.56	295	33	1	140

Biccari (FG)	2675	106.64	25	450	2	100
Caprarica di Lecce (LE)	2386	10.71	223	60	1	150
Carpignano Salentino (LE)	3704	48.99	76	75	1	150
Castri di Lecce (LE)	2805	12.95	217	47	1	150
Castrignano dei Greci (LE)	3779	9.62	393	90	1	150
Cursi (LE)	3999	8.36	479	91	1	150
Deliceto (FG)	3644	75.85	48	575	1	150
Foggia (FG)	149673	509.25	294	76	1	5
Lecce (LE)	93865	238.82	393	49	12	75
Lizzanello (LE)	11686	25.42	460	45	1	130
Melpignano (LE)	2181	11.1	196	89	1	150
Modugno (BA)	37556	32.24	1165	79	1	5.5
Molfetta (BA)	58145	58.97	986	15	2	11
Monteparano (TA)	2327	3.85	605	128	1	150
Montesano Salentino (LE)	2622	8.53	307	106	1	130
Neviano (LE)	5069	16.3	311	108	1	5.5
Nociglia (LE)	2191	11.13	197	102	1	150
Orsara (FG)	257	83.01	31	635	1	125
Ortelle (LE)	2299	10.23	225	99	1	150
Roseto Valforte (FG)	1044	50.05	21	658	1	125
San Marco la Catola (FG)	916	28.62	32	683	1	180
Ugento (LE)	12214	100.4	122	108	1	130
Vieste (FG)	13672	169.19	81	43	2	11
San Vito dei Normanni (BR)	18524	67.08	276	108	2	11
Santu Lussurgiu (OR)	2303	99.8	23	503	1	25
Fondachelli Fantina (ME)	1009	42.21	24	703	1	62
Rometta (ME)	6462	32.12	201	560	1	25
Lascari (PA)	3606	10.33	349	76	1	10
Favignana (TR)	4289	38.31	112	6	1	20
Riparbella (PI)	1599	58.96	27	216	1	60
Siena (SI)	54308	118.53	458	322	1	5.5
San Cassiano - Badia (BZ)	3525	83.07	42	1315	1	150
Castiglione del Lago (PG)	14771	205.27	72	304	1	5.5
Tuoro sul Trasimeno (PG)	3784	55.88	68	309	1	5.5
Gressoney Saint	812	69.65	12	1385	1	5.5

Jean (AO)						
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Analysing the total population and the population density of the municipalities where community composting is applied (Figure 8) it can be noticed that most of the composters are placed in municipalities with low population density (less than 500 inhabitants/km²).

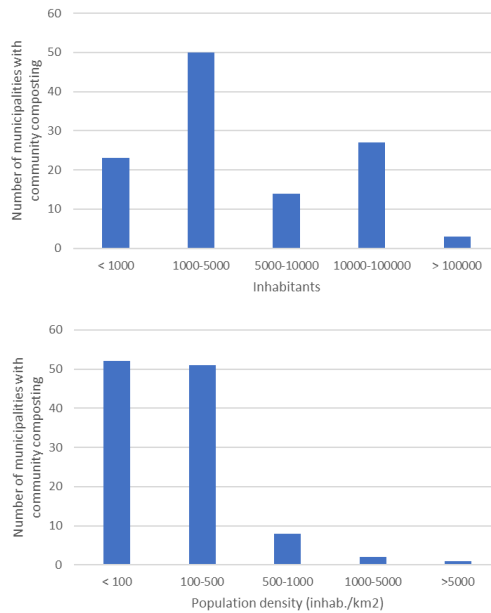


Figure 8: Population and population density of municipalities with community composting
Our study focuses on Basilicata Region. This region, in fact, is characterized by the absence of treatment plants currently active for the organic fraction of waste. For this reason, some interesting activities of community composting have been developed and are described in the following.

1. San Chirico Raparo



Municipality of Basilicata in the province of Potenza with 956 inhabitants (2019), located near the Appennino Lucano Val D'Agri Lagonegrese National Park. The municipality of San Chirico Raparo has an area of 84.07 km² and a population density of 11,05 Ab/km². (<https://ugeo.urbistat.com/AdminStat/it/it/demografia/dati-sintesi/san-chirico-raparo/76074/4?Export=2&MasterType=1>).

Figure 9 shows the demographic trend of the resident population in the municipality from 2001 to 2019.



Figure 9: Trend of the resident population.

In particular, Table 16 shows that the resident population in 2010 is composed of 1.177 individuals, while currently (2019) 956 are residents, with a reduction of 346 inhabitants.

(<https://www.tuttitalia.it/basilicata/34-san-chirico-raparo/statistiche/popolazione-andamento-demografico/>).

Table 16: Resident population

Year	Date	Resident Population	Absolute variation	Percentage variation	Number of families	Average members per family
2001	31 december	1.302	-	-	-	-
2010	31 december	1.177	-125	- 9,60%	575	2,05
2019	31 december	956	- 221	- 18,77%	-	-

Table 17 shows the evolution of separate waste collection in the municipality of San Chirico Raparo from 2010 to 2019. (<https://www.catasto-rifiuti.isprambiente.it/>).

Table 17: Separate waste collection in San Chirico Raparo.

Year	Population	RD (t)	Tot. RU (t)	RD (%)	RD per capita (kg/inh.*year)	RU per capita (kg/inh.*year)
2019	966	5,700	305,190	1,87	5,90	315,93
2018	1.001	5,920	309,790	1,91	5,91	309,48
2017	1.032	22,750	323,770	7,03	22,04	313,73
2016	1.074	26,220	324,990	8,07	24,41	302,60
2015	1.084	28,180	334,650	8,42	26,00	308,72
2014	1.093	38,320	353,610	10,84	35,06	323,52
2013	1.131	29,160	324,010	9,00	25,78	286,48
2012	1.152	35,960	334,190	10,76	31,22	290,10
2011	1.161	34,500	350,690	9,84	29,72	302,06
2010	1.177	39,400	362,880	10,86	33,47	308,31

In 2016, the Municipality of San Chirico Raparo decided to start an aerobic composting activity of the organic fraction of municipal solid waste. The electromechanical community composter, produced by the CrTec company with a capacity of 60 tons/year, is located in an area equipped for a municipal collection center (245.58 m²) in the "località pietra bianca".

The composting plant, aimed at treating the OFMSW produced by domestic users of the municipality of San Chirico Raparo and any neighboring municipalities, provided for the treatment of a limited quantity of 50 t/year with a daily average of 136 kg, a continuous operation 24h/24h for 365 days/year (Figure 10).



Figure 10: Community composter in San Chirico Raparo.

From the inspections carried out, the site doesn't present any constraints that could compromise the performance of the composting activity. The area is stable and safe for carrying out the activities. Overall, the area used has an extension of about 240 m², completely fenced with metal mesh supported by metal poles fixed to the ground and with a height of 2 m, a wooden shed having an area of about 29 m² and a further shed of about 15 m² for loading/unloading operations (Figure 11).

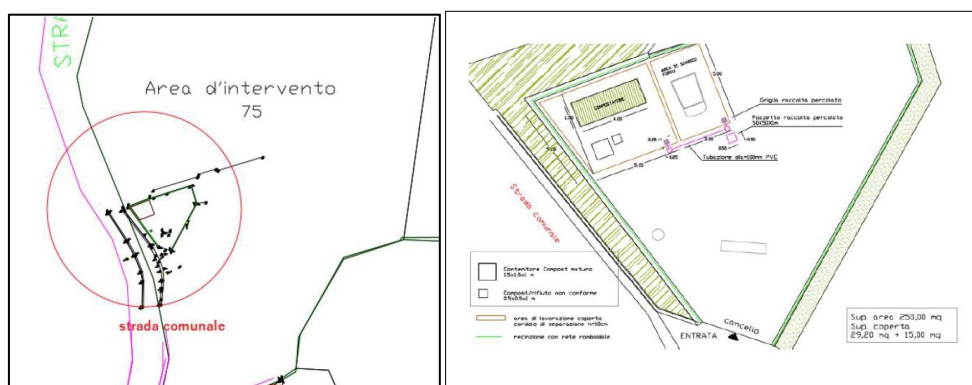


Figure 11: Municipal area used for the installation of the composter.

Currently the plant isn't in operation.

2. Castelgrande



Municipality of Basilicata in the province of Potenza with 864 inhabitants (2019), surrounded by green woods. The Astronomical Observatory of Castelgrande is located 7 km north of the town, on Monte Toppo of Castelgrande.

It has an area of 34,90 km² and a population density of 25,10 inhabitants/km².

(<https://ugeo.urbistat.com/AdminStat/it/it/demografia/popolazione/castelgrande/76021/4>).

Figure 12 shows the demographic trend of the resident population in the municipality from 2001 to 2019.



Figure 12: Trend of the resident population

In particular, Table 18 shows that the resident population in 2010 is composed of 1.177 individuals, while currently (2019) 956 are residents, with a reduction of 346 inhabitants.

Table 18: Resident population

Year	Date	Resident Population	Absolute variation	Percentage variation	Number of families	Average members per family
2001	31 december	1.230	-	-	-	-
2010	31 december	1.032	- 37	- 3%	496	2,08
2019	31 december	864	- 168	- 16,28%	-	-

Table 19 shows the evolution of separate waste collection in the municipality of Calstelgrande from 2010 to 2019 (<https://www.catasto-rifiuti.isprambiente.it>).

Table 19: Separate waste collection in Castelgrande.

Year	Population	RD (t)	Tot. RU (t)	RD (%)	RD per capita (kg/inh.*year)	RU per capita (kg/inh.*year)
2019	876	89,280	224,180	39,83	101,92	255,91
2018	895	84,490	219,430	38,50	94,40	245,17

2017	914	84,200	212,390	39,64	92,12	232,37
2016	918	77,510	221,070	35,06	84,43	240,82
2015	943	83,800	223,830	37,44	88,87	237,36
2014	971	79,655	237,705	33,51	82,03	244,80
2013	977	79,370	244,430	32,47	81,24	250,18
2012	1.011	80,170	240,260	33,37	79,30	237,65
2011	1.018	94,574	257,960	36,66	92,90	253,40
2010	1.032	84,950	245,560	34,59	82,32	237,95

¡Error! No se encuentra el origen de la referencia. Figure 13 shows an increasing trend in the years following 2007 of per capita waste production.

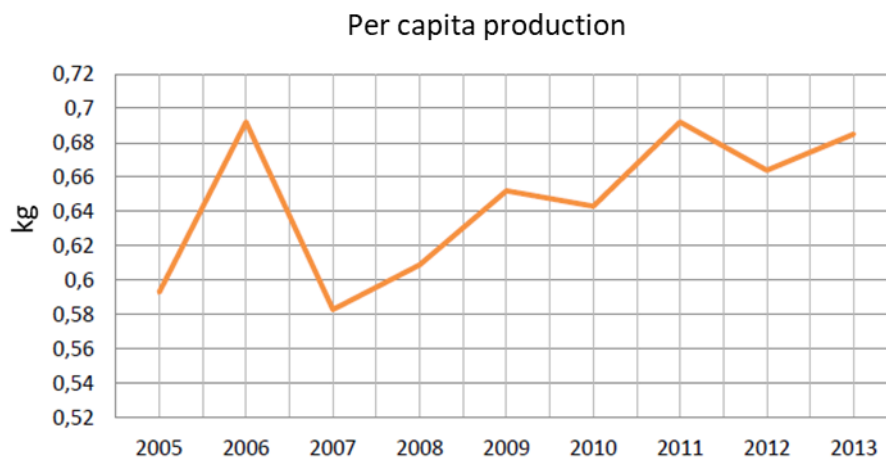


Figure 13: Per capita production of urban solid waste.

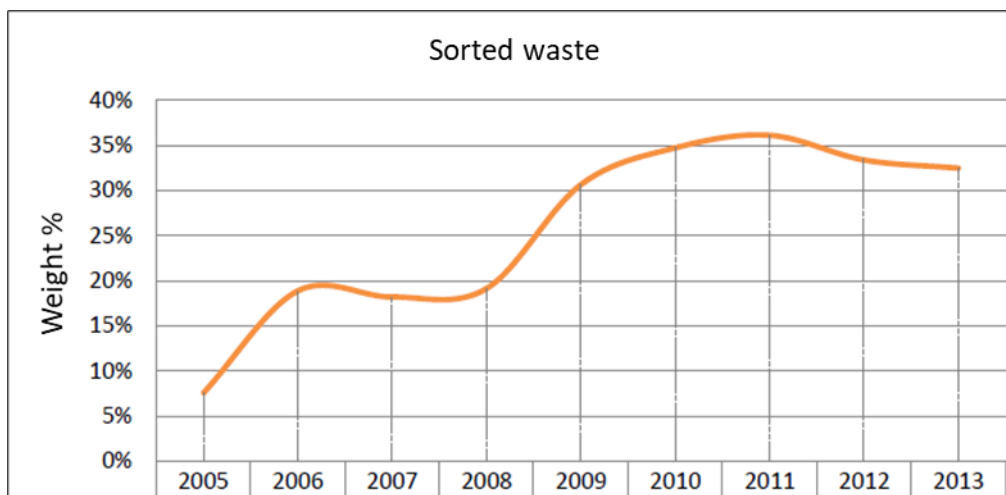


Figure 14: Percentage trend of the quantity of sorted waste.

The previous figure shows that the Municipality of Castelgrande has the maximum performance of 35%, a clear sign that the organic fraction isn't sorted. Therefore, the administration has undertaken a series of actions aimed at the carrying out of a composting plant capable of incorporating all the biological fractions produced in the municipality of Castelgrande. The management of the wet fraction will take place in a municipal composting plant, by installing a composter with a potential of 1000 inhabitants in the Serra delle Brece area. (*Piano di Azione per l'Energia Sostenibile - Patto dei Sindaci*, <http://opservice.regione.basilicata.it/opendata/home.jsp?tile=ATTI.provvedimentiDirigentiAmministrativi.jsp&numAtto=23AA.2018/D.01228&year=2018>).

3. Paterno



Municipality of Basilicata in the province of Potenza with 3.224 inhabitants (2019). Paterno was a fraction of the municipality of Marsico Nuovo until 1973. Its name derives from the latin "patere", meaning "place where you work outdoors". The municipality of Paterno has an area of 40,74 km² and a population density of 79,1 Ab/km².

(<https://ugeo.urbistat.com/AdminStat/it/it/demografia/dati-sintesi/paterno/76100/4>).

Figure 15 xshows the demographic trend of the resident population in the municipality from 2001 to 2019.



Figure 15: Trend of the resident population.

In particular, Table 20 shows that the resident population in 2010 is composed of 3.452 individuals, while currently (2019) 3.202 are residents, with a reduction of 250 inhabitants. (<https://www.tuttitalia.it/basilicata/22-paterno/statistiche/popolazione-andamento-demografico/>).

Table 20: Resident population.

Year	Date	Resident Population	Absolute variation	Percentage variation	Number of	Average members

					families	per family
2001	31 december	4.002	-	-	-	-
2010	31 december	3.452	- 550	- 13,74%	1.430	2,40
2019	31 december	3.202	- 250	- 7,24 %	-	

The following table shows the evolution of separate waste collection in the municipality of Paterno from 2010 to 2019 (<https://www.catasto-rifiuti.isprambiente.it>).

Table 21: Separate waste collection in Paterno.

Year	Population	RD (t)	Tot. RU (t)	RD (%)	RD per capita (kg/inh.*year)	RU per capita (kg/inh.*year)
2019	3.224	259,293	750,873	34,53	80,43	232,90
2018	3.288	249,272	742,052	33,59	75,81	225,68
2017	3.327	336,150	853,060	39,41	101,04	256,41
2016	3.357	238,490	752,260	31,70	71,04	224,09
2015	3.368	192,916	799,456	24,13	57,28	237,37
2014	3.394	232,965	790,635	29,47	68,64	232,95
2013	3.412	331,658	1.170,616	28,33	97,20	343,09
2012	3.432	251,803	808,423	31,15	73,37	235,55
2011	3.423	153,712	674,372	22,79	44,91	197,01
2010	3.452	31,600	1.125,100	2,81	9,15	325,93

In 2015, the municipality of Paterno, with resolution 17053, requested the authorization for the installation and execution of two composters for the treatment of the wet fraction of urban solid waste in the locality "ex Mattatoio" in delle Rubinie. The plant can receive a total of 320 tons/year of organic waste (160 tons/year for each composter) with CER code 20.01.08 and 20.03.02, in addition 50 tons/year of waste from public green maintenance.

4. Vietri di Potenza



Municipality of Basilicata in the province of Potenza with 2751 inhabitants (2019). It is part of the " Marmo - Platano - Melandro " program area. This town is called "the door of Basilicata" due to its geographical position, it is the first town to cross the border for those coming from Campania. The municipality of Vietri di Potenza has an area of 52.24 km² and a population density of 53.1 Ab/km². (<https://ugeo.urbistat.com/AdminStat/it/it/demografia/dati-sintesi/vietri-di-potenza/76096/4>)

Figure 16j **Error! No se encuentra el origen de la referencia.** shows the demographic trend of the resident population in the municipality from 2001 to 2019.



Figure 16: Trend of the resident population.

In particular, Table 22 shows that the resident population in 2010 is composed of 2.933 individuals, while currently (2019) 2.751 residents, with a reduction of 182 inhabitants (<https://www.tuttitalia.it/basilicata/53-vietri-di-potenza/statistiche/popolazione-andamento-demografico/>).

Table 22: Resident population

Year	Date	Resident Population	Absolute variation	Percentage variation	Number of families	Average members per family
2001	31 december	3.100	-	-	-	-
2010	31 december	2.933	- 167	- 5,38 %	1.113	2,63
2019	31 december	2.751	- 182	- 6,21%	-	-

The following table shows the evolution of separate waste collection in the municipality of Vietri di Potenza from 2010 to 2019 (<https://www.catasto-rifiuti.isprambiente.it>).

Table 23: Separate waste collection in Vietri di Potenza.

Year	Population	RD (t)	Tot. RU (t)	RD (%)	RD per capita (kg/inh.*year)	RU per capita (kg/inh.*year)
2019	2.773	408,240	610,980	66,82	147,22	220,33
2018	2.796	428,352	543,052	78,88	153,20	194,22
2017	2.787	428,165	680,105	62,96	153,63	244,03
2016	2.819	489,900	700,620	69,92	173,79	248,53
2015	2.832	432,645	602,314	71,83	152,77	212,68
2014	2.861	263,174	572,937	45,93	91,99	200,26
2013	2.88	271,613	634,385	42,82	94,31	220,27
2012	2.921	233,723	594,383	39,32	80,01	203,49
2011	2.917	214,200	594,060	36,06	73,43	203,65
2010	2.933	47,362	813,512	5,82	16,15	277,37

The waste collection service of the Municipality of Vietri di Potenza is managed by itself and since 2009 it has a "door to door" collection service, which in 2012 allowed them to intercept

and recover 16% of the municipal waste produced. The RU production of the Municipality of Vietri di Potenza is 611 tons/year in 2019.

The following table shows the composition of sorted waste (<https://www.catastorifiuti.isprambiente.it>).

Table 24: Composition of sorted waste.

Year	Other waste	Bulky waste	Paper and cardboard	Organic Fraction	Wood	Metals	Plastic	WEEE	Selective	Textile	Glass	Construction and demolition waste	Road cleaning and recovery.
2019	4,960	-	66,680	191,850	9,700	-	59,460	6,300	0,120	3,670	62,120	3,380	-
2018	-	2,260	68,700	177,420	2,340	-	85,060	15,060	0,052	2,400	56,000	19,060	-
2017	-	30,300	30,340	179,600	-	2,935	91,760	24,400	1,280	5,870	61,680	-	-
2016	-	-	65,180	182,530	14,320	-	100,920	31,520	0,170	24,820	70,440	-	-
2015	5,300	1,970	29,028	201,360	6,186	1,326	67,967	18,900	0,064	11,623	88,921	-	-
2014	0,557	-	23,243	121,420	9,290	7,937	24,860	7,100	-	11,704	57,063	-	-
2013	9,520	-	43,331	124,980	7,455	4,614	6,738	10,200	0,125	11,047	53,602	-	-
2012	2,690	-	-	130,670	-	3,560	10,680	5,860	1,763	0,900	77,600	-	-
2011	-	-	41,629	99,280	3,920	2,404	8,518	3,820	0,130	3,763	50,736	-	-
2010	-	-	5,080	-	-	5,926	3,197	10,690	-	-	22,470	-	-

In particular, the following figure shows that the fraction collected in greater quantity is precisely the OFMSW, equal to 46,99% in 2019. For this reason, the municipal administration has decided to incentivize a more sustainable urban waste management system through domestic composting to realize especially in the suburbs, with low population density. Another intervention to be carried out is a small composting plant at the ecological island of "Costa di Silla" which allows the disposal of the wet fraction collected in a part of the municipal area. (*Piano d'Azione per l'Energia Sostenibile*).

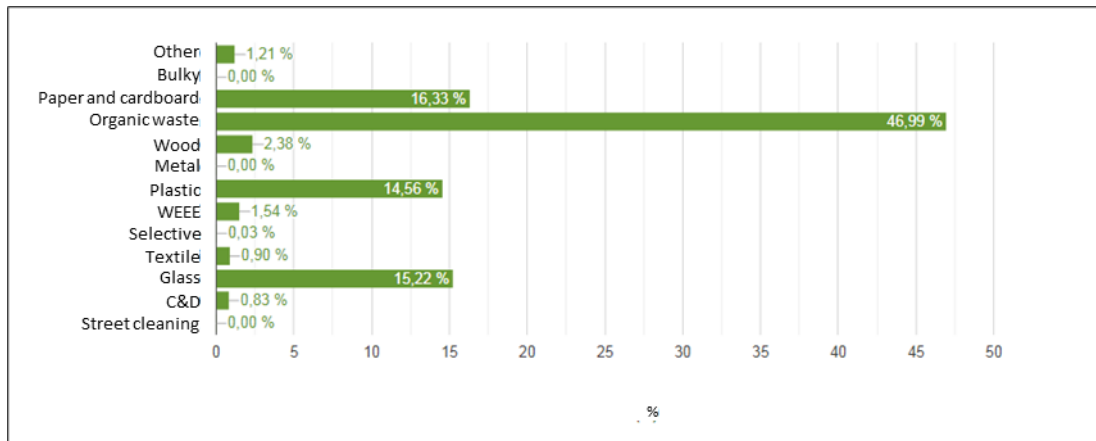


Figure 17: Percentage distribution of the RD by fraction - Municipality of Vietri di Potenza, year 2019.

5. Salandra



Municipality of Basilicata in the province of Matera with 2641 inhabitants (2019). It stands on a hill at 598 m a.s.l. The slope overlooking the Salandrella valley is characterized by strapiombi and clayey gullies; the opposite side is covered with oak woods, olive groves and orchards. The hamlet of Montagnola is located 3 km from the town where the sports facilities of the town are located. The municipality of Salandra has an area of 77,44 km² and a population density of 34,3

Ab/km² ([https://ugeo.urbistat.com/AdminStat/it/it/demografia/dati-sintesi/salandra/77024 / 4](https://ugeo.urbistat.com/AdminStat/it/it/demografia/dati-sintesi/salandra/77024/4)).

Figure 18 shows the demographic trend of the resident population in the municipality from 2001 to 2019.



Figure 18: Trend of the resident population.

In particular, Table 25 shows that the resident population in 2010 is composed of 2974 individuals, while currently (2019) 2641 are residents, with a reduction of 333 inhabitants.

(<https://www.tuttitalia.it/basilicata/75-salandra/statistiche/popolazione-andamento-demografico/>).

Table 25: Resident population

Year	Date	Resident Population	Absolute variation	Percentage variation	Number of families	Average members per family
2001	31 december	3.095	-	-	-	-
2010	31 december	2.974	- 121	- 3,91 %	1.108	2,68
2019	31 december	2.641	- 333	- 11,20%	-	-

The following table shows the evolution of separate waste collection in the municipality of Salandra from 2010 to 2019 (<https://www.catasto-rifiuti.isprambiente.it>)

Table 26: Separate waste collection in Salandra.

Year	Population	RD (t)	Tot. RU (t)	RD (%)	RD per capita (kg/inh.*year)	RU per capita (kg/inh.*year)
2019	7.486	1.598,590	2.078,970	76,89	213,54	277,71
2018	7.637	1.557,820	2.057,220	75,72	203,98	269,38
2017	7.802	1.537,850	2.043,530	75,25	197,11	261,92
2016	2.796	409,714	769,475	53,25	146,54	275,21
2015	2.829	55,855	763,835	7,31	19,74	270,00
2014	2.851	42,210	691,810	6,10	14,81	242,66
2013	2.858	39,800	942,070	4,22	13,93	329,63
2012	2.919	22,250	6.951,550	0,32	7,62	2.381,48
2011	2.934	22,830	903,680	2,53	7,78	308,00
2010	2.974	28,190	952,660	2,96	9,48	320,33

The data entered in the table for the years 2017-2018-2019 refer to an aggregation of municipalities: Accettura, Calciano, Garaguso, Salandra, San Mauro Forte. The following table shows the composition of sorted waste (<https://www.catasto-rifiuti.isprambiente.it>).

Table 27: Composition of sorted waste.

Year	Other waste	Bulky waste	Paper and cardboard	Organic Fraction	Wood	Metals	Plastic	WEEE	Selective	Textile	Glass	C&D Waste	Road cleaning and recovery.
2019	41,099	27,150	305,427	871,930	18,723	27,400	29,683	16,680	1,270	14,350	244,878	-	-
2018	37,514	22,600	300,332	838,900	16,954	24,810	26,878	19,550	2,360	16,775	251,047	0,100	-
2017	36,370	17,290	303,550	812,220	16,570	24,240	41,280	20,920	0,640	2,470	262,300	-	-
2016	57,638	-	90,887	168,488	3,638	5,323	7,473	8,377	0,059	4,098	63,734	-	-
2015	-	10,200	26,330	-	-	-	8,320	1,165	-	-	9,840	-	-
2014	-	11,760	15,480	-	-	-	5,830	-	-	0,900	8,240	-	-
2013	2,100	15,820	7,250	-	-	-	5,040	2,050	-	-	7,540	-	-
2012	0,110	0,580	6,550	-	0,150	-	6,680	2,310	-	0,120	5,750	-	-
2011	-	-	7,150	-	-	-	7,930	1,800	-	-	5,950	-	-
2010	-	-	7,290	-	-	3,000	6,650	3,400	-	-	7,850	-	-

In particular, the following figure shows that the fraction collected in greater quantity is the OFMSW, equal to 54,54% in 2019. The data refers to the aggregation of the municipalities of Accettura, Calciano, Garaguso, Salandra, San Mauro Forte.

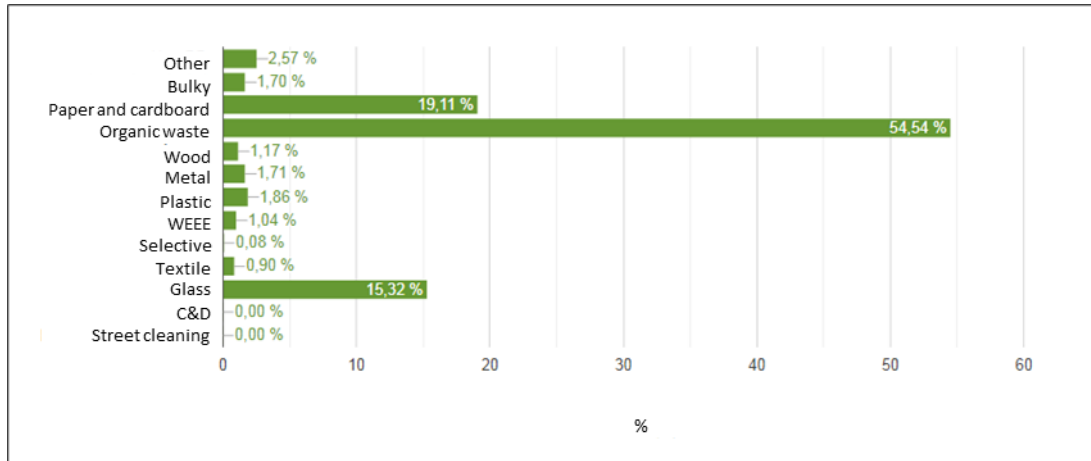


Figure 19: Percentage distribution of the RD by fraction - Municipality of Salandra, year 2019.

The municipality of Salandra installed a 110 ton/year community composter plant in the PIP area (COMAR s.r.l), as shown in Figure 20.



Figure 20: Composter of the municipality of Salandra (PIP AREA).

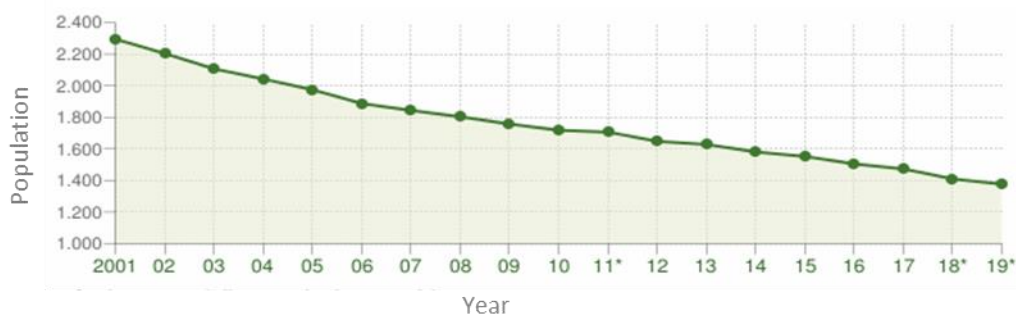
6. San Mauro Forte



Municipality of Basilicata in the province of Matera with 1377 inhabitants (2019). It is included in the territory of the comunità montana Collina Materana. There are civil and military architectures such as the " Torrione cilindrico quattrocentesco" and numerous noble buildings from the 700. The municipality of San Mauro Forte has an area of 87,06 km² and a population density of 16,1 Ab/km².

(<https://ugeo.urbistat.com/AdminStat/it/it/demografia/dati-sintesi/san-mauro-forte/77026/4>).

Figure 21 shows the demographic trend of the resident population in the municipality from 2001 to 2019.



Figure

21: Trend of the resident population.

In particular, Table 28 shows that the resident population in 2010 is composed of 1718 individuals, while currently (2019) 1377 are residents, with a reduction of 341 inhabitants. (<https://www.tuttitalia.it/basilicata/20-san-mauro-forte/statistiche/popolazione-andamento-demografico/>).

Table 28: Resident population.

Year	Date	Resident Population	Absolute variation	Percentage variation	Number of families	Average members per family
2001	31 december	2.294	-	-	-	-
2010	31 december	1.718	- 576	- 25,11%	853	2,01
2019	31 december	1.377	- 341	- 18,85%	-	-

The following table shows the evolution of separate waste collection in the municipality of San Mauro Forte from 2010 to 2019 (<https://www.catasto-rifiuti.isprambiente.it>).

Table 29: Separate waste collection in San Mauro Forte.

Year	Population	RD (t)	Tot. RU (t)	RD (%)	RD per capita (kg/inh.*year)	RU per capita (kg/inh.*year)
2019	7.486	1.598,590	2.078,970	76,89	213,54	277,71
2018	7.637	1.557,820	2.057,220	75,72	203,98	269,38
2017	7.802	1.537,850	2.043,530	75,25	197,11	261,92
2016	1.505	196,152	434,765	45,12	130,33	288,88
2015	1.552	10,220	406,510	2,51	6,59	261,93
2014	1.581	22,260	504,080	4,42	14,08	318,84
2013	1.628	35,340	392,540	9,00	21,71	241,12
2012	1.706	42,600	515,761	8,26	24,97	302,32
2011	1.71	46,080	533,630	8,64	26,95	312,06
2010	1.718	15,460	548,810	2,82	9,00	319,45

The data entered in the table for the years 2017-2018-2019 refer to an aggregation of municipalities: Accettura, Calciano, Garaguso, Salandra, San Mauro Forte.

The municipality of San Mauro Forte installed a 110 ton/ year community composting plant (COMAR s.r.l).

7. Gorgoglione



Municipality of Basilicata in the province of Matera with 903 inhabitants (2019). Its territory is covered by oak woods and is rich in sandstone rocks called "Pietra di Gorgoglione". Gorgoglione is also part of the Comunità Montana Collina Materana. The municipality of Gorgoglione has an area of 34.93 km² and a population density of 26.1 Ab/km².

(<https://ugeo.urbistat.com/AdminStat/it/it/demografia/dati-sintesi/gorgoglione/77010/4>).

Figure 22 shows the demographic trend of the resident population in the municipality from 2001 to 2019.



Figure 22: Trend of the resident population.

In particular, Table 30 shows that the resident population in 2010 is composed of 1.064 individuals, while currently (2019) 903 are residents, with a reduction of 161 inhabitants. (<https://www.tuttitalia.it/basilicata/39-gorgoglione/statistiche/popolazione-andamento-demografico/>).

Table 30: Resident population

Year	Date	Resident Population	Absolute variation	Percentage variation	Number of families	Average members per family
2001	31 december	1.181	-	-	-	-
2010	31 december	1.064	- 117	- 9,91%	470	2,26
2019	31 december	903	- 161	- 15,13 %	-	-

The following table shows the evolution of separate waste collection in the municipality of Gorgoglione from 2010 to 2019 (<https://www.catasto-rifiuti.isprambiente.it>).

Table 31: Composition of sorted waste.

Year	Other waste	Bulky waste	Paper and cardboard	Organic Fraction	Wood	Metals	Plastic	WEEE	Selective	Textile	Glass	Construction and demolition waste	Road cleaning and recovery.
2019	0,869	0,460	23,402	-	0,396	0,580	10,728	-	-	0,290	24,765	-	-
2018	1,628	1,280	35,820	-	0,741	1,085	15,375	-	-	0,542	30,789	-	-
2017	2,533	-	21,778	-	1,154	1,688	13,969	-	-	2,244	17,634	-	-
2016	0,221	-	11,125	-	0,101	3,338	10,930	-	-	1,744	48,931	-	-
2015	-	-	7,8258	-	0,191	3,940	8,053	-	-	1,580	16,222	-	-
2014	-	-	12,167	-	1,852	3,367	6,968	-	-	2,722	6,247	-	-
2013	-	-	5,692	-	0,081	4,508	8,778	-	-	2,223	10,417	-	-
2012	-	-	8,403	-	0,029	6,162	8,041	-	0,022	4,832	12,720	-	-
2011	-	-	5,937	-	0,121	5,124	8,162	-	-	0,116	14,626	-	-
2010	-	-	3,630	-	-	4,440	4,970	-	-	-	15,060	-	-

In particular, the following figure shows that the fractions collected in greater quantities are glass and OFMSW, respectively equal to 40,27% and 38,06% in 2019.

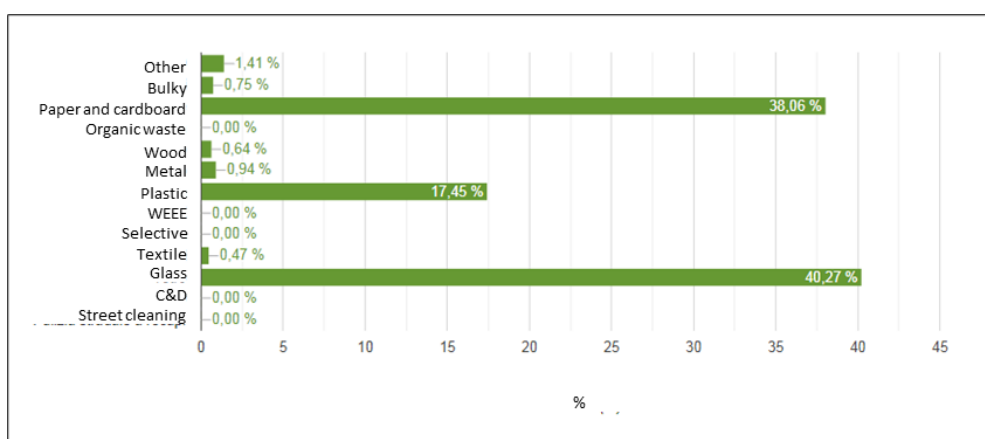


Figure 23: Percentage distribution of the RD by fraction - Municipality of Gorgoglione, year 2019.

The municipality of Gorgoglione has a small center for the composting of the organic fraction of municipal solid waste, located in the PIP area where a rotary composter with a capacity of 110 tons /year was installed. (Figure 24) - planimetry (Figure 25). (<https://gorgoglione.altervista.org/centro-compostaggio-locale-gorgoglione/>).



Figure 24: Composting plant installed in the Municipality of Gorgoglione.

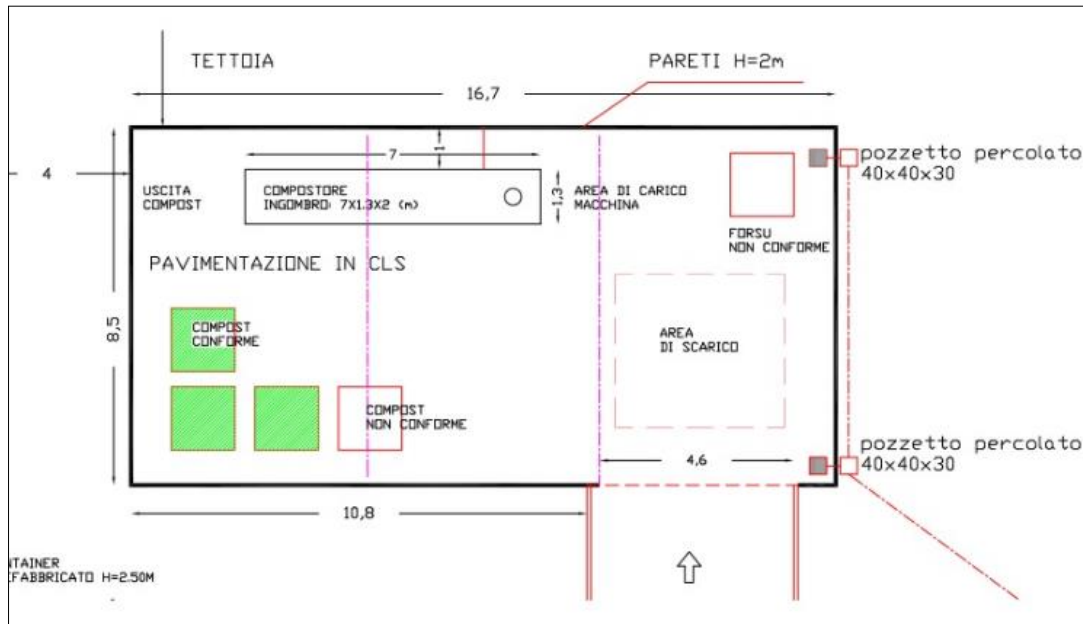


Figure 25: Planimetry.

2.2 Economic analysis

2.2.1 Cost of community composting

A specific analysis has been performed considering the main producers of community composters used in Italy. In the following graph the cost of the composters related with the capacity is reported.

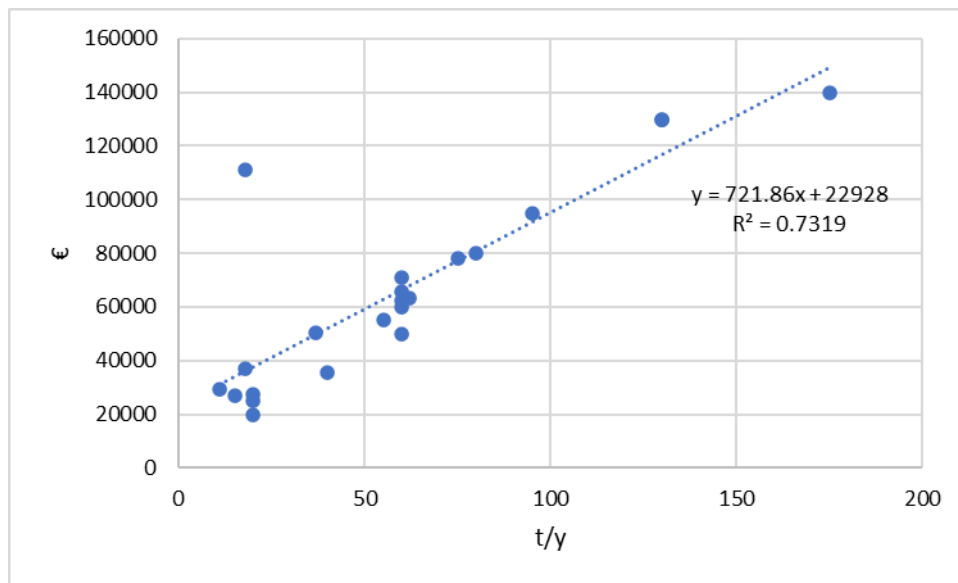
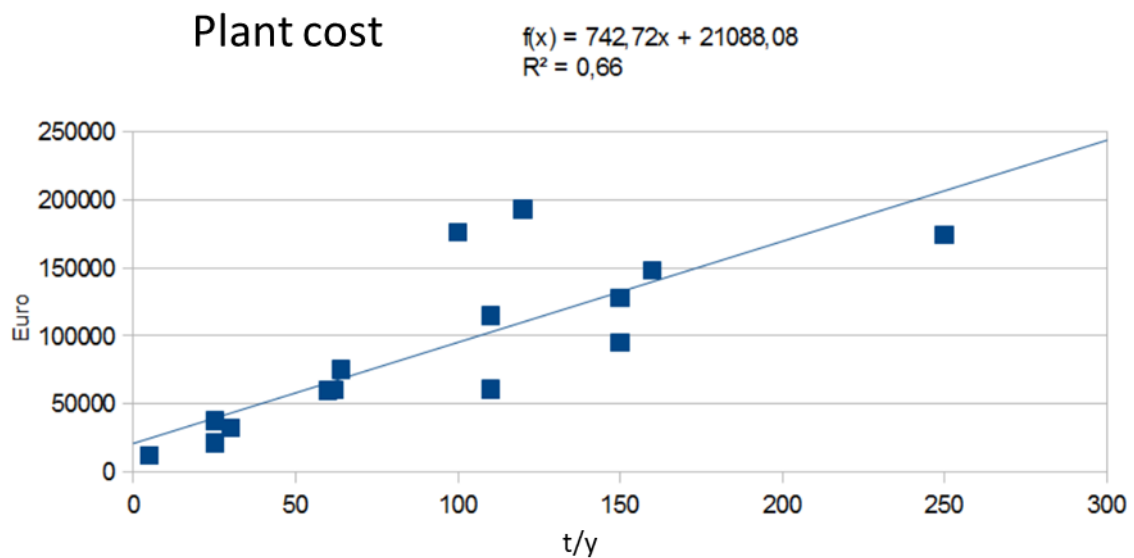


Figure 26: Cost of electromechanical composters

In order to obtain this figure numerous quotations were asked to different provider between 2019 and 2021. In particular only the CAPEX is represented in Figure 26. Very similar results were obtained by ENEA in 2017 (¡Error! No se encuentra el origen de la referencia.). What emerges is that for community composting, machines with a capacity equal or greater than 20 t/y are economically preferable.

Figure 27: Cost of electromechanical composters (ENEA, 2017)



In addition, in the following table, the costs for specific accessorize are reported.

Table 32: Costs of the main optional for electromechanical machines

System	Cost (€)
Biofilter	2400-3990
Loading Hopper	Depending on the size: 8000 (130 lt) – 36000 (3000 lt)
Bin's lifter	Depending on the size: 5900 (80 lt) – 8000 (120 lt)
Weighting system	1950
Screening	575-6000
Access control system	2500
Remote control	2400-4000
Automatic structuring agent dosage	10000

Finally, the monitoring costs should be considered. For these types of machines usually monitoring expenses consider:

- Electric energy: 600 €/y;
- Structuring agent: pellet could be used (190 €/ton) or dried and chopped pruning branches;
- Biofilter: the change of the material could be done every 6 months with a cost of around € 40-50 for each change;
- Ordinary maintenance: 1.3 hours/week

Also, for the monitoring costs ENEA performed an interesting analysis, the main results are reported in the following table:

Table 33: Analysis of the operating costs of electromechanical composters (ENEA, 2017)

ID	Operation	Value	Measure Unit	Notes
A	Load	91	hours	1/4 h/d for 365 days
B	Discharge	18	hours	1 h each 20 days for 365 days
C	Total hours	109	hours	C = A + B
D	Operators hourly cost	27.36	€	Lazio Region (ACER)
E	Labor cost	2982.24	€	E = C x D
F	Depreciation	8832	€	€ 80,000 loan at 2% in 10 years
G	Consumption	1095	kwh	3 kwh/d for 365 days
H	Electricity cost	120.45	€	
I	Pellets	720	kg	18 cycles for 40 kg/cycle
L	Pellet cost	192	€	
M	Total for a year	12126.69	€	M = E + F + H + L
	Total for 10 years	121266.9	€	

2.2.2 Economic returns of community composting

The application of community composting gives two main economic returns:

1. Reduction of the costs related with waste management and disposal;
2. Reduction of the waste tax for citizens.

For what concern the first point two aspects must be considered. In the case of community composting with direct delivery of waste by citizens there is no cost related with collection of organic waste. At the same time since the waste is treated directly inside the municipality in a composter managed by the citizens, there is no cost of transport and of disposal to a centralized plant. If the waste is not delivered by citizens directly, a collection system must be provided, but cost of transport is largely reduced, and no cost of delivery to a centralized plant has to be considered.

For what concern the second point, the Italian legislation provide specific discounts in waste tariffs for both domestic and non-domestic users who practice community composting: “*Non-domestic users who carry out individual aerobic composting for residues consisting of non-hazardous natural substances produced in the context of agricultural and nursery activities and domestic users who carry out individual aerobic composting for their own organic kitchen waste, mowing and garden pruning is applied a reduction in the tariff due for the management of urban waste*” (Ministerial Decree n. 266 of 29/12/2016).

3. H&CC future implementation

The application of community composting in Italy is encouraged and legally defined and this gives an important boost to its diffusion. The application of this solution is suitable especially in order to serve those geographical areas where remote and small communities (islands, mountain villages, etc.) lie away from the main logistic routes. In these cases, the municipal waste management companies have to employ costly waste collection and transportation systems; however, community and home composting of organic waste could be a cheaper and more sustainable alternative (Cafiero et al, 2021). In order to analyse the possible market evolution of community composting until 2021 the Italian Composting Association performed a specific analysis in 2019 (<http://www.associazioneitalianacompostaggio.it/2019/01/07/ipotesi-evoluzione-del-mercato-2019-2020/#more-712>). The study considered the data related to regional calls published and which will involve the purchase of composting equipment between 2020 and 2021. The results are summarized in the following.

Table 34: Estimated number of new composters in 2020-2021
(<http://www.associazioneitalianacompostaggio.it/2019/01/07/ipotesi-evoluzione-del-mercato-2019-2020/#more-712>)

Region	Amount of the call	Money for the composters	Number of composters	Production
	€	€	-	t/y
Lazio	9100000	7280000	135	10800
Campania	19665000	15732000	198	15840
Calabria	9585874	7668699	152	12160
Sicilia	16104160	128883328	161	12883.3
Basilicata	4000000	3200000	40	3200
TOTAL	58455034	46764027	686	54883.3

4. H&CC Providers


The main companies who sell composters in Italy are described in the following paragraph, for each one a technical factsheet has been prepared.

4.1 Achab Group

Achab is a company that offers civic and environmental education services but also communication to improve knowledge on the practice of composting. The operational headquarters of Achab Group is in Turin, Italy (www.achabgroup.it).

The Big Hanna electromechanical community composters have an automatic or programmable composting chamber rotation system with a continuous flow process and room temperature of 55 °C for 3 days. Big Hanna composters are available in different models according to the required capacities (Table 35).

Table 35: Characteristics composters Achab Group.

	Model	Capacity	Families	Dimensions	Volume
		t/y	-	mm	m ³
 https://achabgroup.it/	T40	4-5	25-35	1935x880x1470	3
	T60	8-13	55-70	2320x1080x1550	4
	T75	11-18	70-90	2830x1080x1550	5
	T120	16-26	90-135	3820x1080x1550	6
	T240	21-62	130-300	4800x1400x2070	14
	T480	41-113	275-650	6320x2200x2320	32

Each Big Hanna composter is characterized by:

- Machine body and internal mechanical parts made of AISI 304 stainless steel;
- Easy-to-clean stainless steel loading mouth and cover;
- Automatic compost output with adjustable frequency from the control panel;
- Inspection door of the biological process;
- Programming control unit with numerical display and optional connection possibility remote to computer.

Optional:

- HANNA biofilter is a solution for the treatment of discharges generated by the process, it does not create management problems and neutralizes odors through a layer of bark treated with enzymes, allowing the filtered air to be released outdoors.
- HANNA bin loader is available for the T240 model, it allows the transfer of waste from the bin to the composting machine. It is designed for 80-liter plastic drums.
- Sliding feeder able to manage and facilitate the entry of large volumes of food waste into the composting machine. The hopper capacity is 40 liters and increases the length of the machine by 800 mm.
- Recording and PC control, software is available for T60 -T240 models, which allows you to record temperatures every 10, 30, 60 seconds or minutes.

The Big Hanna - Achab composters have been installed throughout Italy, as shown in Figure 28. (<http://www.compostkmzero.it/index.php/installazioni>).




Figure 28: Location of the Big Hanna - Ahab composters in Italy.

4.2 CityNet

The company is structured in two sectors of activity: the commercial sector which provides customers with technical support and supplies of equipment for the environmental sector; the maintenance sector which deals with assistance and maintenance activities on vehicles for the collection and transport of waste. CityNet Ecologia & Ambiente s.r.l. deals with the supply of machines and equipment for the collection, transport, management and transformation of solid urban waste. CityNet composters are made up of a single chamber which is a rotating cylinder. The composters are available in different models according to the required capacities (Table 36).

Table 36: Composter characteristics CityNet.

	Model	Capacity	Inhabitants	Dimensions	Volume	
		t/y	-	mm	m ³	
 https://www.city-net.it/pages/default.aspx	Kompost City: Automated composting island with direct transfer by the citizen	IKCE 30	11	138	2100x2400x5000	25
		IKCE 50	18	275	2100x2400x5000	25
		IKCE 100	37	463	2100x2400x6300	32
		IKCE 150	55	688	2100x2400x6300	32
		IKCE 200	73	913	2200x2400x7000	37
		IKCE 300	110	1375	2200x2400x7000	37
		IKCE 350	128	1600	2400x2400x7600	44

Electromechanical composter that can be integrated with equipment for loading the waste by vehicle	KCE 30	11	110	2700x959x1151	3
	KCE 50	18	180	3323x1976x1460	10
	KCE 100	37	370	3860x1475x1570	9
	KCE 165	60	600	5115x2066x1596	41
	KCE 200	73	730	5334x2387x2070	26
	KCE 220	80	800	4353x1805x1888	15
	KCE 300	110	1100	4900x2608x2209	28
	KCE 350	128	1280	6184x2000x2250	28
	IKC E 600	220	2200	6234x2196x2635	36
	IKC E 800	290	2900	7834x2370x2606	48
	IKC E 1000	365	3650	8280x3069x3063	78
	IKC E 1600	580	5800	9600x2369x3100	71
	IKC E 2000	730	7300	13000x2500x2800	91
	IKC E 2500	900	9000	14000x2900x3000	122

Each IKCE model has the following standard equipment:

- Computerized management system;
- User recognition with QR code or BR code optical reader or Cardo Health Card;
- Disposal section equipped with weighing system;
- Rear opening for compost container outlet;
- Delivery door positioned at a useful height to allow the delivery of disabled people;
- Side openings through telescopic doors;
- Waste transfer system in composting chamber with screw auger AISI 304;
- Automatic system for the release of the structuring material equipped with a refillable tank;
- Internal video surveillance system on the delivery side.


Optional:

- Filter for the elimination of odors with double enzymatic cortex and activated carbon;
- Hopper with weighing system for direct delivery by means of transport;
- Data management system;

4.3 CrTec

CrTec is a Basilicata company that deals with the construction and installation of composters with different capacities and residence time. Table 37 shows the different characteristics for composters with residence time equal to 90 days.

Table 37: Composter characteristics CrTec.

 https://www.crtec.it/	Model	Capacity	Inhabitants	Dimensions	Volume
		t/y	-	mm	m ³
	BIOBI 1.X	6	47	1290x1750x2400	1.4
	BIOBI 2.X	10	78	1390x1850x2900	2.3
	BIOBI 3.X	15-20	117	1790x2150x3000	3.5

BIOBI 4.X	25	196	1790x2150x4000	5.3
BIOBI 5.X	30	235	1790x2150x5000	7.1
BIOBI 6.X	50	391	1890x2300x6000	10
BIOBI 7.X	60	470	1900x2300x7000	12
BIOBI 8.X	70	548	1990x2400x7000	13.6
BIOBI 9.X	80	626	2000x2500x7000	15.26
BIOBI 10.X	100	783	2390x2800x7000	20.7
BIOBI 11.X	115	900	2490x2900x7000	22.8
BIOBI 12.X	150	1174	2490x2900x9000	30.4

Optional:

- CO₂ monitoring;
- Ozonation system;
- External shredder;
- Integrated rotating screen;
- User identification system with health card or badge;
- "Compostino" system for monitoring CO₂, T, U, CH₄, NH₃ and H₂S;
- Biofilter with pine bark and activated carbon;
- Loading hopper.

The CrTec composters have been installed throughout Italy, as shown in Figure 29.




Figure 29: CrTec installations in Italy.

4.4 Ecopans

Ecopans is a company that produces electromechanical composters for community composting, self-composting and local composting. Ecopans composter have two separate rooms, one for "development" in which the waste is gradually transferred and one for "maturation" where the waste matures for a total of 60 days. Ecopans Composting systems are covered by a patent and CE certification (<http://www.ecopans.it/ecopans-sistema-di-compostaggio-dei-rifiuti-organici/>).

Ecopans composters are available in different models according to the required capacities (Table 38).

Table 38: Composter characteristics Ecopans.

	Model	Capacity	Dimensions	Volume	
		t/y	mm	m ³	
 <p>SISTEMA DI COMPOSTAGGIO eCOPANS http://www.ecopans.it</p>	Waste delivered in compostable bags	Compost 5	5	2350x1000x1200	3
		Compost 10	10	3700x1150x1200	5
		Compost 20	15-25	4700x1800x1600	14
		Compost 30	30	5000x1800x1700	15
		Compost 40	40	5000x1800x1700	15
		Compost 50	50	5000x2300x2100	24
		Compost 60	60	5500x2300x2100	27

		Compost 80	80	7200x2300x2100	36
		Compost 130	130	11000x2300x2200	56
	Waste delivered with vehicle	Compost 30	30	7800x2000x2100	33
		Compost 40	40	7800x2000x2100	33
		Compost 50	50	8500x2100x2300	41
		Compost 60	60	8500x2300x2300	45
		Compost 80	80	11500x2300x2300	61
		Compost 130	130	15000x2300x2300	79
		Compost 150	150	15000x2300x2500	86.25
		Compost 200	200	15000x2300x2500	86.25
		Compost 1000	1000	24000x2500x2500	150

Each Ecopans composter is characterized by:

- A control panel;
- N ° 1 inspection hatch for both ripening chambers, which can be opened with a mechanical key;
- Natural bark biofilter;
- Automatic passage of the material between the chambers;
- Automatic material ejection;
- Structure in AISI 304 steel.

Optional:

- Automatic pellet dispenser;
- Opening system with badge;
- Remote control system;
- Galvanized iron canopy complete with painted sheets;
- Outgoing material sieving system.

The Ecopans composters have been installed throughout Italy, as shown in Figure 30.




Figure 30: Ecopans installations in Italy

4.5 Joraform

Joraform is a Swedish company, in Italy composters produced by this company can be purchased from DBM International. Joraform composters are composed of two chambers, in the first one the waste is aerated and mixed with the continuous addition of new material while in the second one the maturation phase take place. Joraform technology is covered by patent (SE 9704 605 – 6).

Joraform models are different according to the required capacities (Table 39).

Table 39: Composter characteristics Joraform.

 https://www.joracomposters.com/	Model	Capacity	Families	Dimensions	Volume
		t/y	-	mm	m ³
	JK5100	20	100	2900x1170x1470	5
	JK6200	40	200	5310x1170x1470	9

Each Joraform composter is equipped with a shredder and control hatches to ensure the correct execution of the process.

Optional:

- Activated carbon biofilter;
- User identification system with badge and access accounting;
- CO₂ and temperature monitoring;
- Remote control;
- Work vehicle loading system;
- Sifter;
- Patent: SE 9704 605 - 6.

The main installations of Joraform composters in Italy are shown below (**Figure 31**).



Figure 31: Joraform installations in Italy.


4.6 Dizioinoxa

DizioInoxa founded in 2015, produces and installs steel equipment and tanks for different industrial sectors and composting machines.

The EcoKompos.T machines from Dizioinoxa are composed of an horizontal cylindrical container, of different sizes according to different production requirements. Composters have

different treatment capacities from 10 tons/year to 500 tons/year with a product residence time in the machine from 15 days to 90 days.

Table 40: Composter characteristics Dizioinoxa.

 https://www.dizioinoxa.net/ecologia	Model	Capacity	Length	Diameter
		t/y	mm	mm
	EcoKompos.T 20	20	4800	1380
	EcoKompos T60	60	6000	1650

Dizioinoxa composters are equipped with a sophisticated, electronically controlled, heating system able to maintain the ideal temperature during the passage of organic matter, which is constantly mixed by a motorized system. The ventilation system, combined with a refrigerator unit, allows a proper supply of oxygen, as well as air temperature and humidity control (<https://www.dizioinoxa.net/ecologia>).

Optional:

- Loading hopper with work vehicles;
- Biofilter with natural bark;
- Roto-sifting selection of the outgoing compost;
- Probe for the evaluation of CO₂;
- User identification system.

The main installations of Dizioinoxa composters in Italy are shown below (Figure 32 **Figure 31**).



Figure 32: DizioInoxa installations in Italy

The selected companies have carried out installations of composters, with different treatment capacities, throughout Italy, as shown in table 42.

Table 41: Syntesis of the Italian installations

Company	Region	N. plants	Capacity
Achab Group	Campania	2	62 ton/year
		1	33 ton/year
CrTec Group	Puglia	10	150 ton/year
DizioInoxa		2	125 ton/year
CrTec Group		1	50 ton/year
CrTec Group		1	25 ton/year
Comar		3	5.5 ton/year
CrTec Group	Basilicata	1	150 ton/year
Comar		3	110 ton/year
CrTec Group		1	80 ton/year
CrTec Group		2	50 ton/year
DizioInoxa	Calabria	1	125 ton/year
Comar		1	25 ton/year
Joraform		1	20 ton/year
Comar		1	5.5 ton/year

CrTec Group	Sicilia	1	25 ton/year
CrTec Group		1	10 ton/year
Comar	Sardegna	1	25 ton/year
Comar	Lazio	1	200 ton/year
CrTec Group		2	50 ton/year
Comar		1	12 ton/year
Comar		3	5.5 ton/year
Comar	Liguria	1	80 ton/year
Comar		1	40 ton/year
Comar		1	35 ton/year
Comar		6	25 ton/year
Comar		1	20 ton/year
Comar		1	12 ton/year
CrTec Group	Trentino Alto-Adige	1	150 ton/year
Comar	Piemonte	1	22 ton/year

5. MARKET ANALYSIS SPAIN

The purpose of this study is to identify the potential of the market in Spain in relation to the treatment of organic matter through decentralized composting. Initially, it was necessary to analyze the flow of organic matter in terms of its collection and treatment at the national and regional level, in a more concrete way in Catalonia. Subsequently, considering the population of each municipality, the per capita generation of total waste was calculated, as well as that corresponding to organic matter. Through the QGIS software, it was possible to manage, edit, analyze the data and visualize on a map the communities and provinces that contain the characteristics of the potential market taking into account a generation of organic matter no greater than 150Tn/year. The selection criteria of these tons correspond to the business model that is being carried out in the Municipality of Les Masies de Roda -LMR- which aims at treatment of organic matter through decentralized community composting and door-to-door collection of the inorganic waste generated, and in this way reduce transport costs, treatment, and final disposal, obtaining better results in the social, environmental, and economic fields.

Finally, analyzing these elements, it is intended to identify provinces that have municipalities with characteristics like LMR in terms of generation of organic matter in order to replicate this model, as well as analyze the supply of community composters in Spain and thus know the installed capacity.

6. NATIONAL CONTEXT

6.1 Waste Management in Spain

During 2018, in Spain **22 million tons of municipal urban waste** were generated, where 83% (17,646,563 tons) were collected in a mixed way and 17% was collected selectively (3,655,721 Tn), of which **1,010,017 tons** correspond to organic matter: 732,039 tons to kitchen and restaurant waste and 273,640 tons of waste in parks and gardens.

For 2019, projections are estimated at 22,438 million tonnes (Eurostat, 2021). Among the autonomous communities that stand out most for the selective collection of the organic fraction are Catalonia, Madrid, Andalusia, Valencia, and the Basque Country. (Ministry, 2018). Table 1 describes the organic fractions (Tons/the year 2018) collected selectively by Autonomous Communities.

Table 42 Organic fractions (Tn/the year 2018) collected selectively by Autonomous Communities.

autonomous community	Biodegradable kitchen and restaurant waste Tons	Biodegradable waste from park and gardens Tons	Total, Organic matter Tons
Andalusia	77.744	14.651	92.395
Aragon	212	8.291	8.503
Asturias	1.806	3.073	4.879
Balearic	25.350	28.913	54.263
Canary Islands	522	27.400	27.922
Cantabria	-	4.400	4.400
Castile-La Mancha	25	3.942	3.967
Castile and León	693	5.780	6.473
Catalonia	422.138	50.312	472.450
Ceuta	-	-	-
Community of Madrid	37.803	58.042	95.845
Autonomous Community of Navarre	23.680	10.688	34.368
Community of Valencia	39.153	35.358	74.511
Extremadura	-	-	-
Galicia	49.442	2.877	52.319

autonomous community	Biodegradable kitchen and restaurant waste Tons	Biodegradable waste from park and gardens Tons	Total, Organic matter Tons
La Rioja	-	-	-
Melilla	-	-	-
Basque Country	53.471	10.886	64.357
Region of Murcia	-	9.046	9.046
TOTAL	732.039	273.659	1.005.698

Source: Annual report of generation and management of waste of municipal competence 2018. Ministry for ecological transition and demographic challenge

It is noteworthy that the separate collection can be carried out through Differentiated containers, collected at clean points, door-to-door collection, etc. As for the treatment of the organic matter, collected separately, it is treated in composting plants and mostly centralized bio mechanization.

As for the organic matter extracted from the mixed container, it is not always treated for composting, which depends on the physical facilities that each autonomous community has. In some cases, triage facilities are used for the use of inorganic waste, and organic matter is not used.

As for the evolution of the selective collection system and its results in the organic fraction, it is from the year 2006, that begins an increase in bio-waste significantly until doubling in 2012. And it is between the year 2002-2012 that the evolution of the number of treatment facilities becomes visible. During those years, the number of landfills was reduced, the number of mechanical-biological treatment facilities, packaging sorting, and centralized bio-waste composting increased.

6.2 Waste management in Catalonia

The ratio of waste generation per capita per person in 2019 was 1.44 kg/h/day, which has been maintained compared to 2018, considering an increase in the population of the

0,99%. According to the Waste Management Report of Catalonia, during 2019 4,037,309 tons of municipal waste were generated, of which 1.8 million tons of waste (44.8% of the total generated) were collected selectively, where 432,947 Tons correspond to organic matter,

being 6,848 tons (0.4% of the total selectively collected) of the organic matter treated in decentralized composting.

Of the 947 municipalities in Catalonia, 789 have a selective collection system, i.e. 83.31%. (630 containers on the sidewalk, 127 with door-to-door collection, and 32 with a mixed model). Of these 789 municipalities, 457 carry out self-composting through 28,093 composters that are in operation in Catalonia, of these, 7,631 composters are used as an exclusive treatment route (7126 individual and 505 community) and 20,462 composters (20,084 individual and 378 community) are used as other management routes of the FORM.

At the end of 2019, 166 municipalities (most of them small municipalities with less than 1,000 inhabitants) had not yet started the selective collection of the organic fraction, many of which are managing a part of this fraction via self-financing and another is complemented by other forms of management channels.

As for the evolution of the selective collection system and its results in the organic fraction in Catalonia. In 2019, the gross selective collection of the organic fraction (food scraps, small vegetable remains), rose 6.16% more than in 2018. The number of municipalities with this collection and the number of biological treatment plants have been increasing year after year. The vegetable fraction was mainly valued in composting plants, incorporating it into the compost.

6.3 Organic Matter Management in Spain and Catalonia.

The flow of the organic fraction in Spain is directly related to the type of collection. Much of these fractions are used to obtain compost, through large, centralized composting facilities and in small quantities in decentralized composting. As for the remaining quantities of organic matter, a part is disposed of in the landfill or incinerated.

Different autonomous communities have triage, composting and bio mechanization facilities, which allows the recovery of existing organic matter in mixed waste that corresponds to 83% (17,646,563 Tons/year) of the total generation (22 million tons/year) of waste in Spain. Additionally, these facilities also receive part of the organic matter collected selectively to obtain compost. Thus, about 2,532,913 tons/year of organic matter enter these composting and bio mechanization facilities per year, which corresponds to 38.3% of the total organic matter generated throughout Spain, calculating that 30% of the total waste generated corresponds to organic matter (6,600,000 tons/year). This figure (2,532,913 tons/year)

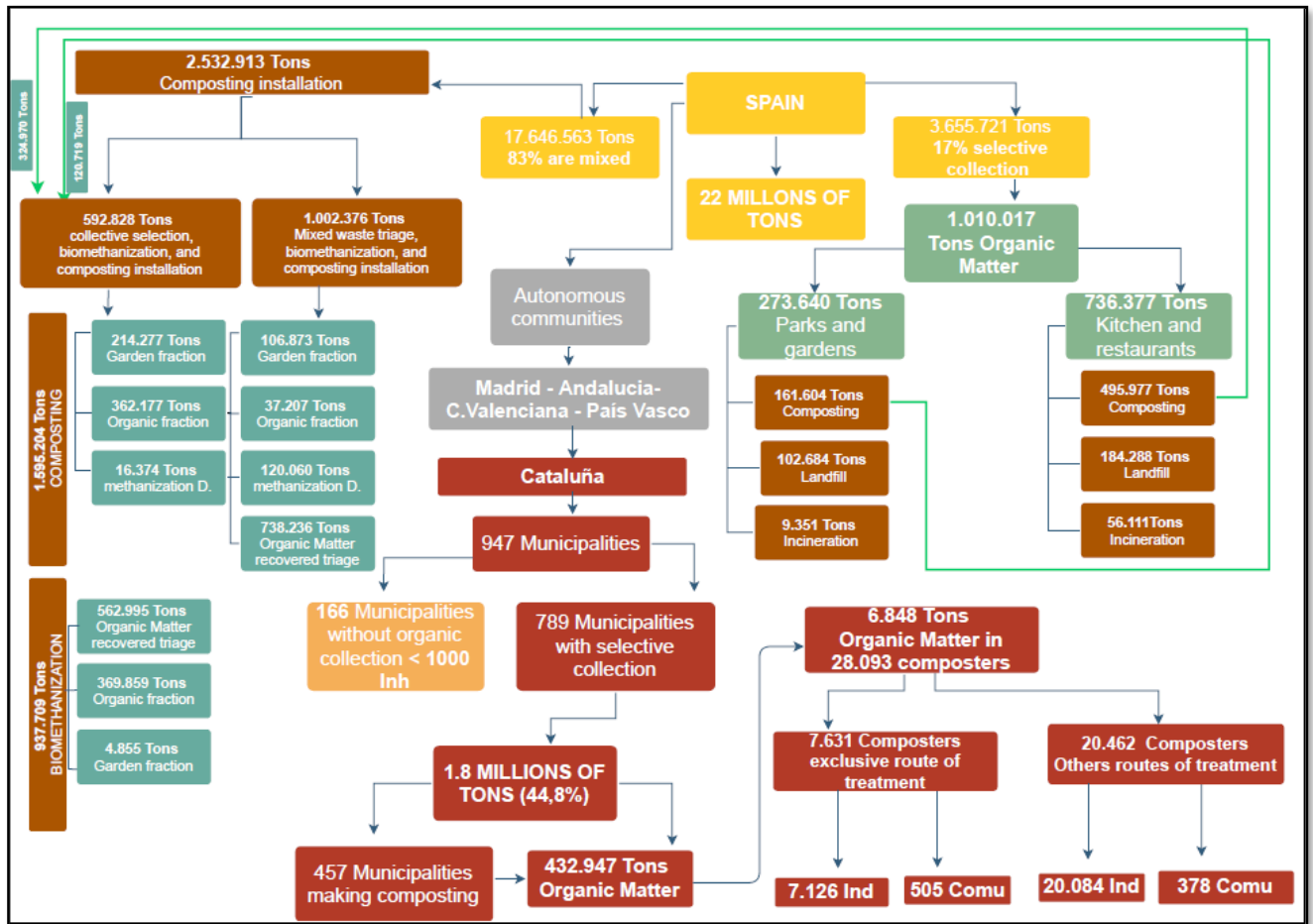
contains the fraction of organic collected selectively, as well as that recovered through triage facilities (mixed), either for the final use of composting or bio mechanization. The detailed description of the figures is in Figure 1, however, it is highlighted that about 1,301,231 tons/year of organic matter (1,595,204 tons/year for composting and 937,709 tons/year for bio mechanization) are being recovered.

As a result of these processes, during 2018, 132,735 tons/year of composting and 1,330,576 tons/year of bio-stabilized material were sold. It is noteworthy that in this context the sludge was not counted, which are treated through these harvesting systems

As for the situation by autonomous communities, according to the report of waste generation in Spain of 2018, inorganic matter generation in the community of Madrid, Andalusia, Valencia, the Basque Country, and Catalonia stand out. As for Catalonia, of its 947 municipalities, 789 municipalities have a selective collection system carrying out a collection of 44.8% of the total waste generated (1.8 million tons/year). Of the 947 municipalities that have a selective collection, 457 municipalities are performing community / individual composting treating about 6,848 tons of organic matter in 28,093 composters as explained above.

In Figure 1, you can see the treatment of organic matter according to the collection system.

Figure 33. The flow of organic matter and its treatment.



Source: Own elaboration, from Technical report Spain and Catalonia years 2018 and 2019

7. IDENTIFICATION OF THE PROBLEM AND MARKET OPPORTUNITY

7.1 Problem Identification

According to the previous context, it can be observed that there is a low ratio of use of the organic fraction (2,532,913 Tons/year), compared to the total waste generated (6,600,000 Tons/year), resulting in a use of 38.3% mostly through centralized composting, since according to the information found only 6,848 Tons/year are obtained by decentralized community composting, that is to say, 0.2%. The low use of this waste is due to the inadequate separation of waste at the source, promoting the content of inappropriate waste that affects the quality of compost and increases the cost of handling (transport, treatment, and final disposal) of municipal waste.

On the other hand, we can see the problem as the opportunity to take advantage of organic waste as a resource, by applying a new model in a door-to-door collection system and decentralized community composters, in this way, the segregated and collected fractions will be preserved, except for organic matter, which will be eliminated in composters located throughout the municipality. As a result, domestic and community composting (H&CC) is obtained which can be applied in urban agriculture projects. In this way, the use of municipal waste generated is increased and the percentage of mixed waste is reduced, building a closed circuit for the recovery of organic waste in a socially, environmentally, and economically sustainable manner.

7.2 Market opportunity

The market opportunity is focused on the implementation of a new model of door-to-door collection and decentralized community composting in cities with less than 1500 inhabitants and generation of organic matter between 0 and 150 Tn. It is noteworthy that community composting can also be applied in a curb collection system or be complementary by neighborhoods, depending on the characteristics of the place.

8. Business model

The business model focuses on small cities, with less than 1500 inhabitants and a generation of 1.3 Kg/hab/day. For the purposes of this study and considering the research being carried out through the DECOST project ("Decentralized Composting in Small Towns") through which a new waste management framework is being developed whose main objective is the recovery of organic waste, integrating decentralized composting systems (community or domestic composting) with urban agriculture activities. The implementation and operation of pilot composting are being developed in different countries, such as Italy, Jordan, Spain, and Palestine, which are carried out through the agreement with the Municipality in which each pilot is carried out.

In the case of Spain, this is currently being developed in the municipality of Les Masies de Roda -LMR-, LMR located in the northeast of the Iberian Peninsula, 90 km north of Barcelona, which is the second-largest city in Spain. The city has a total area of 16.41 km² and an elevation of 468 m. LMR has a low population density (42.7 inhabitants per km²) with a total of 700 inhabitants, a generation of 1.3 kg/hab/day, and a generation of 332 ton/year, of which 30% will be taken as organic matter generation.

The application of the door-to-door model with composting decentralized has shown the following results in the last six months.

Figure 34. Selective curb collection

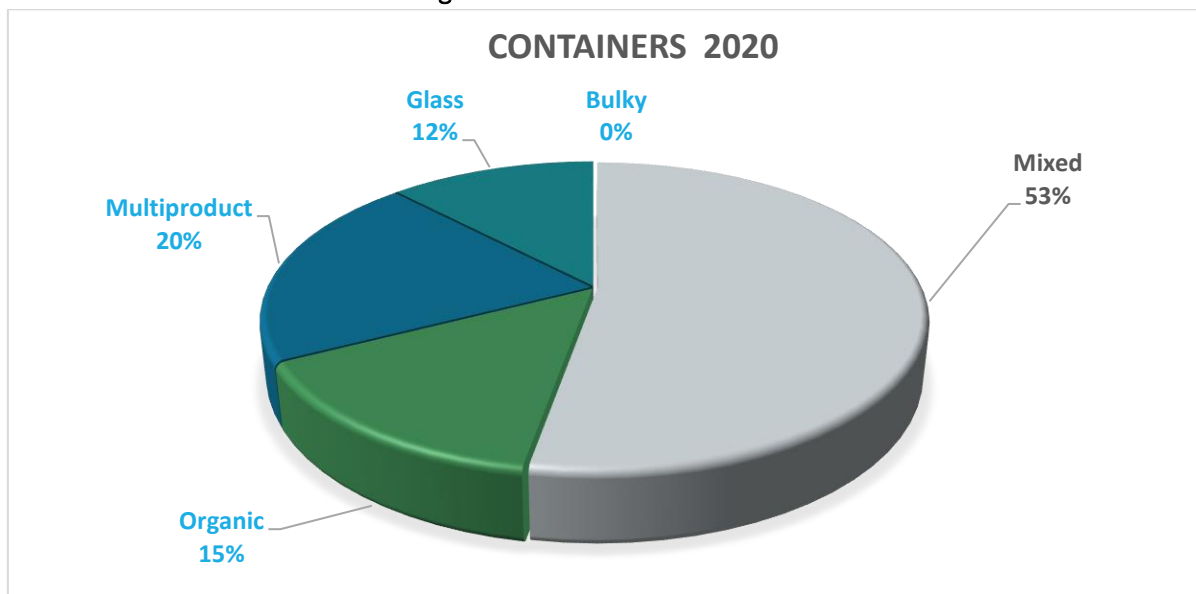
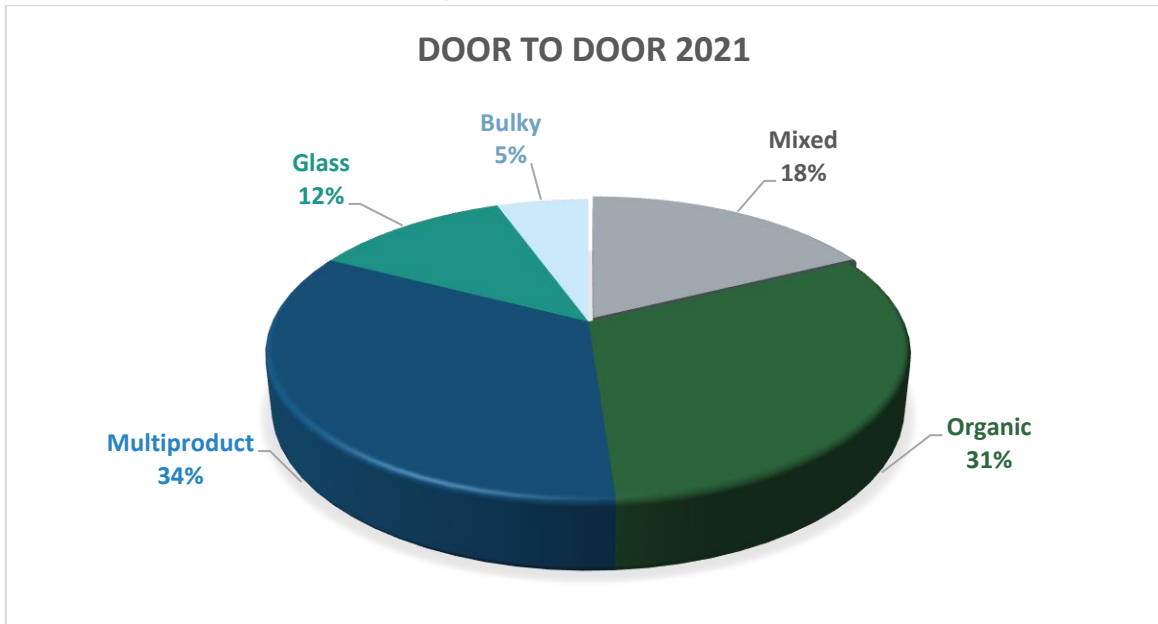


Figure 35. Door-to-door collection



The door-to-door collection has allowed a marked improvement in separation at the source, especially in multi-product whose separation increased from 20% to 34% and organic matter from 15% to 31%, which allows greater use of waste. As a result, there is a reduction in mixed waste from 53% to 18%.

In the case of the use of organic matter, this is being done in a decentralized way through the use of community composters.

In order to extend the business model, Figure 4 describes its phases.

Considering the above context, the proposed business model is described below.

Figure 36 Business model

✓

Key partners	Key Activities	Value propositions	Customer Relationships	Customer Segments
<p><i>¿who are our key partners?</i> Town halls, suppliers</p> <p><i>¿ who are our key suppliers?</i> Vermican</p> <p><i>¿What key resources are we going to acquire from our partners?</i> Municipal ordinances (management model) regarding the implementation of a door-to-door collection system model and the treatment of organic fraction through composters.</p> <p><i>¿What key activities do the partners carry out?</i> allocate budgets, Implementation of the ordinance, inform citizens about the operation of the management model, invest in the implementation and maintenance of the <i>management model (including composters)</i></p>	<p><i>¿what key activities our value proposition requires?</i> Interest of the city council in investing in the new model, raising awareness among citizens permanent maintenance of composters.</p> <p><i>our relationships with clients</i> our clients are the city council and citizens, to whom we provide advice and maintenance in the daily operation of the composters. As well as data analysis for making better decisions in waste management</p> <p><i>our source of income</i> Public resources from the city council and research projects at European level</p>	<p><i>¿What value do we deliver to the customer?</i></p> <ul style="list-style-type: none"> • Differential factor service: A key differential activity for other community composting actions implemented in other regions is the professionalized management of the composters. • Benefit from a treated waste: Through the composting process, citizens can obtain compost for use in urban agriculture projects. • Cost reduction: Reduction in the rate for waste management between 5-15%. • Reduction of environmental impacts: Reduction of emissions by avoiding the use of organic matter transport. • Valorization of organic matter: Permanent treatment close to 1000-1200 tons / year. <p><i>¿which of our client's problems we are going to help him solve?</i> The main problem to be solved is it seeks to value organic matter through the composting process in the municipality (LMR)</p> <p><i>what product and service packages we offer to each customer segment?</i></p> <p>Services (novelty and personalized service): Decentralized composting, Implementation, operation and monitoring of a new management model (door to door) and treatment of organic matter through the composting process through facilities that have user identification, with a product that arises as a consequence of this process that composting.</p> <p><i>¿What customer needs are we satisfying?</i> Reduction of environmental risks and costs: Organic matter use, and reduction in waste management costs in terms of transport, separation and treatment by taxes in the invoice</p>	<p><i>¿what kind of relationship do you expect us to maintain and establish each of our customer segments?</i></p> <p>Dedicated personal assistance: The operation of the composters require assistance 3 times a week, as well as your timely intervention in case of any incident.</p> <p><i>¿How muc they cost?</i> Simple Implementation Cost per-Ton: 304 € Compleat Implementation Cost per-Ton: 1049 €</p>	<p><i>¿Who are our most important clients?Niche market: Small and medium-sized cities (no more than 1500 inhabitants) with a waste generation less than 150 tons /year, with or without door-to-door collection and self-composting</i></p>
	<p>Key Resources</p> <p><i>¿ what key resources our value proposition requires?</i></p> <p>Financial: To invest in the purchase, installation, operation and maintenance of composters.</p> <p>Physical: Space selected according to the allocation system for location and installation.</p> <p>Human: Operation and maintenance of composters, monitoring, and environmental monitoring.</p> <p>Intellectuals: Patentes, Data analysis, improvements that allow the reduction of operating costs.</p> <p>technological: User identification system through the use of an opening card in the composters</p>		<p>Channels</p> <p><i>¿ Through which channels do our customers want to be contacted?</i> Through city councils -Social media</p>	
<p>Cost Structure. which key activities are the most expensive: The estimated total investment budget are simple Implementation Cost per-Ton: 304 € and Compleat Implementation Cost per-Ton: 1049 €</p> <p><i>¿What are the most important costs inherent to our business model?:</i> Permanent Cost : Operational cost: community composting (18.600€)</p> <p><i>¿Which key resources are the most expensive?:</i> Technological, related to the operation of the composter access card</p>			<p>Revenue Streams</p> <p><i>¿ For what value are our clients willing to pay?:</i> Initially due to the change in the door-to-door collection system.</p> <p><i>¿What are they currently paying for?:</i> They pay for the costs of maintaining the collection system. Currently they are not assuming the costs of community composting, but in the future they will have to.</p> <p><i>¿How would you prefer to pay?:</i> Clients will bear the cost of community composting, as long as it is shown that these are less than paying for the transport and treatment of organic matter in a centralized way.</p>	

Source: Own elaboration of the canvas business model.

9. ASPECTS FOR DEFINING THE POTENTIAL MARKET

To establish the potential market according to the business model described, the following criteria were considered for the whole of Spain: Number of inhabitants, generation of waste/year per municipality, generation of organic matter per year (taking into account that the generation of organic matter corresponds to 30% of the total generated), classification of organic matter generation by municipality according to the number of inhabitants.

- **A number of inhabitants:** Identification of singles whose number of inhabitants is less than 1,500. These municipalities were classified into 3 population groups:

Classification of municipalities population of 0-500 inhabitants

Classification of municipalities population of 500 -1000 inhabitants

Classification of municipalities population of 1000-1500 inhabitants

This classification is divided into autonomous communities.

- **Generation of total waste and organic matter/year by municipality:** These ranges allow to calculate of the total generation of waste per municipality (ton/year), by multiplying by the generation factor: Producción per capita of waste 0.0013 ton and the generation of organic matter, which corresponds to 30% of the total generation of waste.
- **Classification of organic matter generation:** For this study, the generation of organic matter will be highlighted, being categorized as follows throughout Spain:
 - Municipalities with organic matter generation of 0-51
 - Municipalities with organic matter generation of 51-101
 - Municipalities with organic matter generation of 101-151
 - Municipalities with organic matter generation of 151-201
 - Municipalities with organic matter generation of 201-251
 - Municipalities with organic matter generation of 251-301
 - Municipalities with organic matter generation of 301-351
 - Municipalities with organic matter generation of 351-401
 - Municipalities with organic matter generation of 401-451
 - Municipalities with organic matter generation of 451-500

Municipalities whose generation of organic matter is greater than 500 were not taken into account, since this study looks for municipalities similar to MRLs in the behavior of waste generation.

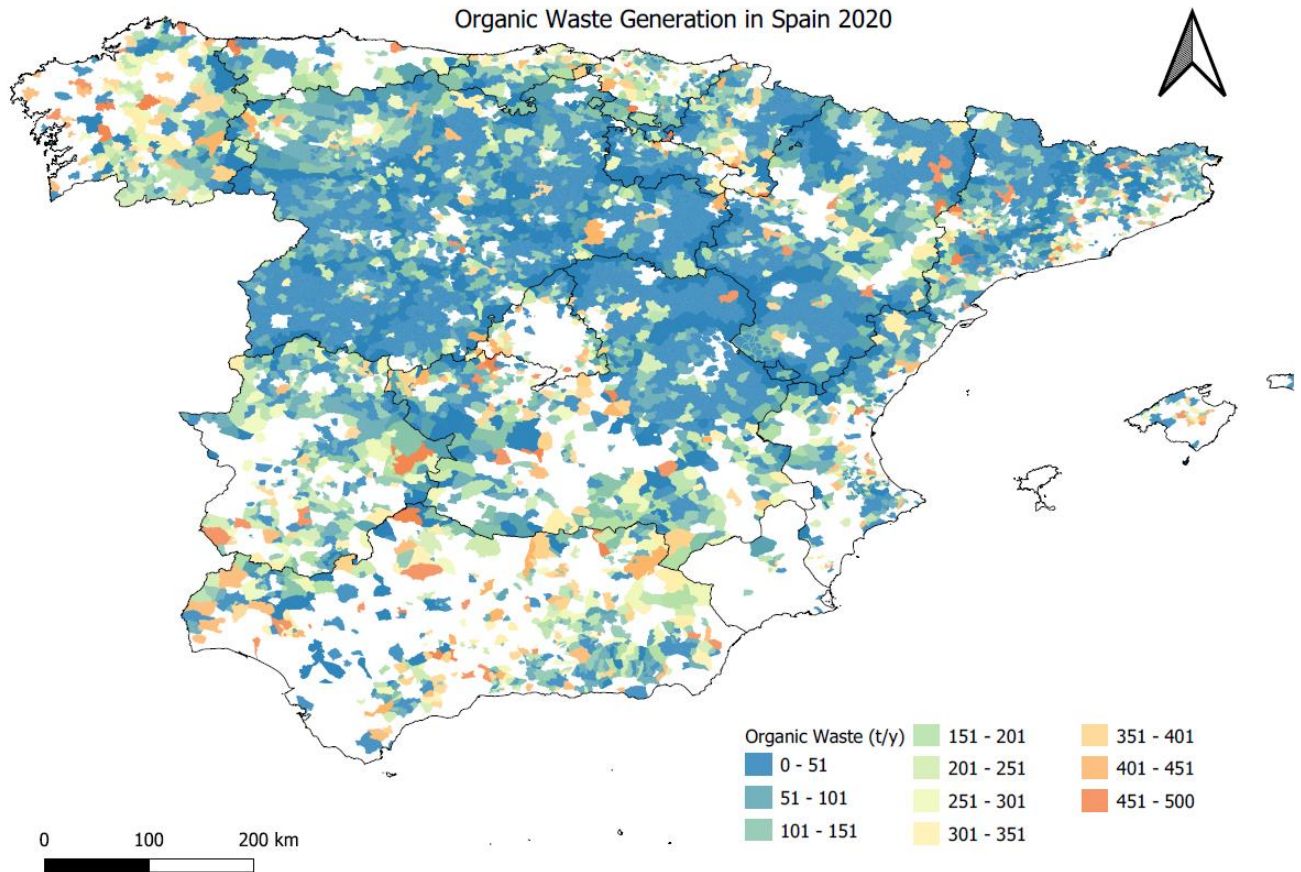
In the case of the Autonomous Community of Catalonia, additional information was analyzed, when filtering the information taking into account the collection system and the existence or not of the self-refueling.

- Municipalities in Catalonia by a number of inhabitants (0-500, 500-1000, 1000-1500) that have a door-to-door collection with and without self-financing.
- Municipalities in Catalonia by a number of inhabitants (0-500, 500-1000, 1000-1500) that have curb collection with and without self-refueling.

9.1 Definition of the potential market

The potential market is defined in the municipalities that generate between 0 and 150 tons/year, figures that are close to the MRL model (100 ton/year), as well as municipalities that are in waste generation ranges of 0-50, 50-100 and 100-150 ton/year. Figure 5 shows the map of organic matter generation in Spain, which highlights the municipalities of blue and green color, which in turn are classified by autonomous communities. White areas are excluded areas because it is a generation greater than 500 ton/year.

Figure 37 Map of organic waste generation in Spain year 2020



Source: Own elaboration

According to the map categorized by organic waste generation, the autonomous communities that show a generation from 0 to 150 tons/year are Castilla y León, Castilla la Mancha, Catalonia, Valencia, and Extremadura.

There are also other communities with values of interest in some areas, such as Andalusia, La Rioja, and the Basque Country.

The following are the autonomous communities, composed of provinces that provide a greater amount of organic matter.

CASTILE AND LEON

There are 2449 municipalities with a generation of organic no more than 150 tons. A greater contribution of organic matter is observed in the province of Burgos with 14,759 tons/year, in second place, in the province of León with 14,486 tons/year, and in third place the province of Salamanca with 12,895. The following table shows the contribution of organic matter of each province, for a total of **94,256** tons /year of the entire autonomous community.

Table 43. Relation of organic matter Autonomous Community Castilla y León

CASTILE AND LEON (CCAA)	
Province	Organic matter (Tons/year)
Burgos	14.759
lion	14.486
Salamanca	12.895
Zamora	11.741
Avila	9.988
Valladolid	8.581
Segovia	8.302
Palencia	7.619
Soria	5.885
TOTAL	94.256

CASTILE-LA MANCHA

There are 608 municipalities with a generation of organic no more than 150 tons. A greater contribution of organic matter is observed in the province of Toledo with 10,047 tons/year, in second place in the province of Cuenca with 9,422 tons/year and in third place the province of Guadalajara with 8,811 tons/year. The following table shows the contribution of organic matter from each province, for a total of **40,636** tons/year for the entire autonomous community.

Table 44. Relation of organic matter Autonomous Community Castilla la Mancha

CASTILE-LA MANCHA (AUTONOMOUS COMMUNITY)	
Province	Organic matter (Tons/year)
Toledo	10.047
basin	9.422
Guadalajara	8.811
Ciudad Real	7.643
Albacete	4.713
TOTAL	40.636

Catalonia

There are 255 municipalities with a generation of organic no more than 150 tons. A greater contribution of organic matter is observed in the province of Lleida with 10,458 tons/year, in second place in the province of Tarragona with 7,622 tons/year and in third place the province of Girona with 8,439 tons/year. The following table shows the contribution of organic matter of each province, for a total of **32,575** tons /year of the entire autonomous community.

Table 45. List of Organic Matter Autonomous Community Catalonia

CATALUNYA (CCAA)	
Province	Organic matter (Tons/year)
Lleida	10.458
Tarragona	7.622
Girona	8.439
Barcelona	6.056
TOTAL	32.575

Extremadura

There are 200 municipalities with a generation of organic no more than 150 tons. A greater contribution of organic matter is observed in the province of Cáceres with 15,040 tons /year, in second place, in the province of Badajoz with 8,706 tons/year. The following table shows the

contribution of organic matter of each province, for a total of **23,746** tons /year of the entire autonomous community.

Table 46. Relation of Organic Matter Autonomous Community Extremadura

EXTREMADURA (CCAA)	
Province	Organic matter (Tons/year)
Caceres	15.040
Badajoz	8.706
TOTAL	23.746

valence

There are 171 municipalities with a generation of organic no more than 150 tons. A greater contribution of organic matter is observed in the province of Valencia with 9,470 tons/year, in second place, in the province of Castellón with 7,276 tons/year, and in third place the province of Alicante with 3,057 tons/year. The following table shows the contribution of organic matter from each province, for a total of **19,803** tons/year for the entire autonomous community.

Table 47. Relation of Organic matter Autonomous Community Valencia

VALENCIA (CCAA)	
Province	Organic matter (Tons/year)
valence	9.470
Castellon	7.276
Alicante	3.057
TOTAL	19.803

9.2 Market size

Considering the total generation in Spain 22,000,000Tons/year and that 30% corresponds to organic matter 6,600,000 Tons/year, and when analyzing the tons per autonomous community of interest according to the business model, which corresponds to a total of 211,016. It can be estimated that the size of the market corresponds to **3.2%** of the generation of organic matter.

Table 48. Relation of organic matter Autonomous Communities

Size of the market	
Province	Organic matter (Tons/year)
Castile Leon	94.256
Catilla La mancha	40.636
Catalonia	32.575
Extramadura	23.746
valence	19.803
TOTAL	211.016

The LMR business model allows us to know the value per ton of organic matter treated. Considering these costs per ton, the implementation costs of the tons of the autonomous communities with the greatest potential in terms of organic matter generation were calculated. The following table is the ratio of investment costs, by the autonomous community according to the tons of organic.

9.3 Implementation costs of community composting

This study proposes two types of implementations:

- Simple: Includes single, composting bins and compostable bags
- Complete: Includes civil works composting sites, composting containers (including magnetic locks), composting containers (without magnetic locks), centralized composting warehouse, centralized post-processing equipment, other machinery (shredder, etc.), household organic containers, compostable bags.

Table 49. Implementation costs by autonomous communities

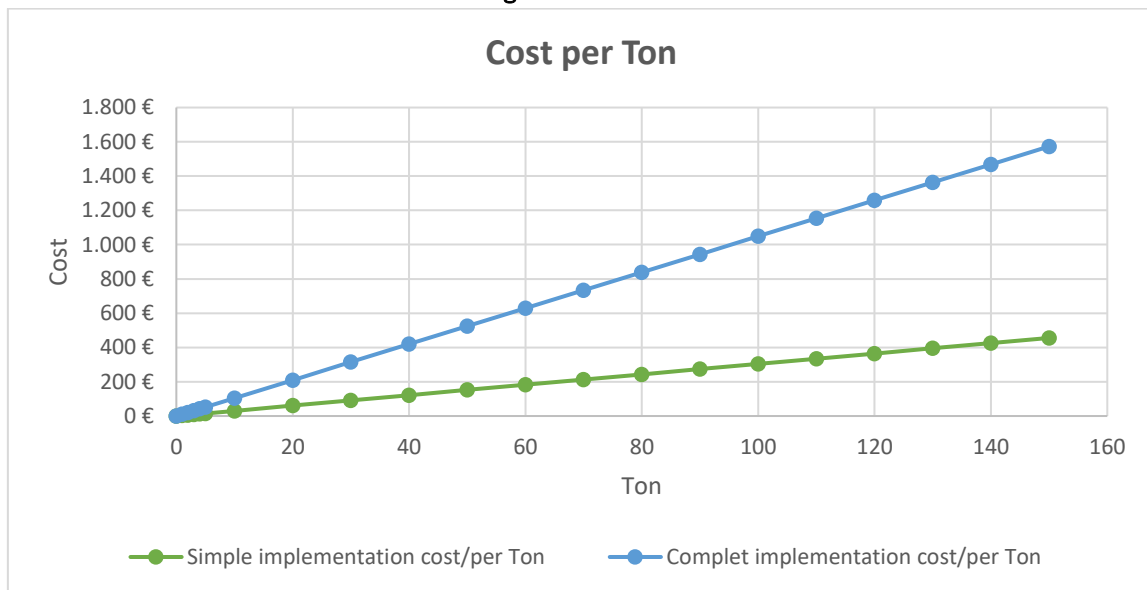
Implementation type	Costs (€)	Tons of LMR/year	Tons of Castilla Leon/year	Tons of Catilla La Mancha/year	Tons of Catalunya/year	Tons of Extremadura/year	Tons of Valencia/year
		100	94.256	40.636	32.575	23.746	19.803
Simple implementation	30.375 €	304 €	28.630.260 €	12.343.185 €	9.894.656 €	7.212.848 €	6.015.161 €
Full implementation	104.875 €	1.049 €	98.850.980 €	42.617.005 €	34.163.031 €	24.903.618 €	20.768.396 €

In terms of operating costs, initial data studies indicate that the costs of decentralized community composting in the short term are similar to the centralized system. In the long term, the costs of centralized composting will be higher, as there is an increasing trend in management costs due to the increase in treatment canons, making community composting more environmentally, socially, and economically attractive.

9.3.1 Implementation costs of community composting per tons

Figure 6 shows the ratio of costs per ton for the implementation of simple and complete community composting. The value per ton for a simple composting is € 3 and for the complete is € 10 It can be shown that the costs for simple composting are not greater than € 500 to treat 150 tons and not more than € 1,600 to treat 150 tons of incomplete composting.

Figure 38 Cost-ton ratio



9.4 Nationally Financed Resources

9.4.1 National taxation

The financing of investments in this type of model comes from the resources generated by the different environmental taxation instruments, taking into account both existing ones and those that can be proposed within the framework of the program itself, such as European sources of funding linked to support for environmental improvement and innovation policies. , dissemination, etc.

Regarding the actions corresponding to the construction and adaptation of existing facilities and new municipal waste management facilities, the provisions of Law 2/2014, of 27 January, on fiscal, administrative, financial, and public sector measures must be taken into account. In the case of Catalonia. From 2020, the new investments, amortizations, and replacements of the facilities will be financed at 50% by the Generalitat de Catalunya, provided that the local entity that owns the plant allocates the other 50% from the first moment. In this regard, a modification of the current legal framework will be promoted in order to protect this desire for cofinancing.

With regard to the municipal waste disposal fee, which has been an effective instrument in encouraging the municipal waste management model, knowing in advance its evolution will allow local authorities to anticipate future costs and plan their actions.

9.4.2 Recovery, transformation, and resilience plan

According to the Recovery, Transformation and Resilience Plan, the Spanish Government has made **available €3,782 million** to carry out the new industrial policy and circular economy strategy to be implemented during the period 2021-23, these resources must be invested in:

- ❖ Sectoral data spaces (contribution to tractor projects for the digitization of strategic productive sectors).
- ❖ Sectoral data spaces (contribution to tractor projects for the digitization of strategic productive sectors).
- ❖ **Plan to support the implementation of waste regulations and the promotion of the circular economy:** The actions envisaged are very diverse and range from the implementation of new separate collections and the improvement of existing ones to the construction of specific facilities for the treatment of these collections. Actions are also planned for the recycling of other waste streams collected separately and investments relating to collection facilities (such as clean points), sorting (packaging, paper, etc.), or improvement of existing mechanical-biological treatment plants. The investment will also pay particular attention to the development of digitization tools for environmental management and the promotion of the circular economy at the enterprise level.

9.4.3 Financing Resources in Catalonia

According to the general program of prevention and management of waste and resources of Catalonia 2020, the budget for waste management according to its hierarchy was as follows:

Table 50. Waste Management Budget in Catalonia

PRECAT20 BUDGET BY WASTE MANAGEMENT HIERARCHY	
Associated hierarchy	Total budget (amount in euro)
Ecodesign	19.855.000
prevention	69.071.000
reuse	2.045.000
TOTAL PREVENTION	90.971.000
Recycling market	18.150.000
Selective collection	55.046.894
Preparing for reuse	32.350.000
valorization	367.655.968
TOTAL, RECOVERY	473.202.862
Rejection disposition	39.600.000
TOTAL, DISPOSITION	39.600.000
Contaminated soils	5.025.000
Transversal actions	144.083.276
TOTAL, OTHER	149.108.276
TOTAL	752.882.138

Source: General Programme for the Prevention and Management of Waste and Resources of Catalonia 2020

In the table above, a budgetary allocation of € **367,655,968** is observed for the recovery of waste and according to the value calculated for the implementation of decentralized community composting the value of the simple investment for the 32,575 tons/year of organic matter is in the range between € **9,894,656 - 34,163,031**, which represents between **2.7 and 9.2%** of the total budget for the treatment of organic matter generated in the same municipalities located in the provinces of Lleida, Tarragona, and Girona.

It should be noted that Law 22 of 2011 defines recovery as: *"Any operation whose main result is that the waste serves a useful purpose by replacing other materials, which would otherwise have been used to fulfill a particular function, or that the waste is prepared to fulfill that function in the facility or in the economy in general"*.

According to Annex II, which contains the list of recovery operations, organic matter is found: *R3 Recycling or recovery of organic substances that are not used as solvents (including composting and other biological transformation processes).*

9.5 Potential of Cataluña considering the collection system and existence of composting.

To know in greater detail, the potential market in Catalonia and considering that the MRL project is developed in this same autonomous community. Additional data from the Waste Agency of Catalonia were analyzed, in relation to the collection system (door to door and sidewalk) by the municipality and whether they have self-packaging or not, the number of inhabitants, and generation of total waste highlighting the organic matter.

The following tables show possible scenarios or equivalent situations, which are also considered as a potential for the market since community composting can be implemented in a sidewalk collection system or be complementary for specific neighborhoods, that is, the MRL model can be modified and adjusted according to the context and needs of each municipality.

Table 51. Door-to-door collection system with composting

Province	Population	Generation of organic fraction (tons/ year)	Number of municipalities	Total generation of organic fraction (tons/ year)
Barcelona	0-500	34	15	510
	500-1000	90	1	90
	1000-1500	175	4	700
Lleida	0-500	50	3	150
	500-1000	100	2	200
	1000-1500	180	3	540
Girona	1000-1500	150	2	300
TOTAL				2490

Table 52 Door-to-door collection system without composting

Province	Population	Generation of organic fraction (tons/year)	Number of municipalities	Total generation of organic fraction (tons/ year)	Invest Cost (€) community composting Simple Implementation	Invest Cost (€) per ton/year community composting Completer implementation
Girona	0-500	40	4	160	48.640	167.840
	500-1000	80	2	160	48.640	167.840
Tarragona	0-500	40	21	840	255.360	881.160
	500-1000	95	5	475	144.400	498.275
	1000-1500	170	4	680	206.720	713.320

Province	Population	Generation of organic	Number of municipalities	Total generation	Invest Cost (€) community	Invest Cost (€) per ton/year community
Lleida	500-1000	130	2	260	79.040	272.740
TOTAL				2575	782.800	2.701.175

*Simple Implementation Cost per-Ton: 304 €

*Compleat Implementation Cost per-Ton: 1049 €

If the municipalities are shown in the table implement community composting, the amount of organic matter to be treated can be doubled, i.e. treat 2575 ton/year more. Total investment costs for simple community composting would be **782,800 (€)** and for full implementation **2,701,175 (€)**

Table 53 Curb collection system with self-composting

Province	Population	Generation of organic fraction (tons/year)	Number of municipalities	Total generation of organic fraction (tons/year)
Barcelona	0-500	45	15	675
	500-1000	60	8	480
	1000-1500	150	5	750
Lleida	0-500	50	25	1250
	500-1000	40	2	80
Girona	0-500	40	20	800
	500-1000	100	9	900
	1000-1500	170	7	1190
TOTAL				6125

Table 54 Curb collection system without self-composting – community composting implementation costs

Province	Population	Generation of organic fraction (tons/year)	Number of municipalities	Total generation of organic fraction (tons/ year)	Invest Cost (€) community composting Simple Implementation	Invest Cost (€) per ton/year community composting Complet implementation
Barcelona	0-500	40	5	200	60.800	209.800
	500-1000	110	15	1650	501.600	1.730.850
	1000-1500	180	9	1620	492.480	1.699.380
Lleida	0-500	45	61	2745	834.480	2.879.505
	500-1000	110	34	3740	1.136.960	3.923.260
	1000-1500	170	13	2210	671.840	2.318.290
Girona	0-500	35	16	560	170.240	587.440
	500-1000	114	5	570	173.280	597.930
	1000-1500	200	2	400	121.600	419.600
Tarragona	0-500	35	30	1050	319.200	1.101.450
	500-1000	90	16	1440	437.760	1.510.560
	1000-1500	170	4	680	206.720	713.320
TOTAL				16.865	5.126.960,00	17.691.385,00

*Simple Implementation Cost per-Ton: 304 €

*Complet Implementation Cost per-Ton: 1049 €

If the municipalities are shown in the table implement decentralized community composting, the amount of organic matter to be treated can be increased by 10,000 tons per year continued with the curb collection system. The total investment costs for a simple implementation would be **5,126,960 (€)** and the complete implementation corresponds to the value of **17,691,385 (€)**.

Although the business model for which this market study was carried out contemplates a door-to-door collection system with decentralized community composting, which shows potential for the use of organic matter of 3.2% of the generation of organic matter and 0.86% of the generation of total waste throughout Spain. It is also observed that this model can have variations, such as a sidewalk system with self-financing, a complementary system. These variations depend on the context and needs of each municipality, whose investment and operating costs may vary and more information is required to analyze the financial viability.

In the next chapter, we study the behavior of the market in relation to the value chain, in order to identify suppliers and types of existing supplies and thus estimate the real market.

9.5.1 Market analysis of decentralized composters in Catalonia

As mentioned in chapter 1, according to the Waste Agency of Catalonia. For the year 2019, Catalonia had 28,093 composters, where 7,631 are used as an exclusive route of treatment, that is to say, 27% of the total, of which 7,126 are individual, that is to say, 93.38% and 505 community, which represents 6.6%. Although there is a market niche in decentralized composting, this must continue to be enhanced, as well as strengthen community composting that does not reach 10%.

In the case of composting as a complementary treatment route, about 72.8% (20,462) of the composters are used for this purpose, being 98% individual and 2% community.

When considering the total number of composters used (28,093) in both treatment routes (exclusive or complementary) it is observed that 97% are individual and 3% community

Taking into account these figures, it is observed that individual composters are the most used in both routes and that these are being used more as complementary routes, which may be due to the fact that decentralized composting arises more from citizen initiatives than those of municipalities or it may also be due to the fact that municipalities are in a phase of exploration of decentralized composting and in terms of costs prefer to start with individual composters.

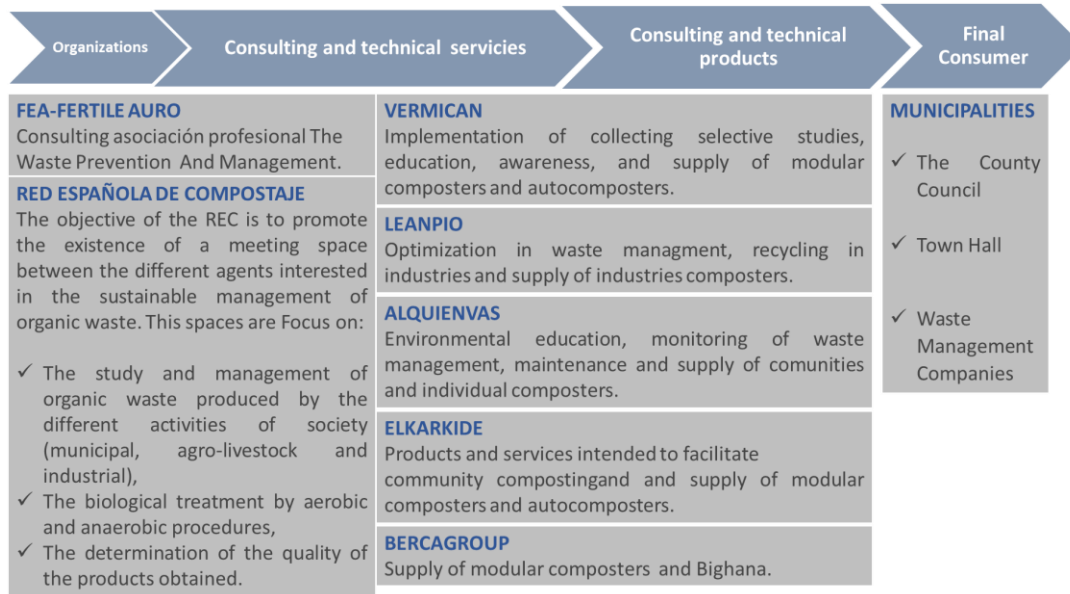
In addition, it is evident that two ways can be contemplated to implement decentralized composting, both as an exclusive way, as well as a complementary way, and that this type of alternative, although it is arousing interest, must be further strengthened in terms of community composting and in this way take advantage of the potential market that Catalonia has (about 19,440 ton/ year of organic matter). Which is equivalent to 3,240 composters to install which would increase the percentage of community composters from 3% to 13%.

10- STAKEHOLDER-SUPPLIER VALUE CHAIN

As for the related suppliers in the value chain, currently, they offer consulting services and products. The value chain is divided into organizations that promote composting through environmental education, technical consulting on products and services (suppliers), and the final consumer.

Figure 7 briefly shows the supply value chain for composters and the most relevant companies that perform consulting and product production.

Figure 39 Value Chain



Source: Own elaboration

The consultancy carries out studies for the implementation of selective door-to-door collection, solid waste optimization studies, solid waste prevention plans, and environmental education.

As for the products, these are related to community and individual composters, as well as tools for their operation and civil works.


In general, the market offers three types of composters:

- ✓ Automatic / individual composter
- ✓ Modular Composter/Community Composter
- ✓ Industrial composter The volume of composters is between 280 L and 1100 L for individual composters, 1100 L for modular or community composters.

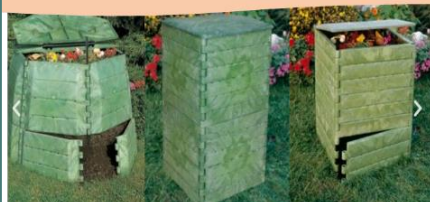
10.1 Existing suppliers and types of technologies

Below is the type of supplier composters, only BERCAGROUP has the three types of composters, LEANPIO offers only industrial composters, ELKARKIDE only offers modular composters, ALQUIENVAS and VERMICAN offers individual and modular composters.

BERCAGROUP



PRODUCTS
HOUSEHOLD COMPOSTING



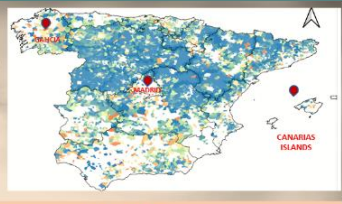
210 L	340 L	400 L	450 L	730 L	800 L
	1050 L	2000 L	1400 L		

Web page:
https://www.berca.es/es_es/



Contact:
+34 658 19 58 81
+34 91 502 84 07

Email:
berca@berca.es


Location



PRODUCTS
COMMUNITY COMPOSTING

PRODUCTS
BIGHANNA COMPOSTERS



LEANPIO



PRODUCTS
INDUSTRIAL COMPOSTER



Web page:
<https://www.leanpio.com/>

Contact:
+34 976 753 000

Email:
leanpio@leanpio.com

MARKET



ELKARKIDE



Web page:
<https://www.elkarkide.com/>

Contact:
+34 948 311 518

Email:
elkarkide@elkarkide.com

PRODUCTS
COMMUNITY COMPOSTING

MARKET

SERVICES






✓ Collection system

ALQUIENVAS



Web page:
<https://www.alquienvas.com>

Contact:
+34 973 58 60 67

Email:
info@alquienvas.com

PRODUCTS
HOUSEHOLD COMPOSTING

PRODUCTS
COMMUNITY COMPOSTING

MARKET

SERVICES



De 300L a 1100L



De 350L a 650L
Compostadores de bajo coste







✓ Sensitization

✓ Management
Control

✓ Maintenance

VERMICAN




Web page:
<https://www.vermican.com>

Contact:
+34 948276310

Email:
info@vermican.com


MARKET

PRODUCTS
HOUSEHOLD COMPOSTING

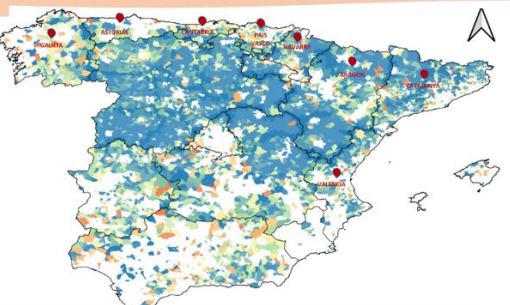


210 L	340 L	400 L
450 L	730 L	800 L
1050 L	2000 L	1400 L

PRODUCTS
COMMUNITY COMPOSTING



MARKET



SERVICES

<ul style="list-style-type: none"> Studies for the implementation of selective collections Waste characterizations Quality control of collection and cleaning service Decentralized composting plants Support public tenders. 	<ul style="list-style-type: none"> Maintenance of community composting areas Waste optimization studies Waste prevention plans Other technical support tasks
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Of the best-known suppliers in the market, it can be seen that Vermican is the one that has reached a greater number of autonomous communities, in addition to offering not only the products but the services associated with them.

Figure 40 List of suppliers by autonomous community

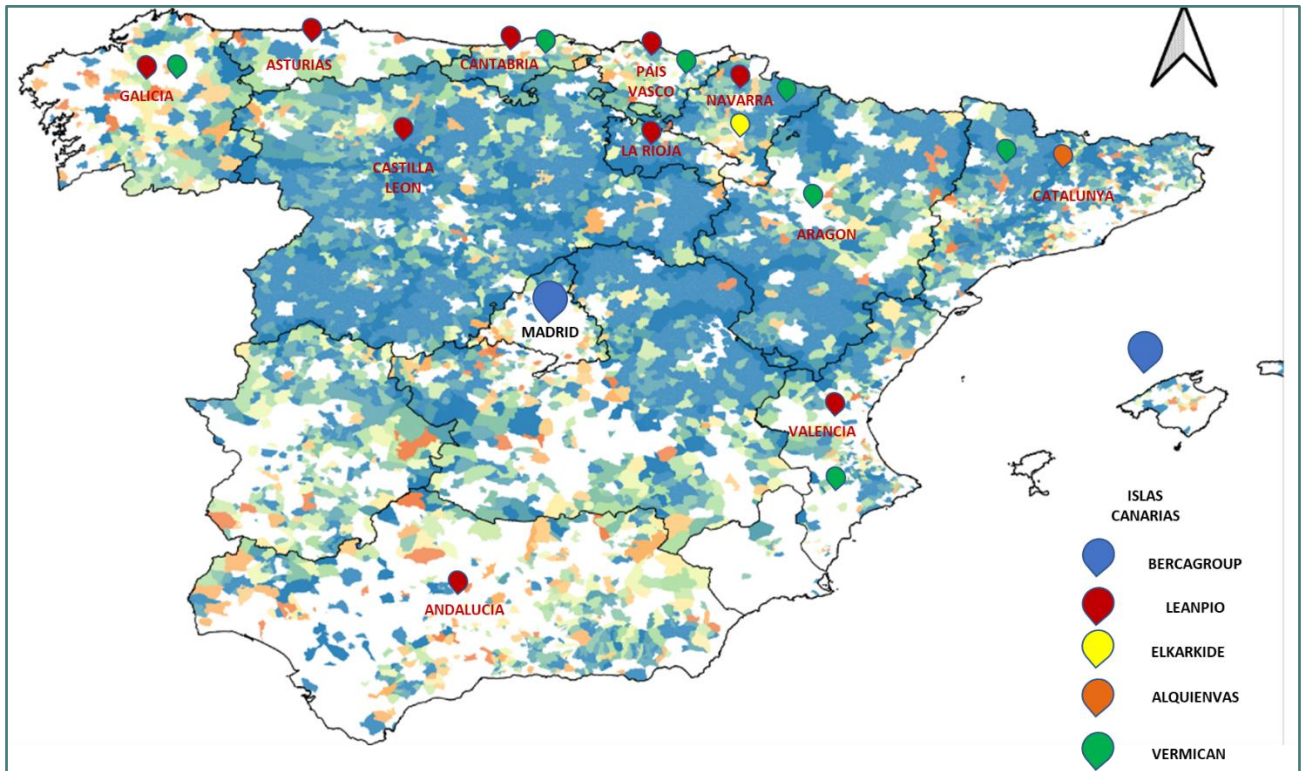


Table 55 List of suppliers by autonomous community

SUPPLIER	AUTONOMOUS COMMUNITY
BERCAGROUP	Madrid
LEANPIO	Community of Valencia
ELKARKIDE	Navarre
ALQUIENVAS	Valencian Community- Galicia
VERMICAN	Navarre- Aragon- Cantabria- Valencian Community- Basque Country- Galicia-Catalonia

According to information on the website. Vermican modular composters are leaders in the community composting market throughout the country. Vermican developed the first modular

composter in 2014 and has since installed more than 2,000 units that each manage around 18 tons of organic matter per year.

Finally, composting composters are the benchmark for quality in the European market, with millions of units served in the institutional segment, composed of local entities and municipalities.

10.2 Installed capacity

In order to know the number of composters and the installation time to treat the 211,016 Tons /year of organic matter. Two scenarios arise with two growth rates: 30% and 50%. To make this calculation, we take into account the 2,386 community composters installed (from 2014 to 2020) by one of the largest producers in the market (Vermican), which have a capacity to treat 2 Tons/year for each composter.

Table 56 Installed capacity

QUANTITY OF COMMUNITY COMPOSTERS (30% Market growth rate)	TONS TREATED	YEAR	QUANTITY OF COMMUNITY COMPOSTERS (50% Market growth rate)	TONS TREATED
2.386,00	14.316,00	2020	2.386,00	14.316,00
3.101,80	18.610,80	2021	3.579,00	21.474,00
4.032,34	24.194,04	2022	5.368,50	32.211,00
5.242,04	31.452,25	2023	8.052,75	48.316,50
6.814,65	40.887,93	2024	12.079,13	72.474,75
8.859,05	53.154,31	2025	18.118,69	108.712,13
11.516,77	69.100,60	2026	27.178,03	163.068,19
14.971,80	89.830,78	2027	35.331,44	211.988,64
19.463,34	116.780,01	2028		
25.302,34	151.814,01	2029		
32.893,04	197.358,22	2030		
35.195,55	211.173,29	2031		

Figure 8 and the table above shows that, if the market shows a growth of 30%, it takes 10 years to reach 197,358 tons/year and an additional year with a growth of 7% to achieve 211,016 tons, that is to say in 11 years to achieve the installation of 35,195 composters.

Figure 41 Market Growth 30%

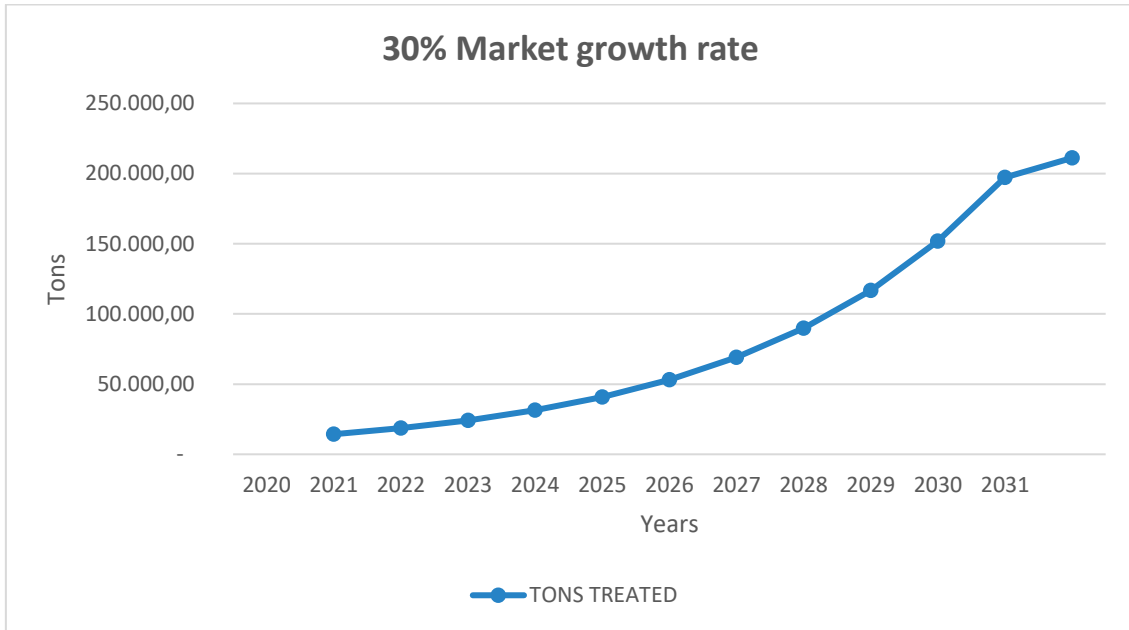
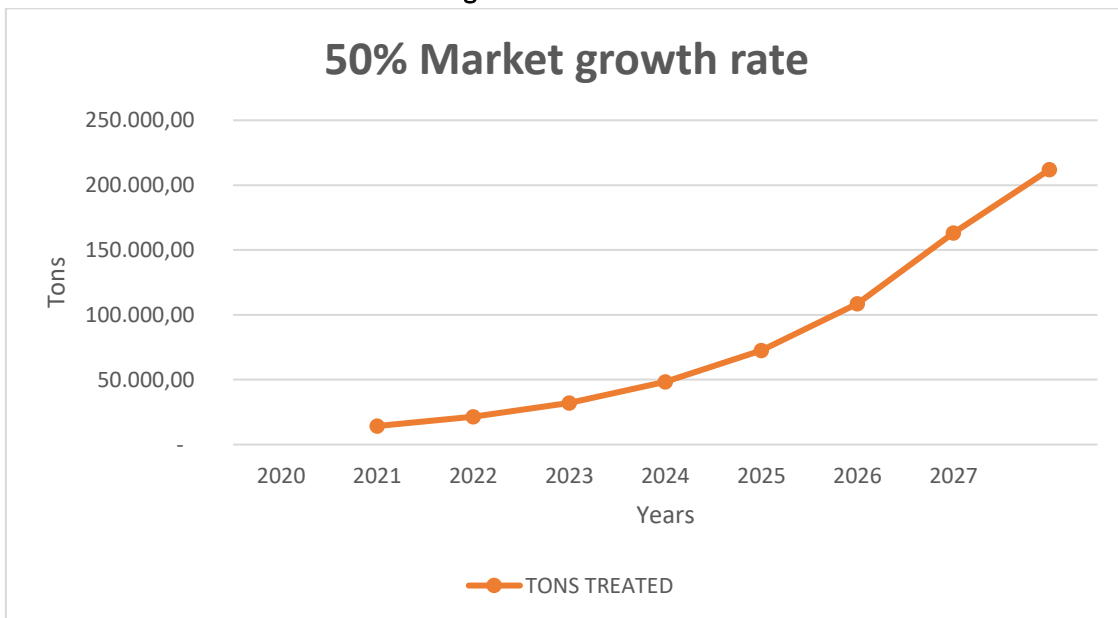


Figure 9 and the table shows that, if the market shows a growth of 50%, it takes 6 years to reach 163,068 tons/year and an additional year with a growth of 30% to achieve 211,016 tons, that is to say in 7 years to achieve the installation of 35,331 composters.

Figure 42 Market Growth 50%



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