ENI CBCMED
Cooperating across borders in the Mediterranean

Project funded by the EUROPEAN UNION

REGIONE AUTÒNOMA DE SARDIGNA
REGIONE AUTONOMA DELLA SARDEGNA

DECOST

Output 5.4

Sustainability Report

LCA: Life cycle assessment
LCC: Life cycle cost
SLCA: Social Life cycle assessment
Pilots Italy-Jordan-Spain-Palestine

This document/publication has been produced with the financial assistance of the European Union under the ENI CBC Mediterranean Sea Basin Program. The contents of this document are the sole responsibility of University of Vic – Central University of Catalonia and can under no circumstances be regarded as reflecting the position of the European Union or the Program management structures

DECOST

Document Information

OUTPUT	**Number**	5.4	**Title:**	Sustainability Report
Work Package	**Number**	WP5	**Title:**	Monitoring, evaluation and sustainability

Semester of delivery	VIII	**Target value**	1.0 Report
Version number	1.0		
Format	MS Office Word document		
Creation date	30/04/2023		
Version date			
Dissemination Level	PU Public X	CO Confidential	
Rights	Copyright "DECOST Partnership". During the drafting process, access is generally limited to the DECOST partners		

Responsible author	**Name:**	Angelica Oviedo	**Email:**	Angelica.oviedo@uvic.cat
	Partner:	UVIC-UCC	**Phone:**	655204422

Other main author	**Name:**	Joan Colon	**Partner:**	UVIC
	Name:	Mabel Mora	**Partner:**	UVIC
	Name:	Munir Rusan	**Partner:**	JUST
	Name:	Tahseen Sayara	**Partner:**	PTUK
	Name:	Francesco Fatone	**Partner:**	UNIVPM

Brief Description	This document describes the results obtained about the LCA assessement (carbon footprint), tons of CO2 equivalent (and monitoring, tecno economic assessment and social assessment of the DECOST project in the four pilots implemented in Italy, Jordan, Palestine and Spain.
Keywords	Sustainability, carbon footprint, monitoring, organic matter, OPEX, CAPEX, social indicators, sustainable development goals

Version log

Rev. No.	Issue Date	Modified by	Comments
1.0			
2.0			
3.0			

Table of content

LIST OF TABLES

LIST OF FIGURES

ENI CBCMED
Cooperating across borders in the Mediterranean

Project funded by the EUROPEAN UNION

REGIONE AUTÒNOMA DE SARDIGNA
REGIONE AUTONOMA DELLA SARDEGNA

DECOST

Output 5.4

Sustainability Report

LCA: Life cycle assessment

Pilots Italy-Jordan-Spain-Palestine

DECOST

EXECUTIVE SUMMARY

LCA: Life cycle assessment

All waste management practices generate GHGs, both directly (e.g. emissions from the biological degradation process of waste) and indirectly (e.g. through electricity consumption). However, the overall impact or benefit of waste management depends on the net GHG emission, taking into account both the emissions generated and those potentially saved. In this sense, the waste sector is in a unique position to move from being a source of global emissions to becoming a way to reduce GHG emissions. A holistic vision of its management that allowed us to understand the positive consequences of the waste sector on GHG emissions from different sectors such as energy and transport and manufacturing, based on the material and energy recovery of waste (UNEP 2010).

Through the DECOST project, the diversion of more than 1,000 t/year of the organic fraction from landfills/incineration was achieved, significantly reducing GHG emissions from this type of waste, which can be between 750 -800 kg CO2eq t-1 OFMSW if the landfill gas is not recovered.

To establish the reduction of emissions and the net impacts emitted, the environmental assessment was carried out for the new waste management model through the calculation of the carbon footprint through the waste streams of each country and their respective treatments and in this way obtain as a result the tons per year of T CO2eq OFMSW. And in this way demonstrate the environmental benefits in the implementation of this type of models in cities with different contexts, but with the common particularity of being small or medium-sized cities.

Additionally, during the composting process, the DECOST team carried out a detailed monitoring of the gaseous emissions of the H&CC systems. Specifically, monitoring gases such as NH3, H2S, VOCs, CH4 and N2O, which are shown in a summarized way in this.

Finally, the valorization of organic matter as a soil amendment is an enormous benefit, especially in the MED area, where there is a significant lack of MO in soils. Replacing chemical fertilisers with compost can provide additional avoided emissions close to 85 kg CO2eq t-1 compost. In addition, the development of the pilots, their operation, planned awareness campaigns, educational programmes and capacity building initiatives allowed to create a new municipal urban waste management framework focusing on community and home composting as the only way to manage the most solid organic matter, increasing the selection at the source of all waste fractions, reducing the generation of food waste and moving municipalities and society as a whole towards a green/circular economy approach not only in waste management, but as a key concept for long-term sustainable development.

The following table summarizes the main objectives obtained in terms of avoided, emitted and net impacts before and after the DECOST project.

DECOST goal	DECOST final output
Reduction of GHG emissions (Tn CO2 eq/year) in the treatment of organic matter.	**Through the DECOST Project, emissions were reduced from 716 Tn CO2eq/year to 209.13 Tn/year CO2eq a reduction of 506.87 Tn CO2eq/year.** Considering that the pilots ran for two years while the DECOST project was in place. This value is equal to **1013,74 Tn CO2eq/year**. It should be noted that the pilots are still in operation, which means that impacts continue to be avoided in this aspect.
Avoid additional emissions by substituting chemical fertilizers with compost.	During the one-year operation of the DECOST project, emissions avoided using compost obtained from community and home composting were around **19 Tn CO2eq/year avoided.** Considering that the pilots ran for two years while the DECOST project was in place and around **850 tons** of **compost** were obtained, this number is equal to **72,25 Tn CO2eq/year avoided.** It should be noted that the pilots are still in operation, which means that impacts continue to be avoided in this aspect.
Detailed monitoring of gaseous emissions from H&CC systems. Specifically, monitoring odors and gases such as NH3, H2S, VOCs, CH4 and N2O	During the operation of the composters, measurements of gases such as **CH4, N2O, NH3, H2S, VOCs and odors were made.**

OBJECTIVE 1: Reduction of GHG emissions (Tn CO2 eq/year) in the treatment of organic matter.

Through the DECOST Project, emissions were reduced from **716 Tn CO_2eq/year to 209.13 Tn/year CO_2eq a reduction of 506.87 Tn CO_2eq/year.**

Before implementing the DECOST project, the cities, and small towns subject to these pilots carried out the treatment of organic matter through biological stabilization processes or in some cases, such as that of the Mediterranean countries, organic matter was disposed of in landfills without carrying out the technical processes for the recovery of methane gas released by the anaerobic decomposition of this waste.

It is for this reason that before the DECOST project, the total net impacts were equal to 716 Tn CO2eq/year. This recovery only applies to the countries of Italy and Spain, since they are the countries that have implemented this technology in the controlled deposit sites. Additionally, we cannot speak of compost, since the applied technology allows to result in a stabilized organic matter, whose impacts are less than depositing organic matter in a landfill, but it does not yet have the characteristics of a compost.

However, it is important to mention the difference in the Tn CO2eq/year (46 Tn CO2eq/year) emitted in countries that have treatment systems such as stabilization of organic matter and recovery of methane gas in landfill since these are much lower than countries that do not have this type of technology (670 Tn CO2eq/year).

The following diagram shows the balance of inputs and outputs of the waste management system of the countries that participated in the development of the DECOST project pilots, where the inputs of the total tons of municipal urban waste by country (1471 Tn/year in total) are observed, emphasizing the organic fraction (521.8 Tn/year in total) and its treatment before the project. In the outputs you can see the net impacts of Tn CO2eq / years generated, as well as the stabilized material and the energy recovery of 1747 Gj / year.

It should be noted that although these impacts are calculated considering all the fractions, it can be observed later how the change in the treatment system of the organic fraction significantly improves the system by reducing emissions and separation at the source, since the percentage of organic matter is due to between 30% and 70% of the total waste generated.

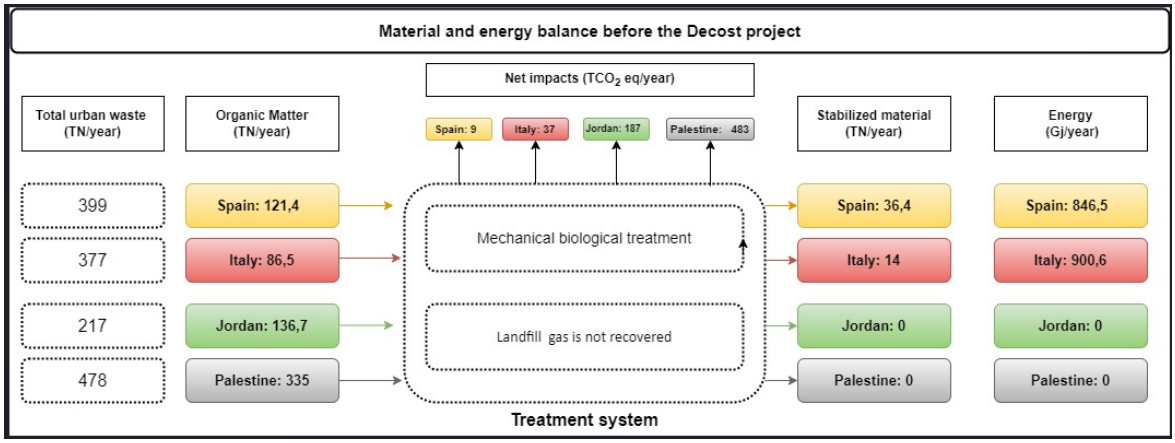

Figura 1 MATERIAL AND ENERGY BALANCE BEFORE THE DECOST PROJECT.
Data Source Provider: DECOST Project (UVIC-Beta Technology Center)

After the implementation of the DECOST project, it is possible to appreciate the balance of inputs and outputs of the waste management system of the countries that participated in the development of the DECOST project pilots, where the entries of the total tons of municipal urban waste by country (1438 Tn/year in total) are observed. emphasizing the organic fraction (742.57 Tn/year in total) and its treatment after the project. The outputs include the net impacts of Tn CO2eq/years generated (209.13 Tn CO2eq/year), as well as obtaining compost of 223.6 Tn/year and energy recovery of 886.5 Gj/year, that is, **Through the DECOST Project, emissions were reduced from 716 Tn CO2eq/year to 209.13 Tn/year CO2eq a reduction of 506.87 Tn CO2eq/year.**

Considering that the pilots ran for two years while the DECOST project was in place. This value is equal to **1013,74 Tn CO2eq/year**. It should be noted that the pilots are still in operation, which means that impacts continue to be avoided in this aspect.

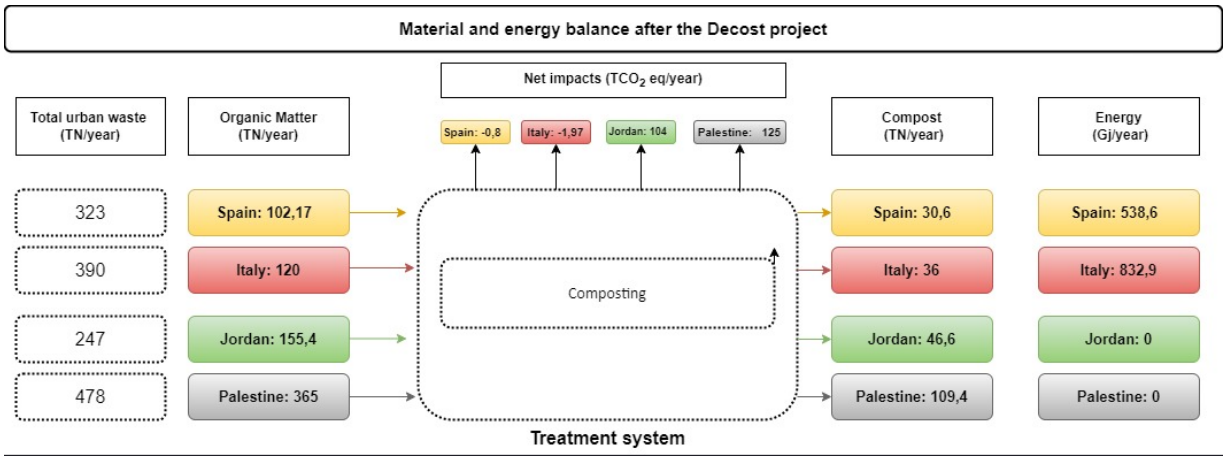

Figura 2 MATERIAL AND ENERGY BALANCE AFTER THE DECOST PROJECT.
Data Source Provider: DECOST Project (UVIC-Beta Technology Center)

*For the purposes of Spain, the calculation of the organic matter of Vic (42 Tn/year) was not carried out.

OBJECTIVE 2: Avoid additional emissions by replacing chemical fertilizers with compost.

During the one-year operation of the DECOST project, emissions avoided using compost obtained from community and home composting were around **19 Tn CO2eq/year avoided.**

One of the most important benefits of community and home composting implemented through the DECOST project is the obtaining of compost. These are since the population under study develops a diversity of agricultural projects, which allows direct use of the compost obtained by replacing the use of chemical fertilizers and thus avoiding emissions close to 85 kg CO2eq t-1 compost.

That is to say that in a year of operation of the pilots where 223.6 Tn / year of compost were obtained in total by the four countries, 19 Tn CO2eq / year were avoided and considering that the pilots ran for two years while the DECOST project was in place and around **850 tons** of **compost** were obtained, this number is equal to **72,25 Tn CO2eq/year avoided.**

It should be noted that the pilots are still in operation, which means that impacts continue to be avoided in this aspect.

The variations of compost obtained depend on the amount of organic matter treated, which will be higher in countries where the percentage of this fraction is between 70% compared to 30% in other countries.

In the following graph you can see the relationship between the use of compost and the emissions avoided by fertilizer use, the greater the amount of compost, the greater the Tn CO2eq/year avoided.

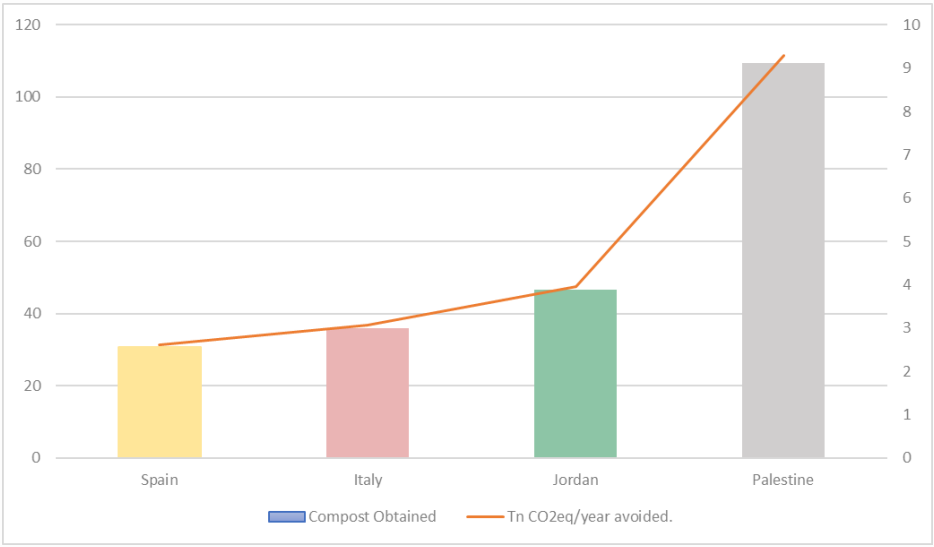

Figura 3 RATIO OF COMPOST OBTAINED TO AVOIDED EMISSIONS FROM THE USE OF CHEMICAL FERTILIZERS.
Data Source Provider: DECOST Project (UVIC-Beta Technology Center)

OBJECTIVE 3: Detailed monitoring of gaseous emissions from H&CC systems.

During the operation of the composters, measurements of gases such as **CH4, N2O, NH3, H2S, VOCs and odors were carried out.**

During the operation of the composters, measurements of gases such as CH4, N2O, NH3, H2S, VOCs and odors were made.

These measurements were performed during a full process cycle (90 days) twice a week. Subsequently, the calculation of gases emitted during the composting process was carried out.

To obtain the odor samples, CH4 and N2O a flow chamber (FC) manufactured by Scentroid (IDES Canada Inc., ON, Canadá), equipped with stainless steel fittings and Teflon™ sampling lines. Air was supplied with the Universal pump at a flow rate of 4.0 L-min-1 for 20 minutes, equivalent to 2 residence times in the FC, to reach constant concentrations inside the FC before sampling, inside the FC before sampling. After 20 minutes, a bag of Nalophan was introduced into an airtight sampling vessel in which, by means of a vacuum pump, the gaseous sample was directed from the CF to the Nalophan bag. This methodology is recommended by the USEPA (USEPA, 1986), from which more consistent and less variable results have been obtained. (González, 2019). The sample is then analyzed in the SCION 456-GC gas chromatograph.

To perform the measurements of NH3, H2S and VOCs also made use of the Flow chamber and the air supply through the universal pump, but the data were obtained through the measurements of the sensor contained by the MultiRAE Lite analyser equipment. Through the flow chamber and a pipe coming directly from the exhaust gas that allows the homogenization and representativeness of the exhaust gases. The MultiRAE Lite analyzer was located inside the flow chamber (plastic container. After stabilization of the signal (between 5 and 10 minutes), the levels of gaseous compounds were taken.

The following photographs show the equipment used described above, as well as the complete assembly inside a composter.

Figura 4 Flow chamber (FC) manufactured by Scentroid (IDES Canada Inc., ON, Canadá- Universal pump- MultiRAE Lite analyser equipment.
Data Source Provider: DECOST Project (UVIC-Beta Technology Center)

Figura 5 Example of field monitoring Community composters LMR-Spain.
Data Source Provider: DECOST Project (UVIC-Beta Technology Center)

Figura 6 Example of field monitoring Community composters Palestine
Data Source Provider: DECOST Project (UVIC-Beta Technology Center)

The following graphs show some results of field monitoring in the different countries of implementation of the DECOST project.

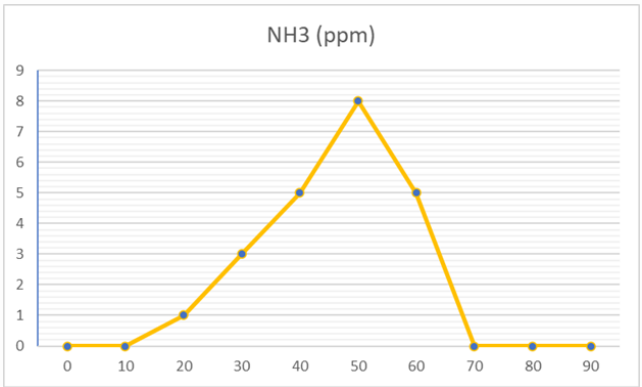

Figura 7 NH3 measurements DECOST Spain project. Data Source Provider: DECOST Project (UVIC-Beta Technology Center)

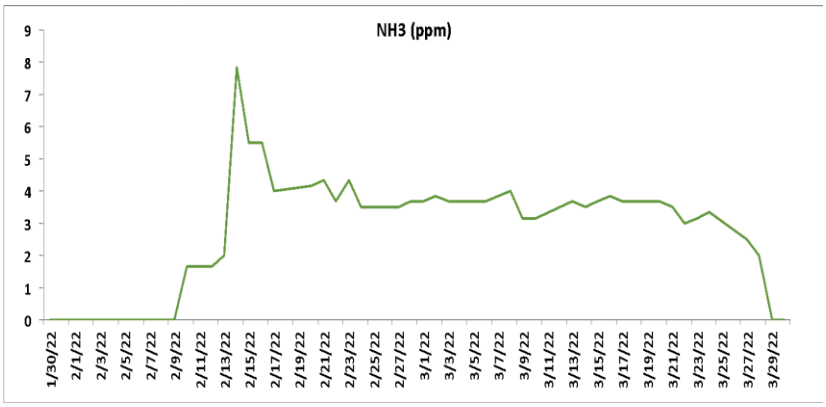

Figura 8 NH3 measurements DECOST Jordan project. Data Source Provider: DECOST Project (UVIC-Beta Technology Center)

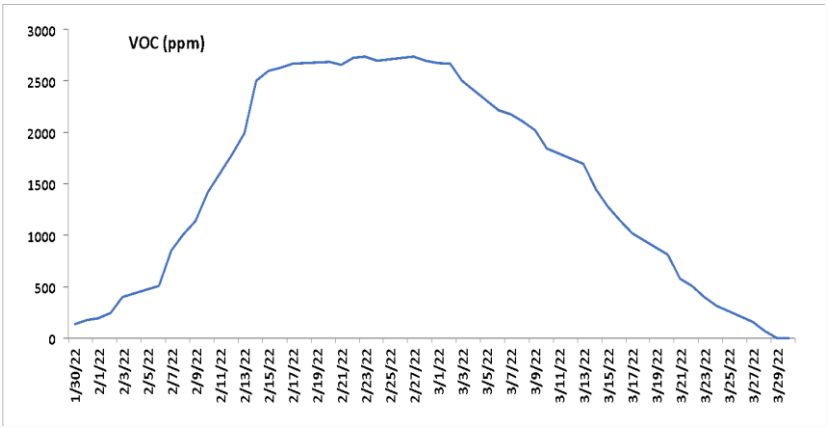

Figura 9 VOC measurements DECOST Jordan project. Data Source Provider: DECOST Project (UVIC-Beta Technology Center)

The composters installed in Italy Scambiologico and ORTIURBAN, has its own monitoring system, whose measurements are made in the graphs shown below.

COMPOSTER – SCAMBIOLOGICO

As an example of this monitoring, in the November period, it can be seen that no CH4 gases were emitted during the composting process, as for H2S gases, slight emissions not exceeding 2.5 ppm are observed. As for NH3 emissions, these are not higher than 20 ppm,

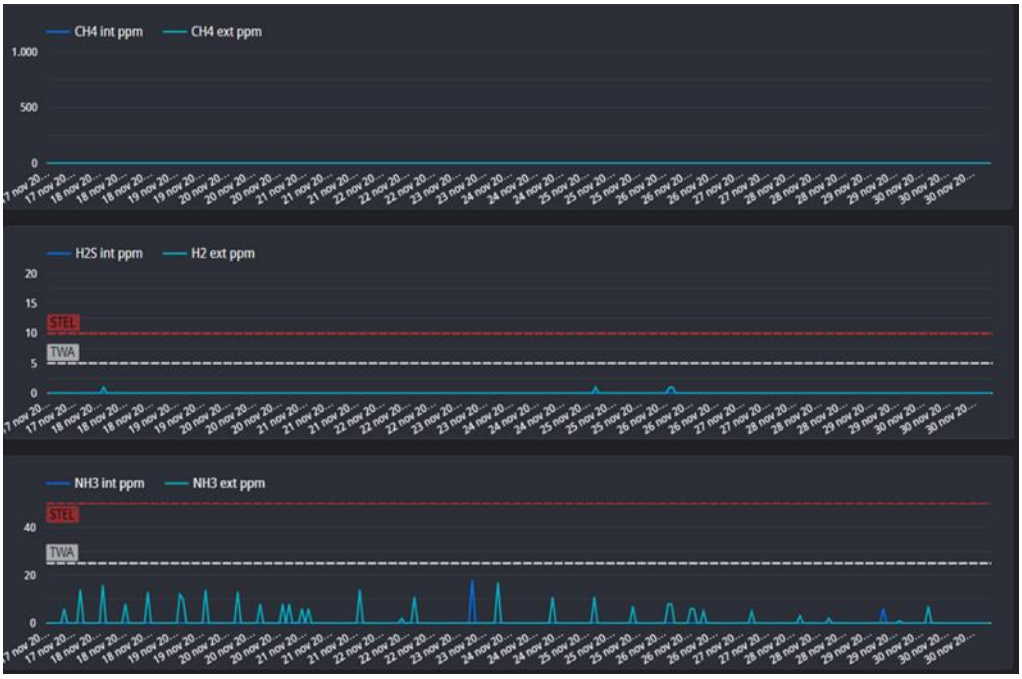

Figura 10 Measurements of NH3-H2S-CH4 DECOST Italia project. Data Source Provider: DECOST Project (UVIC-Beta Technology Center)

COMPOSTER – ORTIURBAM

These graphs show the monitoring carried out in the month of January 2022 which show gas emissions of CH4, H2S, NH3 equal to 0 ppm.

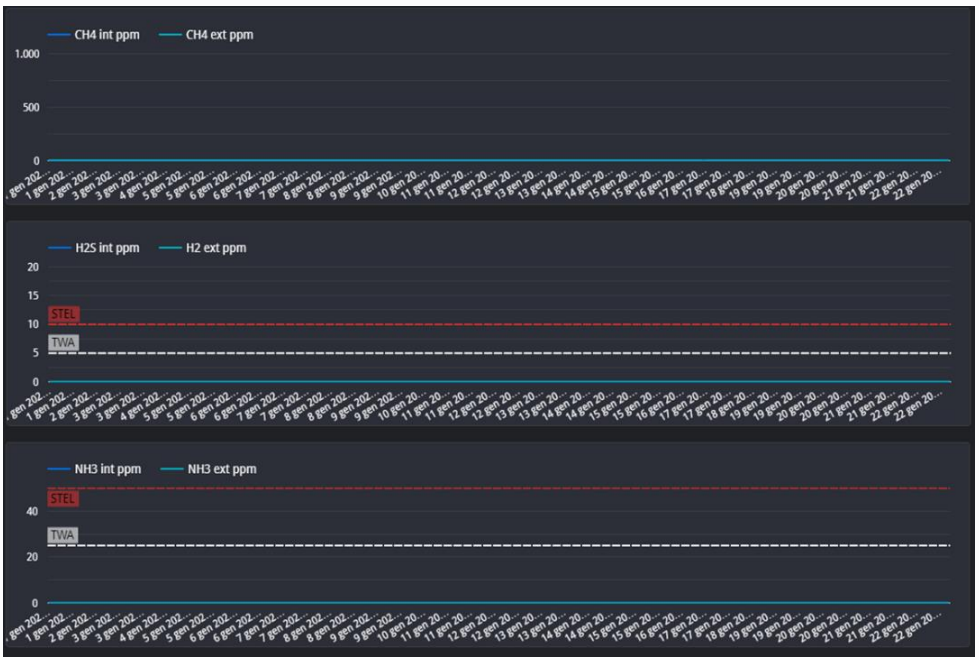

Figura 11 Measurements of NH3-H2S-CH4 DECOST Italia project. Data Source Provider: DECOST Project (UVIC-Beta Technology Center)

In some cases, especially during the thermophilic stage of the process, some gas emission levels, NH3 levels, may be beyond the detection range provided by the device. In such cases, dilution of the gases inside the flow chamber may be necessary or, even in the worst case, dilution series may be necessary to correctly measure the exhaust gases. For dilution, clean air must be pumped into the flow chamber at a known flow rate using the additional valves placed in the flow chamber. (Beta, 2019). The data obtained in the field allowed to calculate the emission rate of each gas and this was multiplied by the tons treated in each country.

COUNTRY	KG NH3/TN OFMSW	KG CH4/TN OFMSW	KG N2O/TN OFMSW
SPAIN	85,82	16,35	69,07
ITALY	100,8	19,2	81,12
JORDAN	130,54	24,86	105,05
PALESTINE	306,6	58,4	246,74

Tabla 1 Emissions rate by country DECOST Project.
Data Source Provider: DECOST Project (UVIC-Beta Technology Center)

ODORS

For the case of odor measurement, the same equipment is used as the flow chamber (FC) manufactured by Scentroid, pump that supplies an air flow, and the sample is taken through a vacuum chamber (suitcase) containing a bag Nalophan bags 10 L, to perform this measurement the ambient T is considered, wind speed and direction and different distances from the composter.

Figura 12 Bag or odour sampling
Data Source Provider: DECOST Project (UVIC-Beta Technology Center)

The sample is analyzed through the olfactometer that allows to determine the concentration of odor in the air, by applying calculations of atmospheric dispersion and, consequently, allows to estimate the immission of odor and therefore the potential affectation of the emission considered. The determination of the odour concentration is carried out by dynamic olfactometry, which is an analysis method developed in the EN 13725 standard. This standard defines dynamic

olfactometry as one that uses a dynamic olfactometer to mix an odorous sample flow and a neutral air flow at a common outlet with known dilution factors. (Enquiol, 2019)

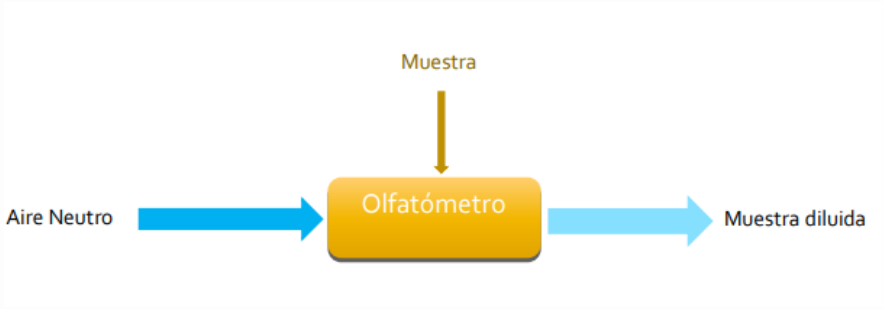

Figura 13 Dilution scheme of odor sample
Source (Enquiol, 2019)

Results of field measurements an Odor concentration: Describes the strength of an odor. - Measured in units called Odor Units (UO). - 3 OU is an odor that must be mixed with 2 parts fresh air + 1 part sample to obtain 1 OO.

1.CALCULATION OF CARBON FOOTPRINT BY COUNTRY.

Goal

Calculate the tons of carbon equivalent in the processes of treatment and final disposal of the organic fraction and other fractions before and after the DECOST project and in this way know the net impacts of each country in which the project was developed.

Scope

the tons of CO2 equivalent in the waste management of the Municipalities Les Masies de Roda (Spain), Potenza and Atella (Italy), Anabta and Kufr Kumman (Palestine) and Al Sarrow (Jordan) considering the tons generated before the DECOST project and after the DECOST project. In this way, the impact of avoided, emitted and net tons of CO2 will be evaluated with the implementation of the DECOST project as the only way to treat the organic fraction.

The functional unit of this system is the MANAGED TONS OF URBAN WASTE GENERATED BEFORE AND AFTER THE IMPLEMENTATION OF THE DECOST PROJECT IN THE MUNICIPALITIES UNDER STUDY

The Inventory analysis

To calculate the tons of CO2 eq the percentages of each of the fractions destined to the different types of treatment (e.g., landfill, incineration, recycling, etc.) as well as information related to the transport of these are taken into account as input information.

Additionally, the characterization of waste, recycling and mixed MSW and the properties of each of the fractions that make up the MSW (e.g., % humidity, % C, % Corg, % degradability, calorific value, etc.) are considered.

The impact assessment

The calculation of the carbon footprint of the municipal management of solid waste was carried out using the CarbonFootprint_Calculator_MSW tool designed by the BETA Technology Center of the University of Vic – Central University of Catalonia. This tool considers the management pathways mentioned above in the table, resulting in the impact of avoided, emitted and net tons of CO2 with the implementation of the DECOST project as the only way to treat the organic fraction.

1.2 CALCULATION OF THE CARBON FOOTPRINT IN SPAIN.

This study will quantify the tons of CO2 equivalent in the waste management of Les Masies de Roda, considering the tons generated in 2018 before the DECOST project and those of 2021 after the DECOST project. In this way, the impact of the avoided, emitted, and net tons of CO2 will be evaluated with the implementation of the DECOST project as the only way to treat the organic fraction.

The functional unit of this system MANAGEMENT OF URBAN WASTE GENERATED BEFORE AND AFTER IN EACH OF THE MUNICIPALITIES SURVEYED

It is important to mention that in the WP3- Base Line Scenario the management model in Les Masias de Roda was described, as summarized in the following table.

System	Description
Collection	Before the DECOST Project, collection was separated by fractions by means of sidewalk containers, identified by color. One of the actions carried out within the framework of the LMR urban waste management system during the implementation of the DECOST project was the change from curbside collection to door-to-door collection, except for the organic fraction that is directly treated in composters located in different parts of the municipality.
Transport	The waste was collected and transported by the Recollida de Residus d'Osona. Distance from LMR 18-20 Km). After DECOST the procedure is the same except for the organic fraction that is treated directly in the composters.
Treatment	The remaining fraction (mixed waste) and organic fractions were transported to the Oris Waste Biological Mechanical Treatment Plant, where mechanical separation is carried out for the recovery of recyclable fraction. As for the organic fraction, it is biostabilized, that is, the organic matter biodegrades under conditions like those established for composting, but without producing a value-added product, such as compost. The fraction of waste that cannot be recovered or recycled is incinerated or recovered energetically. As for the multi-product fractions (dry fraction: paper, cardboard, and plastic), these were moved to the Triage plant distance from MRL 13-15 km. As for glass, this fraction is collected and transported directly to a recycling plant where the glass is cleaned and treated to make new products.
Final waste disposal	The final disposition of that which cannot be taken advantage of is disposed of. in controlled landfills (in this case the Orís Landfill), incinerated or energetically valorized to 20 km from the municipality.

Tabla 2. BRIEF DESCRIPTION OF THE MRL-SPAIN WASTE MANAGEMENT SYSTEM.
Data Source Provider: DECOST Project (UVIC-Beta Technology Center)

The following figure shows the input and output flows considered for the calculation of CO2 equivalent tons in 2018.

In 2018, 399 Tn/year of urban waste were generated, of which 185.53 Tn were sent to mechanical biological treatment, 123.9 Tn being incinerated, and 14.3 Tn of dry fraction and 47.3 Tn of wet fraction recovered.

As for the selective collection of 213.42 tons, 69.7 tons correspond to recycling of dry fraction and 74 tons of wet fraction, and 69.7 tons were incinerated by recycling disposal.

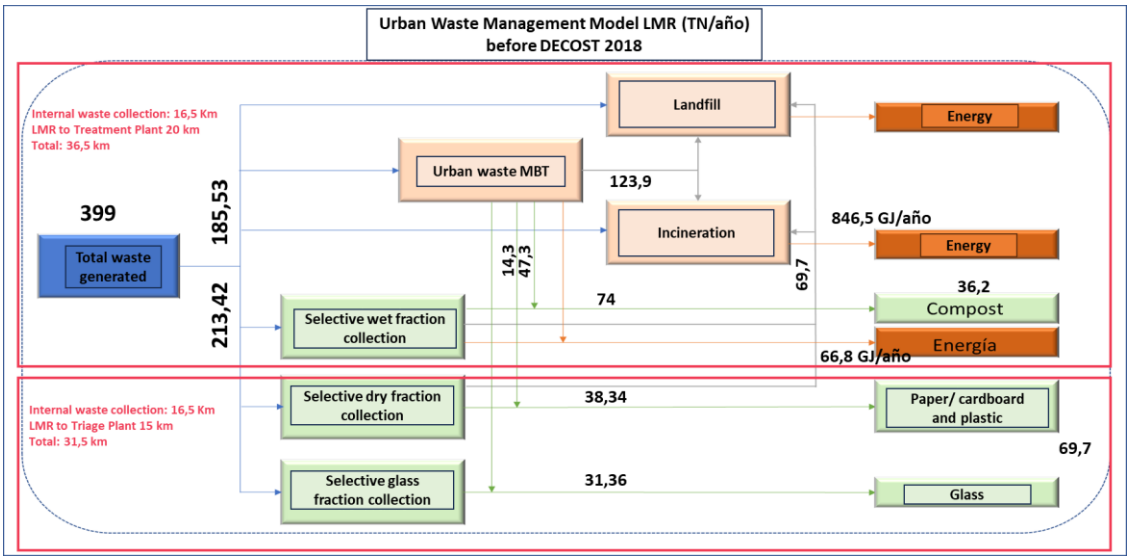

Figura 14 URBAN WASTE MODEL LMR-SPAIN BFORE DECOST 2018.
Data Source Provider: DECOST Project (UVIC-Beta Technology Center)

In 2021, 323.3 Tn/year of urban waste were generated, where a better separation at the source is observed, which affects a better use of waste (76.6 Tn less) since only 74.89 Tn were sent to mechanical biological treatment, being incinerated 67 Tn, 0.9 Tn sent to controlled deposit and 7 Tn of dry fraction recovered.

As for the selective collection of 248.42 tons, 102 tons correspond to wet fraction, 79 tons of dry fraction recycling and 79 tons were incinerated by recycling disposal.

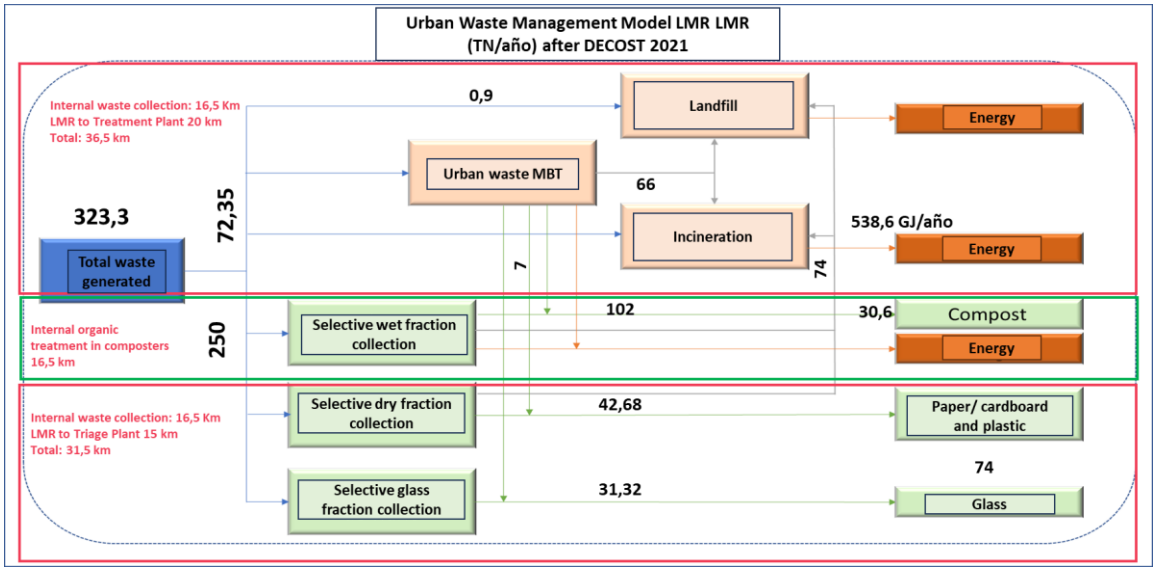

Figura 15 URBAN WASTE MODEL LMR-SPAIN AFTER DECOST 2021.
Data Source Provider: DECOST Project (UVIC-Beta Technology Center)

It is noteworthy that in 2021 the collection system went from being curbside to being door to door. The organic fraction residues are disposed directly by the user in the composters located in the LMR neighborhoods, receiving 2 times a week maintenance, and after three months collecting the material to be sifted, it is noteworthy that all this is done in the same MRL avoiding the 20 km of displacement that was previously made. This route is carried out in the following frequencies:

BARRIO	PUNTO	DIAS
Fontanelles	Primero	LUNES Y JUEVES
	Granja	
	Huerto	
	Parque	
Esquerda	Esquerda	
Punto de recogida		
Vicentç	Tenis	
	Casas	
	Granja	
Casas Nuevas	I	MARTES Y VIERNES
	II	
	III	
	Industria	
	Bar	

Tabla 3 OPERATING AND MAINTENANCE FREQUENCIES OF THE ORGANIC MATERIAL.
Data Source Provider: DECOST Project (UVIC-Beta Technology Center)

RESULTS

2018

The following table relates the number of tons transported, treated and/or disposed of to the tons of CO2 equivalent. Depending on the type of treatment, for example, incineration considers the energy recovered, as well as the tons of compost and recyclable material, depending on the fraction and type of treatment are emitted and avoid impacts. The sum of these impacts results in net impacts.

In the following table of the 123.9 tons sent to incineration, 45.8 TCO2eq/year were emitted, in terms of the recycling of organic matter recovered by MBT plus that separated at the source, 16.1 TCO2eq/year were emitted, -71.1 TCO2eq/year for the recycling of the dry fraction and 18 TCO2eq/year in terms of internal collection transport and transfer to treatment systems.

The sum of these emitted impacts minus those avoided results in the MRL waste management system generating net impacts of 9 TCO2eq/year in 2018.

	Tons	Carbon footprint		recovered energy		Compost	Recyclables
	(t/year)	t CO2eq/year	kg CO2 eq/t UW	(GJ/year)	(GJ/tUW)	(t/year)	(t/year)
Landfill							
Waste without Treatment	0,0	0	0,0	0,0	0,0		
Refusal MBT	0,0	0,0		0,0			
Refusal recycling	0,0	0,0		0,0			
Incineration							
Waste without Treatment	0,0	0	236,9	0,0	4,0		
Refusal MBT	123,9	9,7		442,5			
Refusal recycling	69,7	36,1		337,2			
Recycling Organic matter							
MBT	47,3	9	132,4	26,0	0,6	14,2	
OFMSW	74,1	7,1		40,8		22,2	
Recycling dry fraction							
Material recovered MBT	14,3	-13,1					14,3
Recovered material dry fraction	69,7	-58					70
Transport							
Waste to Landfill		0	0,0	0,0	0,0		
Waste to Incineration		0		0,0			
Waste to MBT		6		0,0			
Bio-waste composting		2					
Recyclables to sorting plant		4					
Refusal MBT		4					
Refusal recycling		2					
Total	399,0	9					

Tabla 4 TCO2 eq BY FRACTION TREATMENT BEFORE DECOST SPAIN
Data Source Provider: DECOST Project (UVIC-Beta Technology Center)

The following graph shows the tons treated by treatment system were incinerated 193.60 Tn, the separation of organic matter at the source was 74.10 Tn and MBT of 47.30 for a total of 121.40 Tn. As for the dry fractions of recycling at the source, these were 69.70 Tn and 14.30 Tn material recovered from MBT for a total of 84 Tn.

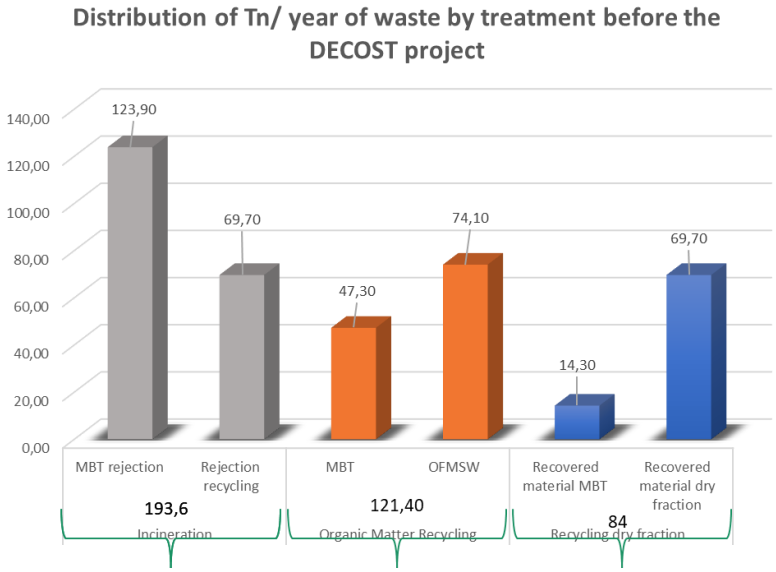

Figura 16 DISTRIBUTION OF TN/YEAR OF WASTE BY TREATMENT BEFORE DECOST.
Data Source Provider: DECOST Project (UVIC-Beta Technology Center)

2021

In the following table you can see the tons emitted by treatment, in this way it is observed that the tons sent to incineration 43.8 TCO2eq / year, recycling of organic matter recovered by MBT 20.2 TCO2eq / year and -77.7 TCO2eq / year for the recycling of the dry fraction and 13 TCO2eq / year in terms of internal collection transport and transfer to treatment systems. By 2021, the MRL waste management system generated net impacts of -0.9 tCO2eq/year.

	Tons	Carbon footprint		recovered energy		Compost	Recyclables
	(t/year)	t CO2eq/year	kg CO2 eq/t UW	(GJ/year)	(GJ/tUW)	(t/year)	(t/year)
Landfill							
Waste without Treatment	0,88	0	107,5	0,0	23,4		
Refusal MBT	0,00	0,0		0,0			
Refusal recycling	0,00	0,0		0,0			
Incineration							
Waste without Treatment	0,00	0	302,8	0,0	3,9		
Refusal MBT	65,70	2,8		151,5			
Refusal recycling	74,02	39,5		387,0			
Recycling Organic matter							
MBT	0,00	0	209,8	0,0	0,0	0,0	
OFMSW	102,17	21,4		0,0		30,6	
Recycling dry fraction							
Material recovered MBT	6,65	-5,7					6,6
Recovered material dry fraction	74,02	-72					74
Transport							
Waste to Landfill		0	0,0	0,0	0,0		
Waste to Incineration		0		0,0			
Waste to MBT		2		0,0			
Bio-waste composting		2					
Recyclables to sorting plant		4					
Refusal MBT		2					
Refusal recycling		2					
Total	323,4	-0,8					

Figura 17 TCO2 eq BY FRACTION TREATMENT AFTER DECOST.
Data Source Provider: DECOST Project (UVIC-Beta Technology Center)

As for the tons treated by treatment system, 0.9 tons were sent to the treatment system, 145.55 tons were incinerated, the separation of organic matter at the source was 100% treated in situ by

community composting of 91.34 tons. As for the dry fractions of recycling, at the source these were 78.54 Tn and 6.98 Tn material recovered from MBT for a total of 85.52 Tn. Therefore, a significant improvement is observed in the separation at the source, which affects the treatment of recycling and organic fraction.

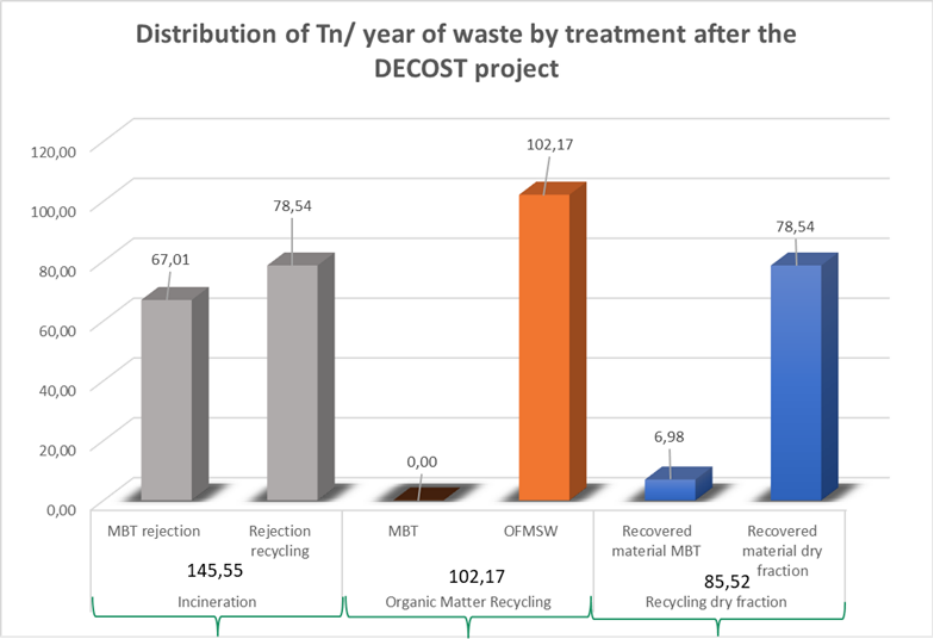

Figura 18 DISTRIBUTION OF TN/YEAR OF WASTE BY TREATMENT AFTER DECOST.
Data Source Provider: DECOST Project (UVIC-Beta Technology Center)

TONS OF EMISSIONS AVOIDED BY CHEMICAL FERTILIZER SUBSTITUTION.

During the year 2021, 30.6 Tn of compost were obtained, the substitution of chemical fertilizers by compost can provide additional avoided emissions close to 85 kg CO2eq t-1 compost that is, in the case of MRLs, **2.6 Tn CO_2** eq were avoided.

RESULTS BEFORE AND AFTER DECOST

2018

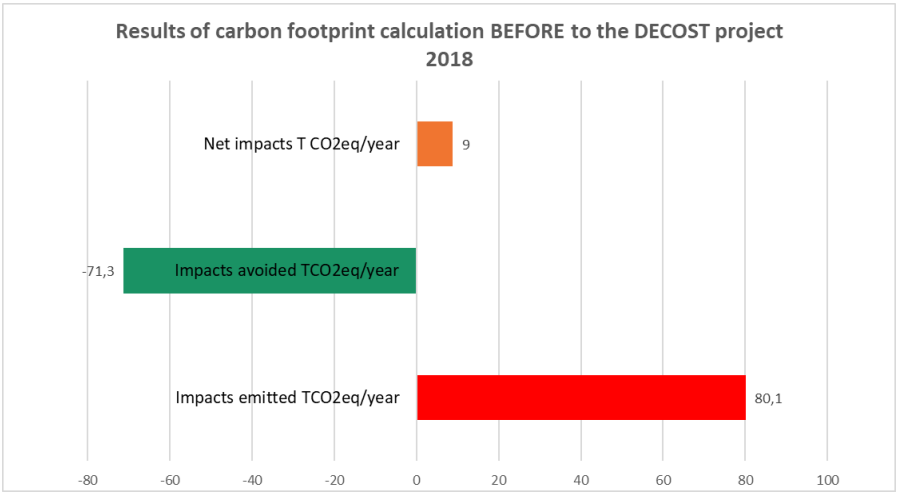

Figura 19 RESULT OF CARBON FOOTPRINT CALCULATION BEFORE DECOST.
Data Source Provider: DECOST Project (UVIC-Beta Technology Center)

2021

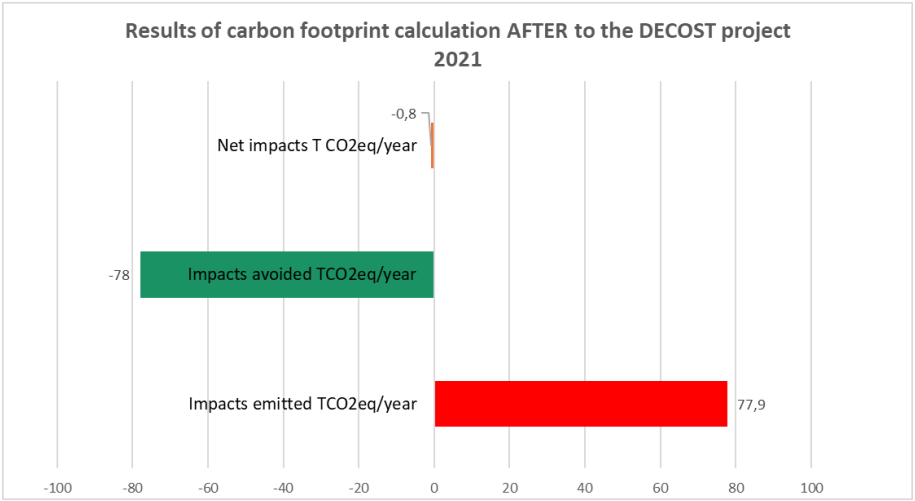

Figura 20 RESULT OF CARBON FOOTPRINT CALCULATION AFTER DECOST.
Data Source Provider: DECOST Project (UVIC-Beta Technology Center)

The negative net result indicates that the environmental credits exceed the impacts issued, these results are the positive consequences of the implementation of the DECOST project, since there may be an improvement in the separation at the source which allows a better use of the fractions. Additionally, the in situ treatment of the organic fraction generates as a result the obtaining of compost the cueles brings other additional positive benefits such as emissions avoided by not using chemical fertilizers and improvements in soil conditions.

1.3 CALCULATION OF THE CARBON FOOTPRINT IN ATELLA AND POTENZA-ITALY.

This study will quantify the tons of CO2 equivalent in the waste management of Potenza and Atella Italy, considering the tons generated in Atella 2020 before the DECOST project and those of 2022 after the DECOST project and Potenza 2020 before the DECOST project and those of 2021 after the DECOST project. In this way, the impact of the avoided, emitted, and net tons of CO2 will be evaluated with the implementation of the DECOST project as the only way to treat the organic fraction.

1.3.1 CALCULATION OF THE CARBON FOOTPRINT IN ATELLA -ITALY.

The functional unit of this system MANAGEMENT OF URBAN WASTE GENERATED BEFORE AND AFTER IN EACH OF THE MUNICIPALITIES SURVEYED

It is important to mention that in the WP3- Base Line Scenario the management model in Potenza was described, as summarized in the following table:

System	Description
Collection	Before the DECOST Project, the collection was separated by fractions just the 28% of total of waste.
Transport	The waste was collected and transported until Cafaro Plantform. After DECOST the procedure is the same except for the organic fraction that is treated directly in the composters.
Treatment	The remaining fraction (mixed waste) and organic fractions were transported to the Oris Waste Biological Mechanical Treatment Plant, where mechanical separation is carried out for the recovery of recyclable fraction. As for the organic fraction, it is biostabilized, that is, the organic matter biodegrades under conditions like those established for composting, but without producing a value-added product, such as compost. The fraction of waste that cannot be recovered or recycled is incinerated or recovered energetically. As for the multi-product fractions (dry fraction: paper, cardboard, glass, and plastic), these were moved to the Triage Plant SEARI CONSORTIUM. The distance from Atella until the Plant is 4,5 km. As for glass, this fraction is collected and transported directly to a recycling plant where the glass is cleaned and treated to make new products.
Final waste disposal	The final disposition of that which cannot be taken advantage of is disposed of. in controlled landfills (Cafaro Platform), incinerated or energetically valorized to 7 km from the municipality.

Tabla 5. BRIEF DESCRIPTION OF THE ATELLA-ITALY WASTE MANAGEMENT SYSTEM.
Data Source Provider: DECOST Project (UVIC-Beta Technology Center)

The following figure shows the input and output flows considered for the calculation of CO2 equivalent tons in 2020.

In 2020, 269 tons / year of urban waste were generated, since the target population corresponds to 640 inhabitants and per capita production corresponds to 1.15 kg inhabitants / d. Of these 269 Tn, 193 Tn were sent mechanical biological treatment, being incinerated 95 Tn and recovered 5 Tn of dry fraction and 14 Tn of wet fraction sent to controlled deposit.

As for the selective collection of 76 tons, 38 tons correspond to recycling of dry fraction 69.7 tons and 38 tons were incinerated by recycling disposal.

It is noteworthy that in 2020 the collection was carried out by sidewalk containers including the organic fraction, which was not used at all and was disposed of in the cells of the landfill.

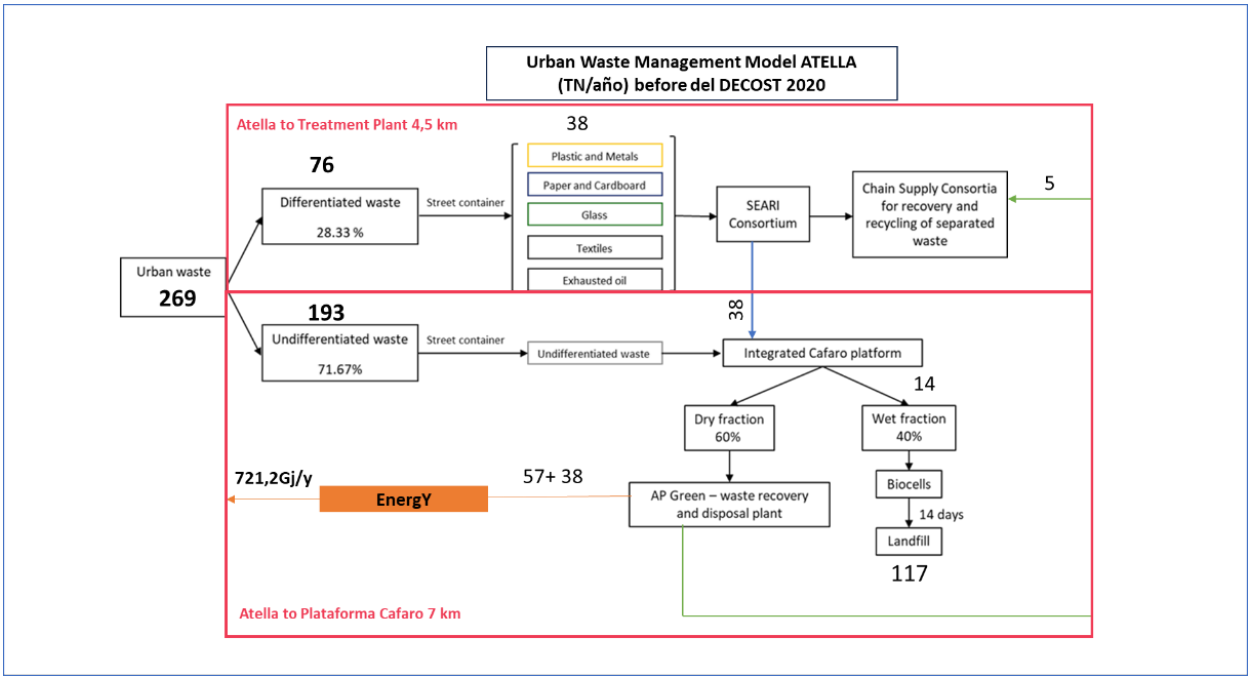

Figura 21 URBAN WASTE MODEL ATELLA-ITALY BEFORE DECOST 2020.
Data Source Provider: DECOST Project (UVIC-Beta Technology Center)

In 2022, after the implementation of the DECOST project, 282 Tn/year of urban waste were generated, where a better separation at the source is observed since 132 Tn were sent to mechanical biological treatment, being incinerated 73 Tn, 52 Tn sent to controlled deposit and 7 Tn of dry fraction recovered. It should be noted that although the organic fraction is collected selectively, it is treated through the Ecopans composter installed by the DECOST project, located on the Cafaro platform, where around 70 tons of organic matter were treated.

As for the biological mechanical treatment of 132 tons, 73 tons were incinerated, 52 tons were sent to controlled storage and 7 tons were recovered for recycling.

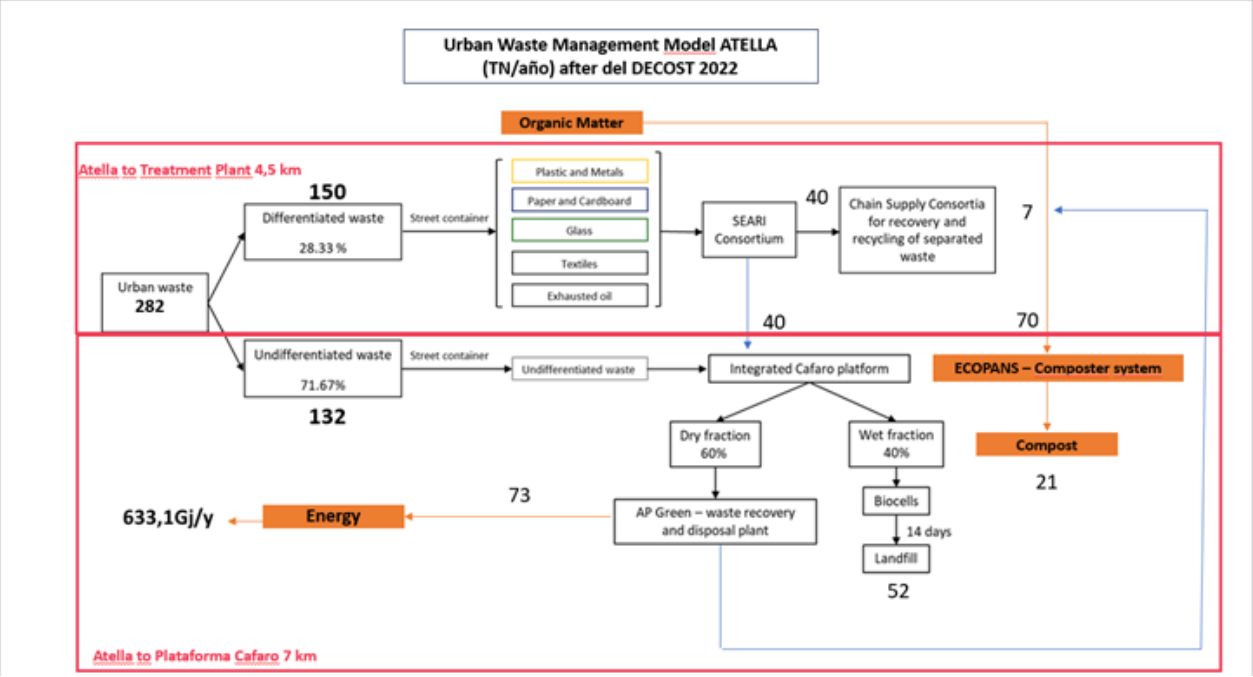

Figura 22 URBAN WASTE MODEL ATELLA-ITALY AFTER DECOST 2022.
Data Source Provider: DECOST Project (UVIC-Beta Technology Center)

RESULTS

The following table relates the number of tons transported, treated and/or disposed of to the tonnes of CO2 equivalent. Depending on the type of treatment, for example, incineration considers the energy recovered, as well as the tons of compost and recyclable material, depending on the fraction and type of treatment are emitted and avoid impacts. The sum of these impacts results in net impacts.

2020

In the following table you can see the tons emitted by treatment, in this way it is observed that the tons sent to controlled deposit generate 27 TCO2eq / year, incineration 43.5 TCO2eq / year, recycling of organic matter recovered by MBT 2 TCO2eq / year and -56.9 TCO2eq / year for the recycling of the dry fraction and 14 TCO2eq / year corresponding to transport.

The sum of these emitted impacts minus those avoided results in the Atella waste management system generating net impacts of 29 TCO2eq/year in 2020

	Tons	Carbon footprint		recovered energy		Compost	Recyclables
	(t/year)	t CO2eq/year	kg CO2 eq/t UW	(GJ/year)	(GJ/tUW)	(t/year)	(t/year)
Landfill							
Waste without Treatment	116,8	27	230,0	7,7	65,8		
Refusal MBT	0,0	0,0		0,0			
Refusal recycling	0,0	0,0		0,0			
Incineration							
Waste without Treatment	0,0	0	456,3	0,0	7,5		
Refusal MBT	57,4	11,9		442,5			
Refusal recycling	38,0	31,6		271,1			
Recycling Organic matter							
MBT	13,8	2	125,8	7,6	0,6	4,1	
OFMSW	0,0	0,0		0,0		0,0	
Recycling dry fraction							
Material recovered MBT	5,1	-7,9					5,1
Recovered material dry fraction	38,0	-49					38
Transport							
Waste to Landfill		5	0,0	0,0	0,0		
Waste to Incineration		0		0,0			
Waste to MBT		3		0,0			
Bio-waste composting		0					
Recyclables to sorting plant		2					
Refusal MBT		2					
Refusal recycling		2					
Total	269,00	29					

Tabla 6 TCO2 eq BY FRACTION TREATMENT BEFORE DECOST ATELLA-ITALY.
Data Source Provider: DECOST Project (UVIC-Beta Technology Center)

Between the rejection of MBT and recycling, 95.4 tons were incinerated, there was no separation at the source of organic matter, however, 13.80 tons were recovered from the MBT. As for the fractions of dry recycling at the source, these were 38 Tn and 5.10 Tn material recovered from MBT for a total of 43.1 Tn.

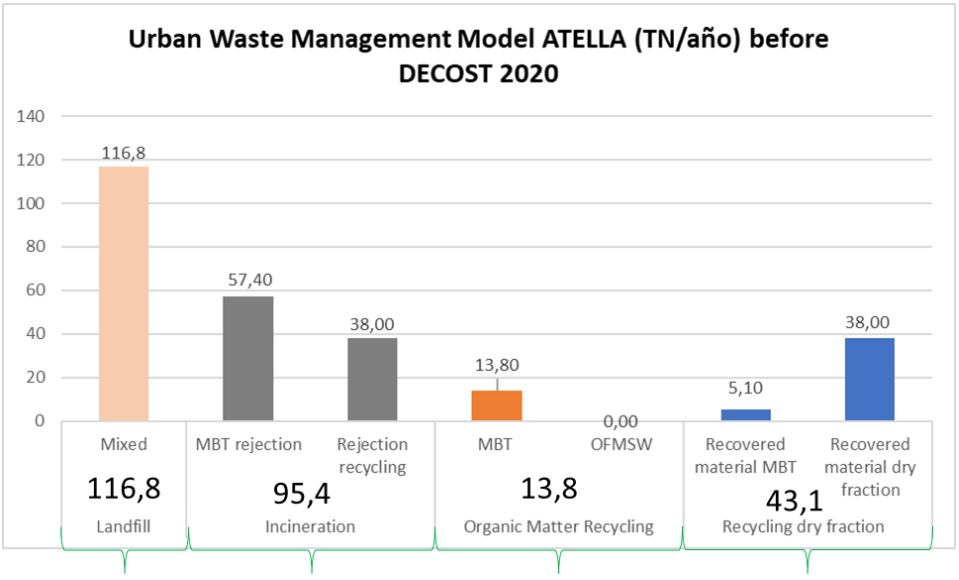

Figura 23 DISTRIBUTION OF TN/YEAR OF WASTE BY TREATMENT BEFORE DECOST.
Data Source Provider: DECOST Project (UVIC-Beta Technology Center)

2022

In the following table you can see the tons emitted by treatment, in this way it is observed that the tons sent to controlled deposit generate 23 TCO2eq / year, incineration 54 TCO2eq / year, recycling of organic matter recovered by MBT 5.6 TCO2eq / year and -94.9 TCO2eq / year for the recycling of the dry fraction.

The sum of these emitted impacts minus those avoided results in the Atella waste management system generating net impacts of 2 TCO2eq/year in 2020

	Tons	Carbon footprint		recovered energy		Compost	Recyclables
	(t/year)	t CO2eq/year	kg CO2 eq/t UW	(GJ/year)	(GJ/tUW)	(t/year)	(t/year)
Landfill							
Waste without Treatment	51,3	24	464,3	7,5	146,9		
Refusal MBT	0,0	0,0		0,0			
Refusal recycling	0,0	0,0		0,0			
Incineration							
Waste without Treatment	0	0	472,4	0,0	5,3		
Refusal MBT	71,6	17,8		329,1			
Refusal recycling	40	34,9		258,0			
Recycling Organic matter							
MBT	0,0	0	65,5	0,0	0,6	0,0	
OFMSW	80,3	5,3		44,1		24,1	
Recycling dry fraction							
Material recovered MBT	5,4	-11,9					5,4
Recovered material dry fraction	40	-83					37
Transport							
Waste to Landfill		2	0,0	0,0	0,0		
Waste to Incineration		0		0,0			
Waste to MBT		3		0,0			
Bio-waste composting		3					
Recyclables to sorting plant		2					
Refusal MBT		3					
Refusal recycling		2					
Total	289	2					

Tabla 7 TCO2 eq BY FRACTION TREATMENT AFTER DECOST ATELLA-ITALY. Data Source Provider: DECOST Project (UVIC-Beta Technology Center)

During the year 2022, 52.6 Tn of untreated waste were taken to controlled deposit, half of that of the year 2020, additionally, between the rejection of MBT and recycling 113.2 Tn were incinerated, the organic fraction was used 100% according to the capacity of the installed composter preventing this waste from going to the controlled deposit, as for the dry fraction increased this was 46 Tn presenting a slight increase compared to 2020.

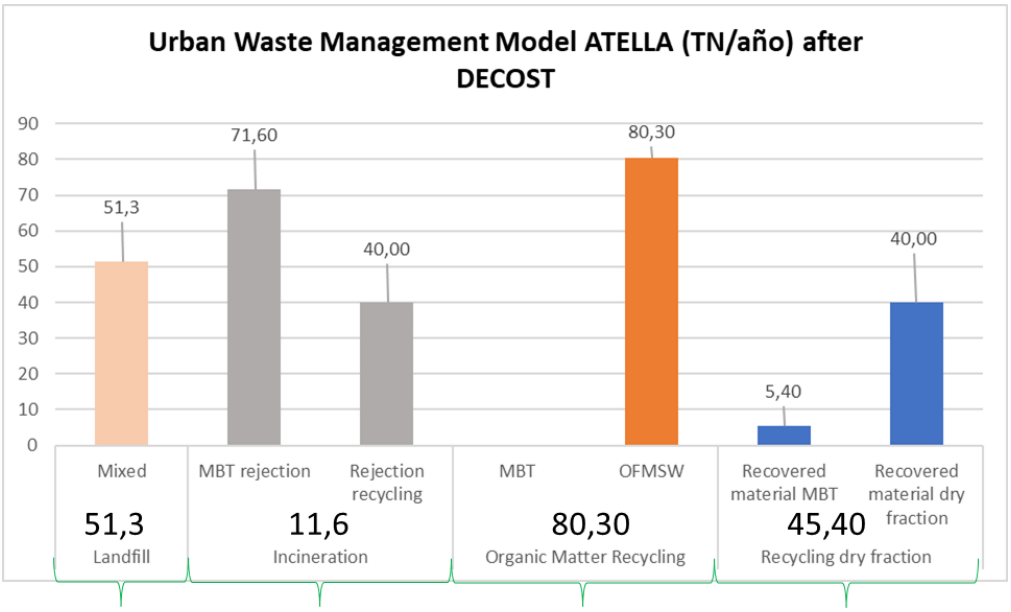

Figura 24 DISTRIBUTION OF TN/YEAR OF WASTE BY TREATMENT AFTER DECOST.
Data Source Provider: DECOST Project (UVIC-Beta Technology Center)

Tons of emissions avoided by chemical fertilizer substitution.

During the year 2022, 24.1 Tn of compost were obtained, the substitution of chemical fertilizers by compost can provide additional avoided emissions close to 85 kg CO2eq t-1 compost that is, in the case of Atella, 2 Tn CO2 eq were avoided.

RESULTS BEFORE AND AFTER DECOST

2020

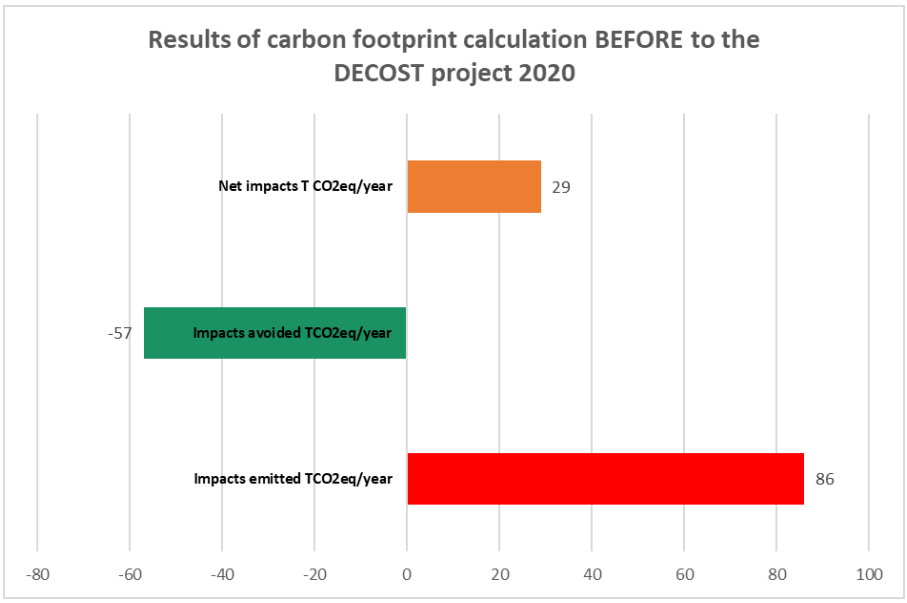

Figura 25 RESULT OF CARBON FOOTPRINT CALCULATION AFTER DECOST.
Data Source Provider: DECOST Project (UVIC-Beta Technology Center)

2022

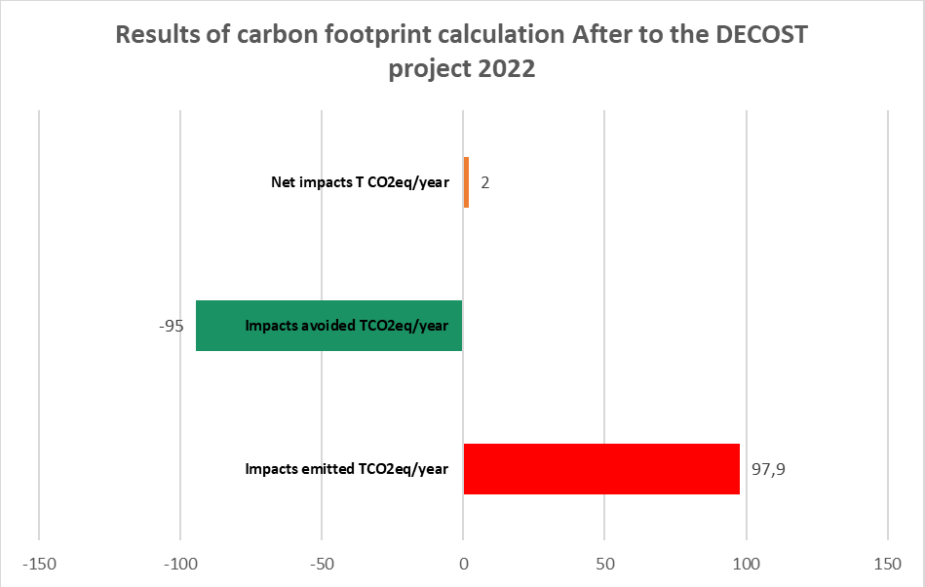

Figura 26 RESULT OF CARBON FOOTPRINT CALCULATION AFTER DECOST.
Data Source Provider: DECOST Project (UVIC-Beta Technology Center)

When comparing the net impacts of 2020 versus 2022, these decreased from 29 to 2. The tons avoided, that is, there is a decrease of 27 T CO2 eq, which shows the benefits of collecting organic matter at the source and treating it in the composter.

1.3.2 CALCULATION OF THE CARBON FOOTPRINT IN POTENZA- ITALY.

The functional unit of this system MANAGEMENT OF URBAN WASTE GENERATED BEFORE AND AFTER IN EACH OF THE MUNICIPALITIES SURVEYED

It is important to mention that in the WP3- Base Line Scenario the management model in Potenza was described, as summarized in the following table:

Sistema	Descripción
Collection	The waste management in the municipality of Potenza is carried out by the public utility A.C.T.A. S.p.A. (Municipal Company for Environmental Protection). This is a public limited company within the Municipality of Potenza that aims to complete the activities for the management of integrated public and private environmental services (the collection, transport, storage, and disposal of solid urban waste, sweeping, cleaning, and weeding of roads and public and private areas). The collection of municipal waste is coordinated by the waste management utility with a "door to door" system in the city area, and with the use of street bins in rural areas. Before the Decost, organic matter was sent to mechanical biological treatment
Transport	A door-to-door system was implemented in the urban areas. The waste can be collected outside the door in special bins for single or two-family houses, for condominiums or multi-family structures. Every day, a different fraction is collected with differences for domestic and non-domestic users.
Treatment	The fractions resulting from the selective collection are transported to the New Ecology Plant and Ageco treatment plants 14 km away.
Final waste disposal	The organic fraction is brought to the treatment plant New Ecology System s.r.l., while the other separated fractions (plastic and metals, paper and cardboard, glass, small WEEE, toner and exhausted batteries) are sent to the recycling station AGECO s.r.l. Both treatment plants are in Tito (PZ). The unsortedunsorted waste is treated at the Cafaro integrated platform in Atella, equipped with biocells and landfills. Los camiones municipales dedicados a la recogida de residuos transportan los residuos sólidos recogidos al relleno sanitario plataforma Cafaro a 40 km de distancia

Tabla 8 BRIEF DESCRIPTION OF THE POTENZA-ITALY WASTE MANAGEMENT SYSTEM.
Data Source Provider: DECOST Project (UVIC-Beta Technology Center)

The following figure shows the input and output flows considered for the calculation of CO2 equivalent tons in 2020. In 2020, 108 Tn/year of urban waste were generated, of which 69 Tn correspond to selective collection and 39 Tn are sent to controlled deposit, being recovered 23.4 Tn of dry fraction and 15.6 Tn of wet fraction sent to controlled deposit. It is noteworthy that in 2020 the organic fraction was simply stabilized.

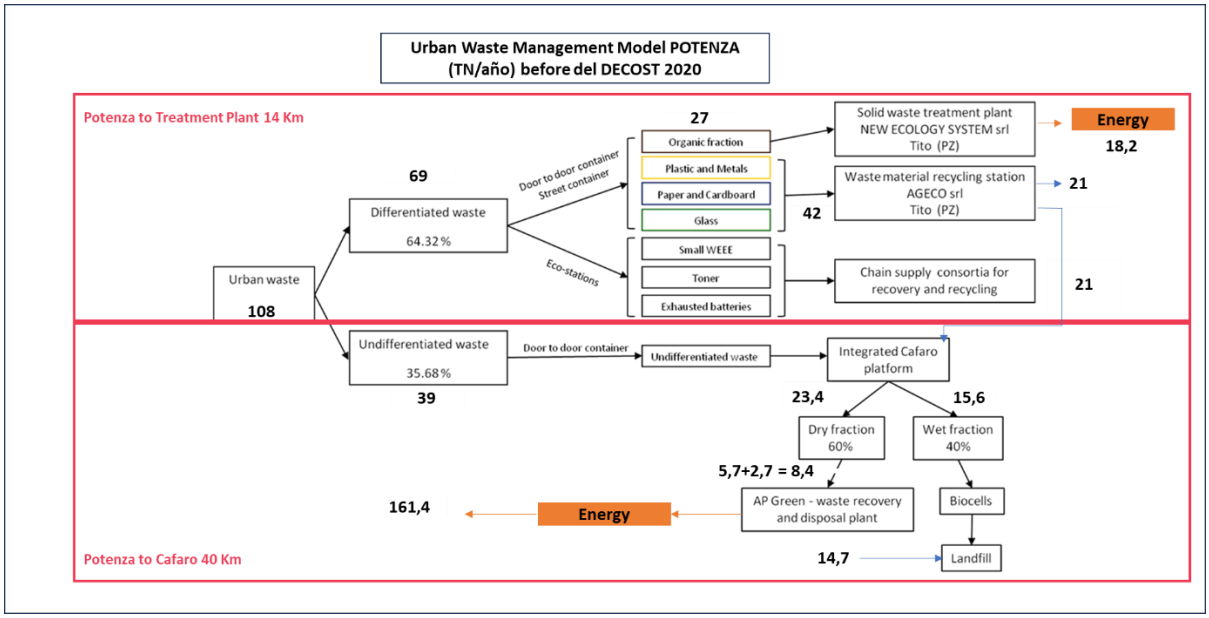

Figura 27 URBAN WASTE MODEL POTENZA-ITALY BEFORE DECOST 2020.
Data Source Provider: DECOST Project (UVIC-Beta Technology Center)

In 2021, after the implementation of the DECOST project, an improvement is observed in the separation at the source, as well as its treatment, since the separation at the source increased from 64.32% to 76%, this because the organic matter generated (40 Tn) was treated in its entirety by the composters installed through the DECOST project. As for the dry fraction, 21 tons were used, and the other 21 tons were incinerated the 26 tons of mixed were incinerated resulting in energy recovery.

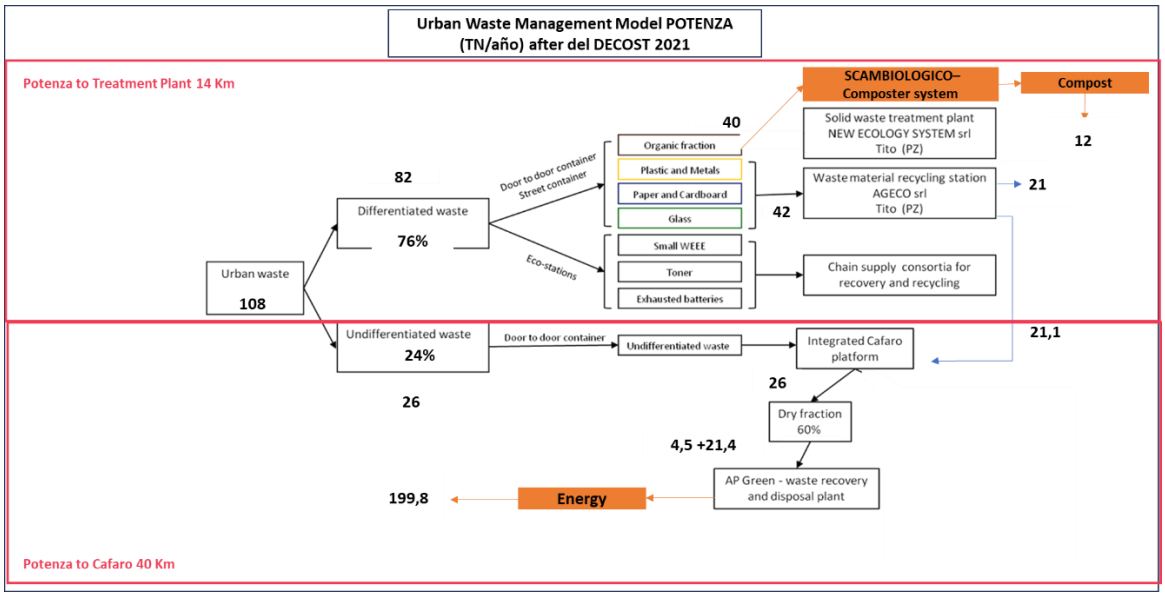

Figura 28 URBAN WASTE MODEL POTENZA-ITALY AFTER DECOST 2021.
Data Source Provider: DECOST Project (UVIC-Beta Technology Center)

RESULTS

The following table relates the number of tons transported, treated and/or disposed of to the tons of CO2 equivalent. Depending on the type of treatment, for example, incineration considers the energy recovered, as well as the tons of compost and recyclable material, depending on the fraction and type of treatment are emitted and avoid impacts. The sum of these impacts results in net impacts.

2020

In the following table you can see the tons emitted by treatment, in this way it is observed that the tons sent to controlled deposit generate 16 TCO2eq / year, incineration 10.3 TCO2eq / year, recycling of organic matter recovered by MBT 2.5 TCO2eq / year and -25.1 TCO2eq / year for the recycling of the dry fraction and 3 TCO2eq / year corresponding to transport.

By 2020, Potenza's waste management system generated net impacts of 8 tCO2eq/year

	Tons	Carbon footprint		recovered energy		Compost	Recyclables
	(t/year)	t CO2eq/year	kg CO2 eq/t UW	(GJ/year)	(GJ/tUW)	(t/year)	(t/year)
Landfill							
Waste without Treatment	15,6	16	1.022,7	0,0	0,0		
Refusal MBT	0,0	0,0		0,0			
Refusal recycling	0,0	0,0		0,0			
Incineration							
Waste without Treatment	0,0	0	286,5	0,0	4,5		
Refusal MBT	14,7	-0,6		63,9			
Refusal recycling	21,1	10,9		97,5			
Recycling Organic matter							
MBT	5,7	1	63,1	3,1	0,6	1,7	
OFMSW	27,4	1,5		15,1		8,2	
Recycling dry fraction							
Material recovered MBT	2,7	-3,1					2,7
Recovered material dry fraction	21,1	-22					21
Transport							
Waste to Landfill		1	0,0	0,0	0,0		
Waste to Incineration		0		0,0			
Waste to MBT		1		0,0			
Bio-waste composting		1					
Recyclables to sorting plant		1					
Refusal MBT		0					
Refusal recycling		0					
Total	108,20	7,7					

Tabla 9 TCO2 eq BY FRACTION TREATMENT BEFORE DECOST POTENZA-ITALY.
Data Source Provider: DECOST Project (UVIC-Beta Technology Center)

The following graph shows the tons by type of treatment sent to controlled deposit 15.6 Tn, incineration 35.7 Tn, recycling of organic matter 33.1 Tn and 23.8 Tn of recycling of the dry fraction.

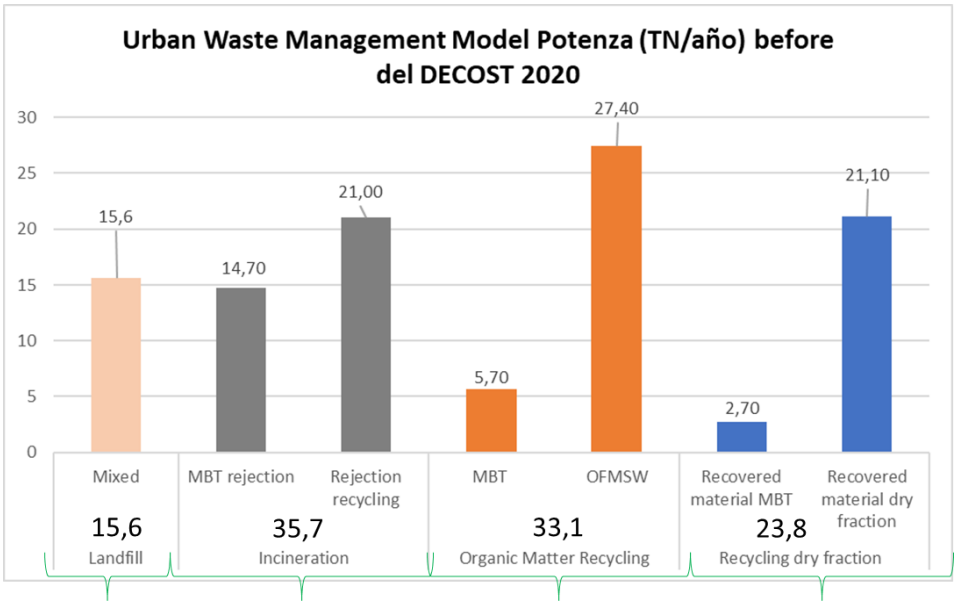

Figura 29 DISTRIBUTION OF TN/YEAR OF WASTE BY TREATMENT BEFORE DECOST.
Data Source Provider: DECOST Project (UVIC-Beta Technology Center)

2021

In the following table you can see the tons emitted by treatment, in this way it is observed that there are no tons of waste sent to controlled deposit, incineration 10.2 TCO2eq / year, recycling of organic matter recovered by MBT 8.4 TCO 2eq / year, -27.1 TCO2eq / year for the recycling of the dry fraction and 3 TCO2eq / year for transport.

By 2021, Potenza's waste management system generated net impacts of -3,97 tCO2eq/year

	Tons	Carbon footprint		recovered energy		Compost	Recyclables
	(t/year)	t CO2eq/year	kg CO2 eq/t UW	(GJ/year)	(GJ/tUW)	(t/year)	(t/year)
Landfill							
Waste without Treatment	0,0	0	0,0	0,0	0,0		
Refusal MBT	0,0	0,0		0,0			
Refusal recycling	0,0	0,0		0,0			
Incineration							
Waste without Treatment	0,0	0	240,6	0,0	4,7		
Refusal MBT	21,4	-0,7		102,4			
Refusal recycling	21,1	10,9		97,5			
Recycling Organic matter							
MBT	0,0	0	218,3	0,0	0,0	0,0	
OFMSW	40,0	8,4		0,0		12,0	
Recycling dry fraction							
Material recovered MBT	4,5	-5,1					4,5
Recovered material dry fraction	21,1	-22					21
Transport							
Waste to Landfill		0	0,0	0,0	0,0		
Waste to Incineration		0		0,0			
Waste to MBT		1		0,0			
Bio-waste composting		1					
Recyclables to sorting plant		1					
Refusal MBT		0					
Refusal recycling		0					
Total	108,04	-3,97					

Tabla 10 TCO2 eq BY FRACTION TREATMENT AFTER DECOST POTENZA-ITALY.
Data Source Provider: DECOST Project (UVIC-Beta Technology Center)

During the year 2021, the tons corresponding to the wet fraction that in 2021 were disposed of in the landfill were treated together with the organic fraction collected at the source by the composter installed by the DECOST project, for a total of 40 tons of organic matter used, additionally, between the rejection of MBT and recycling 42.5 tons were incinerated, the organic fraction was used by 100% according to the capacity of the installed composter, as for the dry fraction increased this was 25.6 Tn presenting a slight increase compared to 2020.

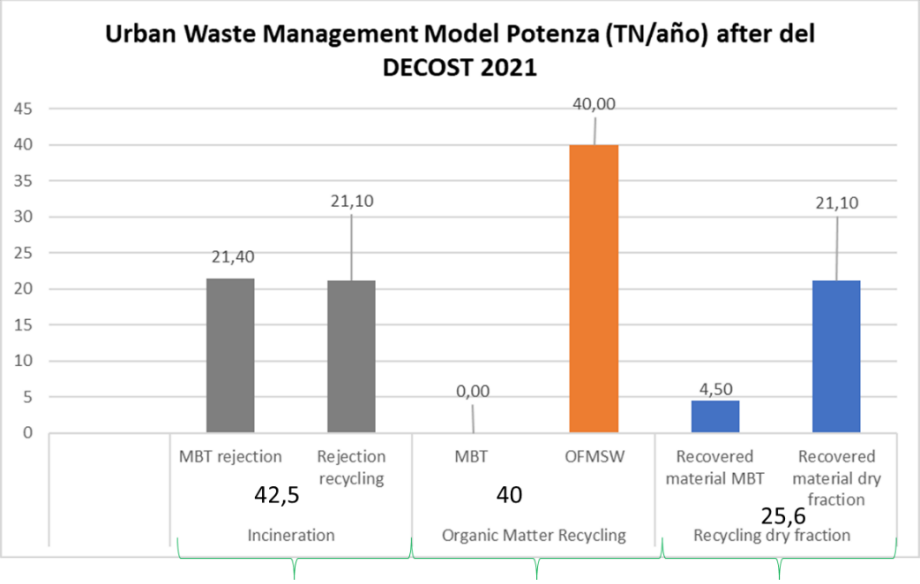

Figura 30. DISTRIBUTION OF TN/YEAR OF WASTE BY TREATMENT AFTER DECOST.
Data Source Provider: DECOST Project (UVIC-Beta Technology Center)

Tons of emissions avoided by chemical fertilizer substitution.

During the year 2022, 12 Tn of compost were obtained, the substitution of chemical fertilizers by compost can provide additional avoided emissions close to 85 kg CO2eq t-1 compost that is, in the case of Atella, **1.02** Tn CO2 eq were avoided**.**

RESULTS BEFORE AND AFTER DECOST

2020

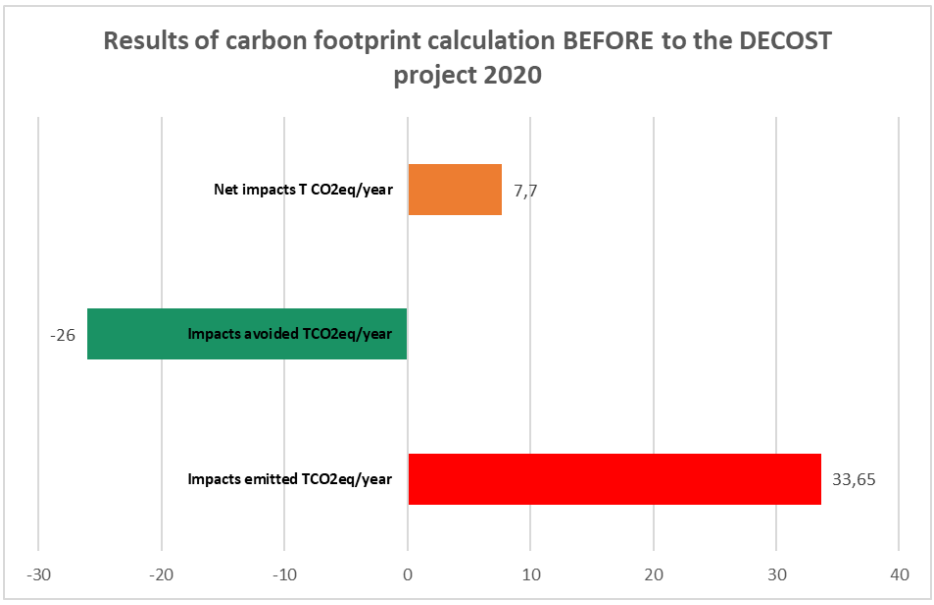

Figura 31. RESULT OF CARBON FOOTPRINT CALCULATION AFTER DECOST.
Data Source Provider: DECOST Project (UVIC-Beta Technology Center)

2021

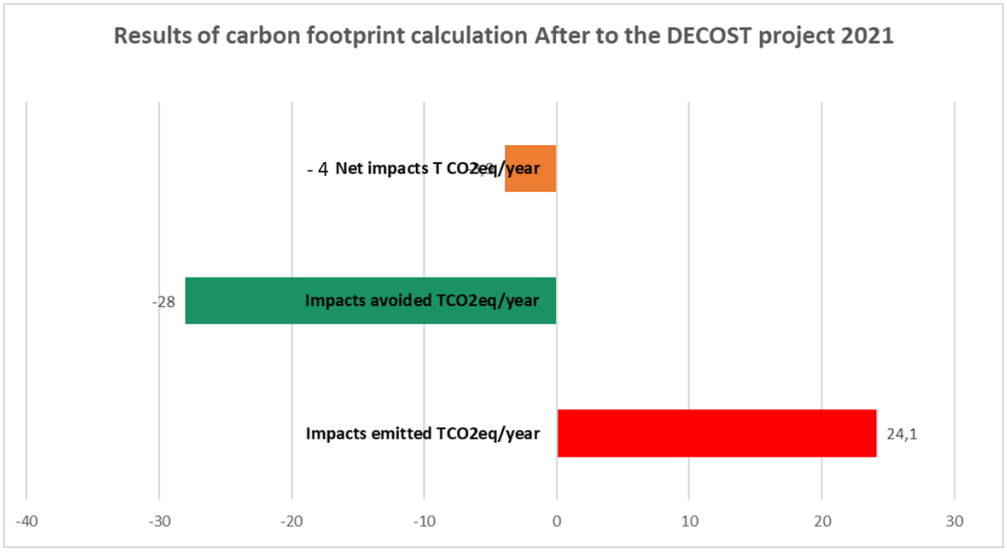

Figura 32. RESULT OF CARBON FOOTPRINT CALCULATION AFTER DECOST.
Data Source Provider: DECOST Project (UVIC-Beta Technology Center)

When comparing the net impacts of 2020 versus 2021, these decreased from 8 to -4.4, that is, there are net impacts avoided of 3.6 T CO2 eq, which shows the benefits of collecting organic matter at the source and treating it in the composter.

1.5 CALCULATION OF THE CARBON FOOTPRINT IN JORDAN

This study will quantify the tons of CO2 equivalent in the waste management Al-Sarrow, Jordan, considering the tons generated in Jordan 2021 before the DECOST project and those of 2022 after the DECOST project. In this way, the impact of the avoided, emitted, and net tons of CO2 will be evaluated with the implementation of the DECOST project as the only way to treat the organic fraction.

The functional unit of this system MANAGEMENT OF URBAN WASTE GENERATED BEFORE AND AFTER IN EACH OF THE MUNICIPALITIES SURVEYED

It is important to mention that in the WP3- Base Line Scenario the management model in Jordan was described, as summarized in the following table:

Sistema	Descripción
Collection	The Climate and Clean Air Coalition's Municipal Solid Waste Initiative Report (2018) estimated that 85% of the solid waste generated is being officially collected and disposed of. While the remaining rate of waste is burned, it is either disposed of by informal recyclers (such as waste pickers), or dumped on the side of the road or in drainage channels. The municipality uses steel containers of 1100 L galvanized steel capacity for storage purposes. The municipality does not use waste separation at source as an approach or practice to minimize the amount of waste transferred to a landfill.
Transport	The collected waste is transported to the Al Akeeder landfill which is located 40 km from the City.
final waste disposal	Municipal waste collection trucks transport collected solid waste for dumping and disposal at Al Akeeder landfill

Tabla 11 BRIEF DESCRIPTION OF THE JORDAN-AL SARROW WASTE MANAGEMENT SYSTEM.
Data Source Provider: DECOST Project (UVIC-Beta Technology Center)

The following figure shows the input and output flows considered for the calculation of tons of CO2 equivalent in 2021

Considering the target population in the DECOST-Jordan project. During the year 2021, the number of inhabitants corresponded to 595, the per capita production of 0.001 Tn/inhab/day. During the year 2020, 217.13 Tn/year were generated, with 57% (124 Tn/year) corresponding to organic matter and 6% of pruning (13 Tn/year), which given the previous description all were sent to the landfill of Al Akeeder City.

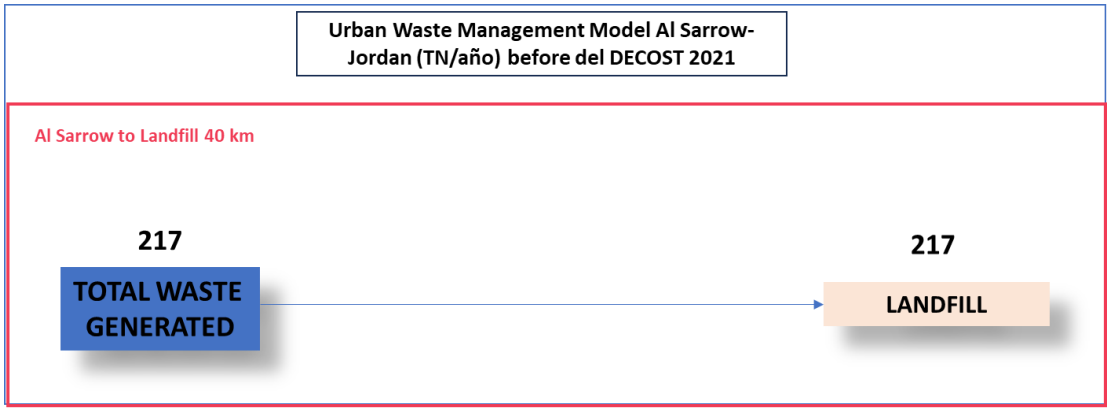

Figura 33 URBAN WASTE MODEL Al SARROW-JORDAN AFTER DECOST 2021.
Data Source Provider: DECOST Project (UVIC-Beta Technology Center)

In 2022, 246.74 Tn/year of urban waste were generated, where the advantages of separation at the source of the organic fraction are observed due to the implementation of the DECOST project treating 155.4 Tn/year of organic matter through home composting and sending 91.3 Tn/year of mixed waste to the Al Akeeder landfill.

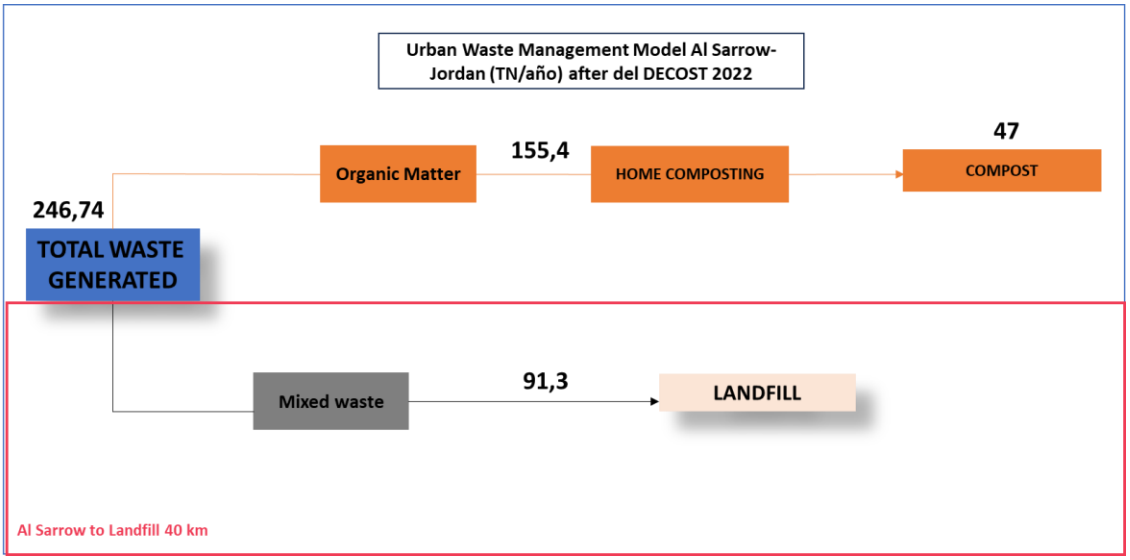

Figura 34 URBAN WASTE MODEL AL SARROW-JORDAN AFTER DECOST 2022.
Data Source Provider: DECOST Project (UVIC-Beta Technology Center)

RESULTS

The following table relates the number of tons transported, treated and/or disposed of to the tonnes of CO2 equivalent. Depending on the type of treatment, for example, incineration considers the energy recovered, as well as the tons of compost and recyclable material, depending on the fraction and type of treatment are emitted and avoid impacts. The sum of these impacts results in net impacts.

2021

Considering the operating conditions of the landfill, for the calculation of CO2 eq/year in the controlled deposit the percentage of the recovery rate was equal to zero. The tons sent to controlled warehouse generate 178 TCO2eq/year and 9 TCO2eq/year emitted by transport, resulting in the year 2021 that the waste management system of Al Sarrow in Jordan generated net impacts of 187 tCO2eq/year.

	Tons	Carbon footprint		recovered energy		Compost	Recyclables
	(t/year)	t CO2eq/year	kg CO2 eq/t UW	(GJ/year)	(GJ/tUW)	(t/year)	(t/year)
Landfill							
Waste without Treatment	217,0	178	822,4	0,0	0,0		
Refusal MBT	0,0	0,0		0,0			
Refusal recycling	0,0	0,0		0,0			
Incineration							
Waste without Treatment	0,0	0	0,0	0,0	0,0		
Refusal MBT	0,0	0,0		0,0			
Refusal recycling	0,0	0,0		0,0			
Recycling Organic matter							
MBT	0,0	0	0,0	0,0	0,0	0,0	
OFMSW	0,0	0,0		0,0		0,0	
Recycling dry fraction							
Material recovered MBT	0,0	0,0					0,0
Recovered material dry fraction	0,0	0					0
Transport							
Waste to Landfill		9	0,0	0,0	0,0		
Waste to Incineration		0		0,0			
Waste to MBT		0		0,0			
Bio-waste composting		0					
Recyclables to sorting plant		0					
Refusal MBT		0					
Refusal recycling		0					
Total	217,00	187					

Tabla 12 TCO2 eq BY FRACTION TREATMENT BEFORE DECOST AL SARROW-JORDAN.
Data Source Provider: DECOST Project (UVIC-Beta Technology Center)

2022

The tons sent to landfill generated 67 TCO2eq/year, 111 TCO2eq/year less than the year before DECOST and 9 TCO2eq/year emitted by transport, resulting in the fact that by 2021 the Al Sarrow waste management system in Jordan generated net impacts of 187 tCO2eq/year. Additionally, the recycling of organic matter generates 32.6 tCO2eq/year, a figure that is also still lower than the total tCO2eq/year of all mixed waste (178 tCO2eq/year). The same happens with transport, which was reduced from 9 TCO2eq/year to 4 TCO2eq/year. The implementation of the DECOST project resulted by 2022 in the Al Sarrow waste management system in Jordan generating net impacts of 104 tCO2eq/year, i.e. 83 TCO2eq/year less than the previous year, prior to the implementation of DECOST.

		Tons	Carbon footprint		recovered energy		Compost	Recyclables
		(t/year)	t CO2eq/year	kg CO2 eq/t UW	(GJ/year)	(GJ/tUW)	(t/year)	(t/year)
Landfill								
	Waste without Treatment	91,3	67	736,2	0,0	0,0		
	Refusal MBT	0,0	0,0		0,0			
	Refusal recycling	0,0	0,0		0,0			
Incineration								
	Waste without Treatment	0,0	0	0,0	0,0	0,0		
	Refusal MBT	0,0	0,0		0,0			
	Refusal recycling	0,0	0,0		0,0			
Recycling Organic matter								
	MBT	0,0	0	209,8	0,0	0,0	0,0	
	OFMSW	155,4	32,6		0,0		46,6	
Recycling dry fraction								
	Material recovered MBT	0,0	0,0					0,0
	Recovered material dry fraction	0,0	0					0
Transport								
	Waste to Landfill		4	0,0	0,0	0,0		
	Waste to Incineration		0		0,0			
	Waste to MBT		0		0,0			
	Bio-waste composting		0					
	Recyclables to sorting plant		0					
	Refusal MBT		0					
	Refusal recycling		0					
Total		246,74	104					

Tabla 13 TCO_2 eq BY FRACTION TREATMENT AFTER DECOST AL SARROW-JORDAN.
Data Source Provider: DECOST Project (UVIC-Beta Technology Center)

During the year 2022, 91.3 tons of untreated waste less than half of the total urban waste generated were taken to landfill, since of the total generation 57% corresponds to organic fraction and 6% to pruning, for a total of 63% equal to 155.4 tons, which were treated in their entirety through decentralized composting through home composters.

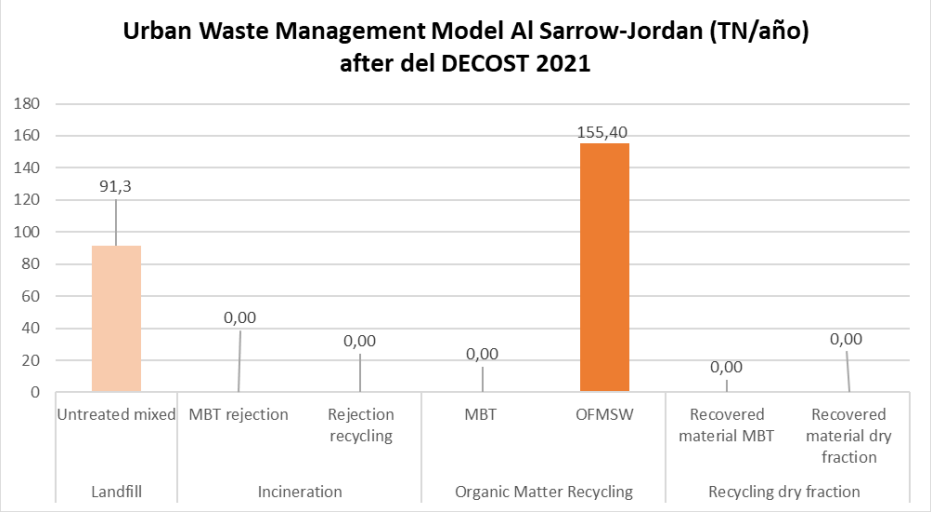

Figura 35. DISTRIBUTION OF TN/YEAR OF WASTE BY TREATMENT AFTER DECOST.
Data Source Provider: DECOST Project (UVIC-Beta Technology Center)

Tons of emissions avoided by chemical fertilizer substitution.

During the year 2022, 46.6 Tn of compost were obtained, the substitution of chemical fertilizers by compost can provide additional avoided emissions close to 85 kg CO2eq t-1 compost that is, in the case of Atella, **3.9 Tn CO_2 eq** were avoided.

RESULTS BEFORE AND AFTER DECOST

2021

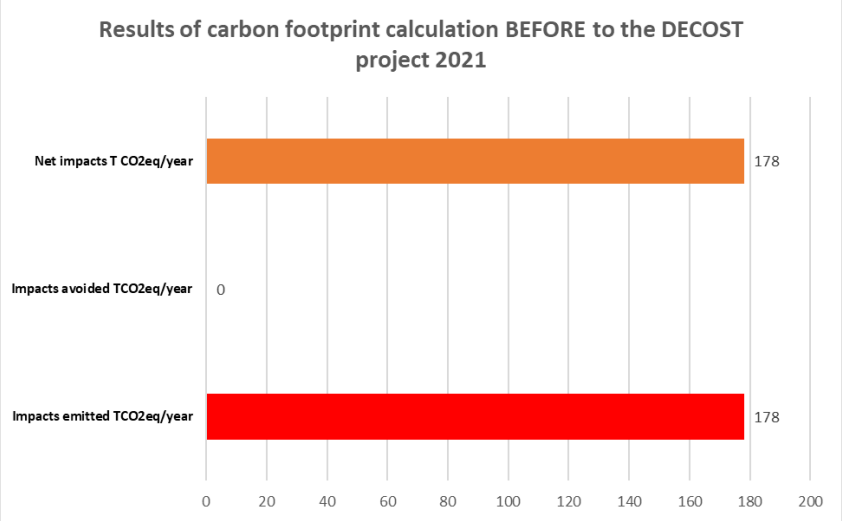

Figura 36. RESULT OF CARBON FOOTPRINT CALCULATION BEFORE DECOST.
Data Source Provider: DECOST Project (UVIC-Beta Technology Center)

2022

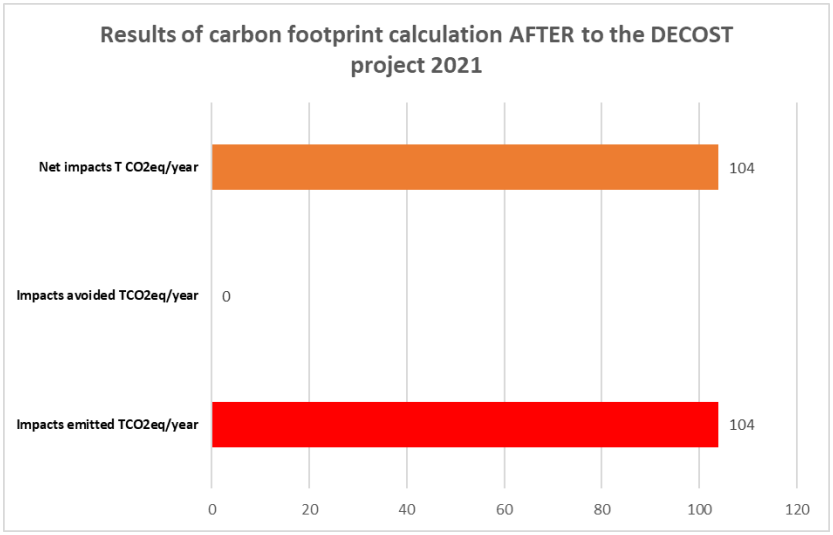

Figura 37 RESULT OF CARBON FOOTPRINT CALCULATION AFTER DECOST.
Data Source Provider: DECOST Project (UVIC-Beta Technology Center)

Although no avoided impacts are observed, a decrease in the impacts emitted in 2021 compared to 2022 of 74 Tn CO2 eq can be observed. This decrease is due to the implementation of the DECOST project for the treatment of 100% of the organic fraction generated by the target population.

1.6 CALCULATION OF THE CARBON FOOTPRINT IN KURF RUMMAN AND ANABTA-PALESTINE

This study will quantify the tons of CO2 equivalent in waste management in the Jordan region, considering the tons generated before and after the DECOST project. In this way, the impact of the avoided, emitted, and net tons of CO2 will be evaluated with the implementation of community composting as the only way to treat the organic fraction.

In the case of Palestine, the corresponding analyses are carried out for the cities of Kurf Rumman and Anabta, for both cases the functional unit of this system THEY ARE THE MANAGED TONS OF URBAN WASTE GENERATED IN 2020 AND 2021 IN THE CITY OF KURF RUMMAN AND IN THE YEARS 2021 AND 2022 IN THE CITY OF ANABTA.

It is important to mention that in the WP3- Base Line Scenario the management model in Potenza was described, as summarized in the following table:

Sistema	Descripción
Collection	The waste collection and transportation are managed by "Anabta Municipality", where people collect their wastes into mainly nylon bags, then waste is thrown into fixed-place metallic or plastic containers supplied by the municipality, these containers are located within 100-150 meter far from housing units.
Transport	The municipality vehicle collects the waste from the containers and transfer the waste to the transfer station of JSC, to be transferred to ZAF LF. 100% of the waste collected is transferred later to ZAF. The total distance travelled intra-city is approximately 20 km from the city to the Zahrat alFinjan landfill is 40 km
final waste disposal	Municipal trucks dedicated to waste collection transport the collected solid waste for dumping and disposal at the Zahrat landfill alFinjan is 40 km

Tabla 14 BRIEF DESCRIPTION OF THE ANABTA AND KURF RUMMAN-PALESTINE WASTE MANAGEMENT SYSTEM.
Data Source Provider: DECOST Project (UVIC-Beta Technology Center)

1.6.1 KURF RUMMAN

The following figure shows the input and output flows considered for the calculation of CO2 equivalent tons in 2020

Considering the target population in the DECOST-Palestine project, Kurf Rumman City is 1000 inhabitants and the per capita production of 0.0012 Tn/inhab/day. The generation of waste during the year 2020 was 438 Tn / year, being 70% (307 Tn / year) corresponding to organic matter, which given the previous description all were sent to the Zahrat Al-Finjan landfill.

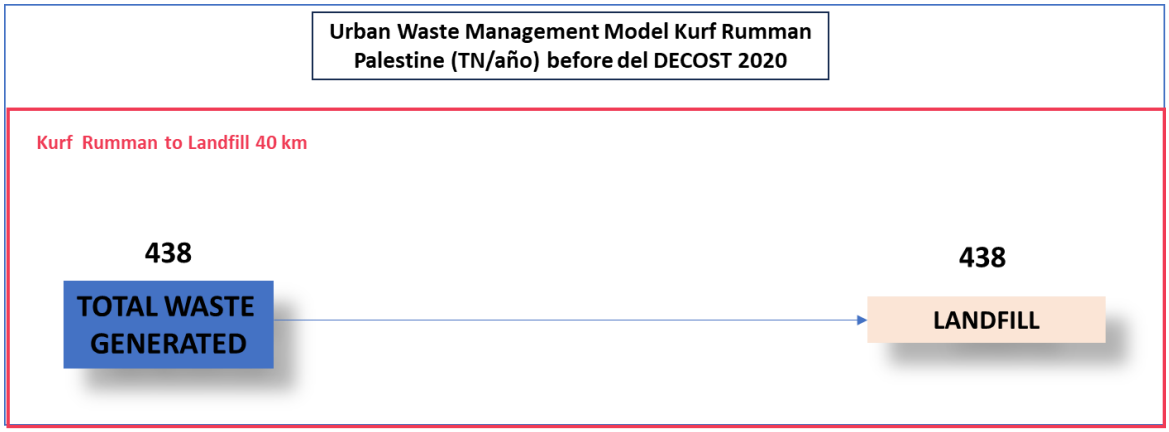

Figura 38. URBAN WASTE MODEL KURF RUMMAN-PALESTINE BEFORE DECOST 2020. Data Source Provider: DECOST Project (UVIC-Beta Technology Center)

In 2021, 438 Tn/year of urban waste were generated, where the advantages of separation at the source of the organic fraction are observed due to the implementation of the DECOST project treating 337 Tn/year of organic matter through home composting and sending 100.8 Tn/year of mixed waste to the Zahrat Al-Finjan landfill.

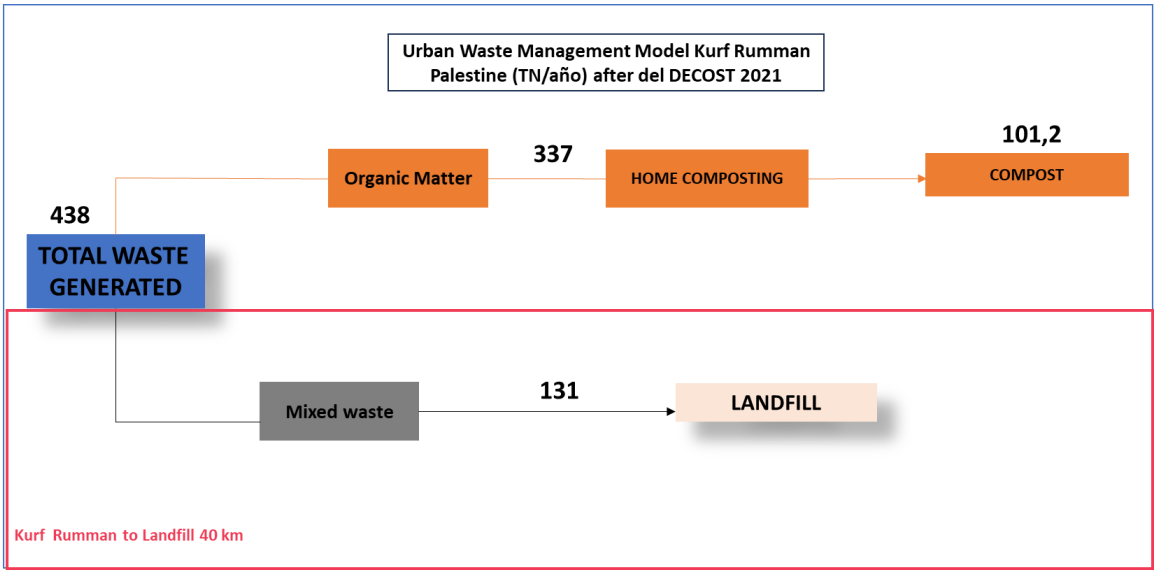

Figura 39 URBAN WASTE MODEL KURF RUMMAN-PALESTINE AFTER DECOST 2021. Data Source Provider: DECOST Project (UVIC-Beta Technology Center)

RESULTS

2020

The following table shows the relationship on the number of tons transported and per treatment and/or final disposal versus the equivalent tons of CO2. According to the type of treatment, for this case, considering the operating conditions of the landfill, for the calculation of CO2 eq/year in the controlled deposit the percentage of the recovery rate was equal to zero. The tons sent to controlled deposit generate 442 TCO2eq/year and 20 TCO2eq/year emitted by transport,

resulting in the year 2020 that the waste management system of Kurf Rumman Palestine generated net impacts of 442 tCO2eq/year.

	Tons	Carbon footprint		recovered energy		Compost	Recyclables
	(t/year)	t CO2eq/year	kg CO2 eq/t UW	(GJ/year)	(GJ/tUW)	(t/year)	(t/year)
Landfill							
Waste without Treatment	438,0	422		0,0			
Refusal MBT	0,0	0,0	963,6	0,0	0,0		
Refusal recycling	0,0	0,0		0,0			
Incineration							
Waste without Treatment	0	0		0,0			
Refusal MBT	0,0	0,0	0,0	0,0	0,0		
Refusal recycling	0,0	0,0		0,0			
Recycling Organic matter							
MBT	0,0	0	0,0	0,0	0,0	0,0	
OFMSW	0,0	0,0		0,0		0,0	
Recycling dry fraction							
Material recovered MBT	0,0	0,0					0,0
Recovered material dry fraction	0	0					0
Transport							
Waste to Landfill		20		0,0			
Waste to Incineration		0		0,0			
Waste to MBT		0		0,0			
Bio-waste composting		0	0,0		0,0		
Recyclables to sorting plant		0					
Refusal MBT		0					
Refusal recycling		0					
Total	438,0	442					

Tabla 15 TCO2 eq BY FRACTION TREATMENT BEFORE DECOST KURF RUMMAN-PALESTINE.
Data Source Provider: DECOST Project (UVIC-Beta Technology Center)

2021

the tons sent to landfill generated 82 TCO2eq/year, 340 TCO2eq/year less than the year before DECOST and 5 TCO2eq/year emitted by transport, resulting in the fact that by 2021 Kurf Rumman's waste management system in Palestine generated net impacts of 107 TCO2eq/year. Additionally, it can be observed that the recycling of organic matter generates 20.6 TCO2eq/year, a figure that is also lower than the total TCO2eq/year of all mixed waste (422 tCO2eq/year). The same happens with transport, which was reduced from 20 TCO2eq/year to 5 TCO2eq/year. The implementation of the DECOST project resulted by 2021 in Kurf Rumman's waste management system in Palestine generating net impacts of 108 tCO2eq/year, i.e. 315 TCO2eq/year less than the previous year, prior to the implementation of DECOST.

	Tons	Carbon footprint		recovered energy		Compost	Recyclables
	(t/year)	t CO2eq/year	kg CO2 eq/t UW	(GJ/year)	(GJ/tUW)	(t/year)	(t/year)
Landfill							
Waste without Treatment	100,8	82	809,1	0,0	0,0		
Refusal MBT	0,0	0,0		0,0			
Refusal recycling	0,0	0,0		0,0			
Incineration							
Waste without Treatment	0	0	0,0	0,0	0,0		
Refusal MBT	0,0	0,0		0,0			
Refusal recycling	0,0	0,0		0,0			
Recycling Organic matter							
MBT	0,0	0	65,5	0,0	0,0	0,0	
OFMSW	337,3	22,1		0,0		101,2	
Recycling dry fraction							
Material recovered MBT	0,0	0,0					0,0
Recovered material dry fraction	0	0					0
Transport							
Waste to Landfill		5	0,0	0,0	0,0		
Waste to Incineration		0		0,0			
Waste to MBT		0		0,0			
Bio-waste composting		0					
Recyclables to sorting plant		0					
Refusal MBT		0					
Refusal recycling		0					
Total	438,0	108					

Tabla 16 TCO2 eq BY FRACTION TREATMENT AFTER DECOST KURF RUMMAN-PALESTINE.
Data Source Provider: DECOST Project (UVIC-Beta Technology Center)

During the year 2021, 100.8 tons of untreated waste less than half of the total urban waste generated were taken to landfill, since of the total generation 70% corresponds to organic fraction equal to 337 tons, which were treated in their entirety through decentralized composting through the 400 home composters distributed in the homes.

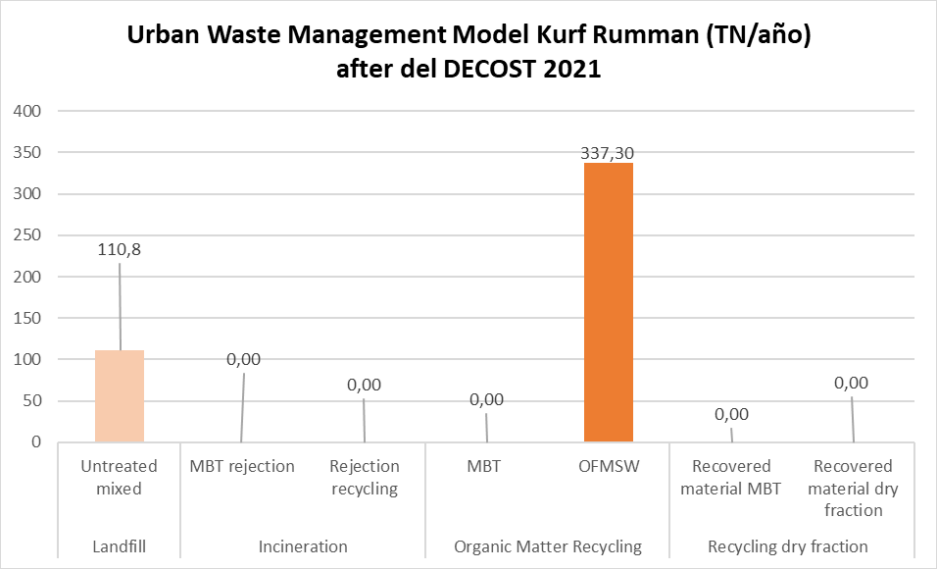

Figura 40 DISTRIBUTION OF TN/YEAR OF WASTE BY TREATMENT AFTER DECOST.
Data Source Provider: DECOST Project (UVIC-Beta Technology Center)

Tons of emissions avoided by chemical fertilizer substitution.

During the year 2021, 101.2 Tn of compost were obtained, the substitution of chemical fertilizers by compost can provide additional avoided emissions close to 85 kg CO2eq t-1 compost that is, in the case of Kurf Rumman- Palestine 8.6 Tn CO2 eq were avoided.

RESULTS BEFORE AND AFTER DECOST

2020

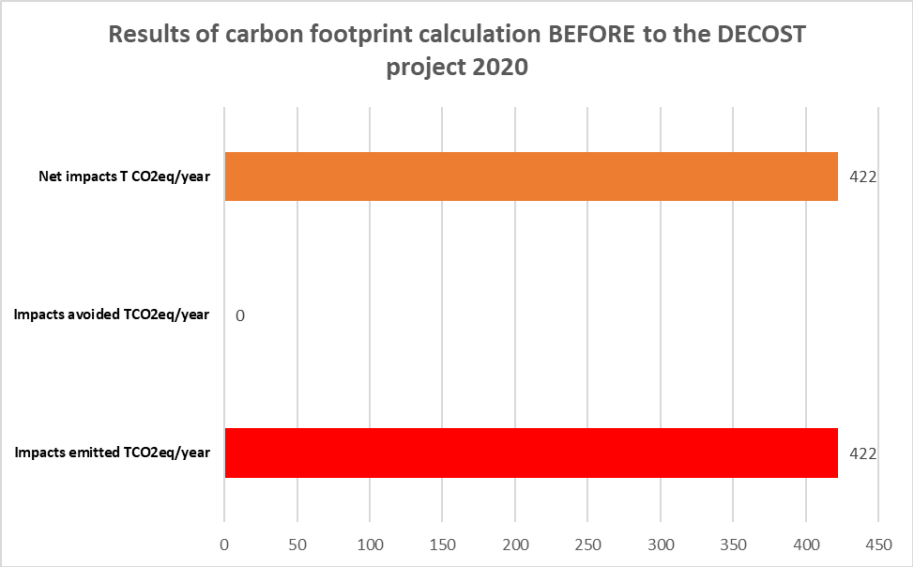

Figura 41 NRESULT OF CARBON FOOTPRINT CALCULATION BEFORE DECOST.
Data Source Provider: DECOST Project (UVIC-Beta Technology Center)

2021

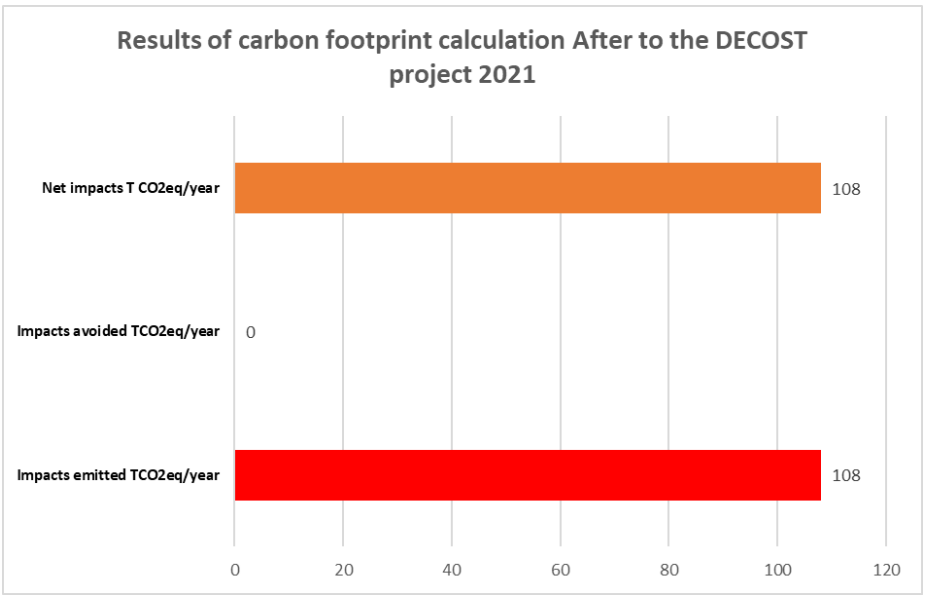

Figura 42 RESULT OF CARBON FOOTPRINT CALCULATION BEFORE DECOST.
Data Source Provider: DECOST Project (UVIC-Beta Technology Center)

Although no avoided impacts are observed, there is a decrease in the impacts emitted in 2020 compared to 2021 of 314 Tn CO2 eq. This decrease is due to the implementation of the DECOST project for the treatment of 100% of the organic fraction generated by the target population.

1.6.2 ANABTA

The following figure shows the input and output flows considered for the calculation of tons of CO2 equivalent in 2021.

Considering the target population in the DECOST-Palestine project, Anabta City is 91 inhabitants and per capita production is 0.0012 Tn/inhab/day. The generation of waste during the year 2021 was 40 Tn / year, being 70% (28 Tn / year) corresponding to organic matter, which given the previous description all were sent to the Zahrat Al-Finjan landfill.

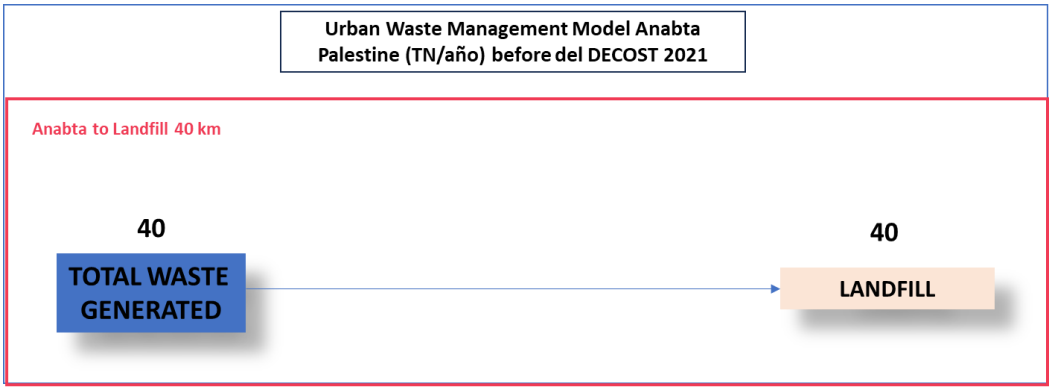

Figura 43. URBAN WASTE MODEL ANABTA-PALESTINE BEFORE DECOST 2021.
Data Source Provider: DECOST Project (UVIC-Beta Technology Center)

In 2022, the same amount of waste was generated 40 Tn/year of urban waste, where the advantages of separation at the source of the organic fraction are observed due to the implementation of the DECOST project treating 28 Tn/year of organic matter through community composting and sending the remaining waste to the Zahrat Al-Finjan landfill the remaining 12 Tn/year of mixed waste.

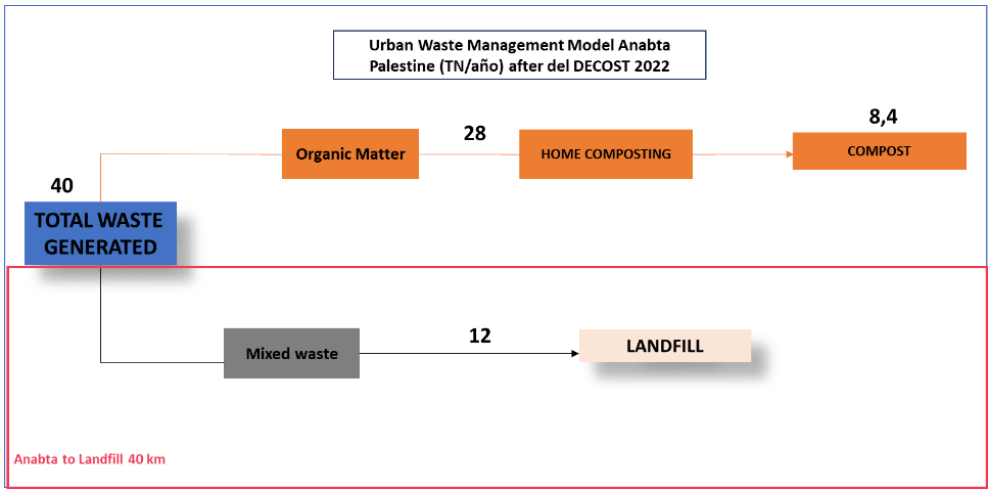

Figura 44 URBAN WASTE MODEL ANABTA-PALESTINE AFTER DECOST 2022.
Data Source Provider: DECOST Project (UVIC-Beta Technology Center)

RESULTS

2021

The following table shows the relationship on the number of tons transported and per treatment and/or final disposal versus the equivalent tons of CO2. According to the type of treatment, for this case, considering the operating conditions of the landfill, for the calculation of CO2 eq/year in the controlled deposit the percentage of the recovery rate was equal to zero. The tons sent to controlled deposit generate 39 TCO2eq/year and 2 TCO2eq/year emitted by transport, resulting in the year 2021 that Anabta's waste management system in Palestine generated net impacts of 41 tCO2eq/year.

	Tons	Carbon footprint		recovered energy		Compost	Recyclables
	(t/year)	t CO2eq/year	kg CO2 eq/t UW	(GJ/year)	(GJ/tUW)	(t/year)	(t/year)
Landfill							
Waste without Treatment	40,2	39		0,0			
Refusal MBT	0,0	0,0	967,5	0,0	0,0		
Refusal recycling	0,0	0,0		0,0			
Incineration							
Waste without Treatment	0,0	0		0,0			
Refusal MBT	0,0	0,0	0,0	0,0	0,0		
Refusal recycling	0,0	0,0		0,0			
Recycling Organic matter							
MBT	0,0	0	0,0	0,0	0,0	0,0	
OFMSW	0,0	0,0		0,0		0,0	
Recycling dry fraction							
Material recovered MBT	0,0	0,0					0,0
Recovered material dry fraction	0,0	0					0
Transport							
Waste to Landfill		2		0,0			
Waste to Incineration		0		0,0			
Waste to MBT		0		0,0			
Bio-waste composting		0	0,0		0,0		
Recyclables to sorting plant		0					
Refusal MBT		0					
Refusal recycling		0					
Total	40,17	41					

Tabla 17 TCO2 eq BY FRACTION TREATMENT BEFORE DECOST ANABTA-PALESTINE.
Data Source Provider: DECOST Project (UVIC-Beta Technology Center)

2022

The tons sent to landfill generated 11 TCO2eq/year, 28 TCO2eq/year less than the year before DECOST and 1 TCO2eq/year emitted by transport, resulting in the 2022 Anabta's waste management system in Palestine generating net impacts of 17 tCO2eq/year. Additionally, it can be observed that the recycling of organic matter generates 5.9 tCO2eq/year, a figure that is also still lower than the total tCO2eq/year of all mixed waste (41 tCO2eq/year). The same happens with transport, which was reduced from 2 TCO2eq/year to 1 TCO2eq/year. The implementation of the DECOST project resulted by 2022 in Anabta's waste management system in Palestine generating net impacts of 17 tCO2eq/year, i.e. 28 TCO2eq/year less than the previous year, prior to the implementation of DECOST.

	Tons	Carbon footprint		recovered energy		Compost	Recyclables
	(t/year)	t CO2eq/year	kg CO2 eq/t UW	(GJ/year)	(GJ/tUW)	(t/year)	(t/year)
Landfill							
Waste without Treatment	12,1	11	895,5	0,0	0,0		
Refusal MBT	0,0	0,0		0,0			
Refusal recycling	0,0	0,0		0,0			
Incineration							
Waste without Treatment	0,0	0	0,0	0,0	0,0		
Refusal MBT	0,0	0,0		0,0			
Refusal recycling	0,0	0,0		0,0			
Recycling Organic matter							
MBT	0,0	0	209,8	0,0	0,0	0,0	
OFMSW	28,1	5,9		0,0		8,4	
Recycling dry fraction							
Material recovered MBT	0,0	0,0					0,0
Recovered material dry fraction	0,0	0					0
Transport							
Waste to Landfill		1	0,0	0,0	0,0		
Waste to Incineration		0		0,0			
Waste to MBT		0		0,0			
Bio-waste composting		0					
Recyclables to sorting plant		0					
Refusal MBT		0					
Refusal recycling		0					
Total	40,17	17					

Tabla 18 TCO2 eq BY FRACTION TREATMENT AFTER DECOST ANABTA-PALESTINE.
Data Source Provider: DECOST Project (UVIC-Beta Technology Center)

During the year 2022, 12 tons of waste corresponding to 30% of the total urban waste generated were disposed of to landfill, since of the total generation 70% corresponds to organic fraction equal to 28 tons, which were treated in their entirety through decentralized composting.

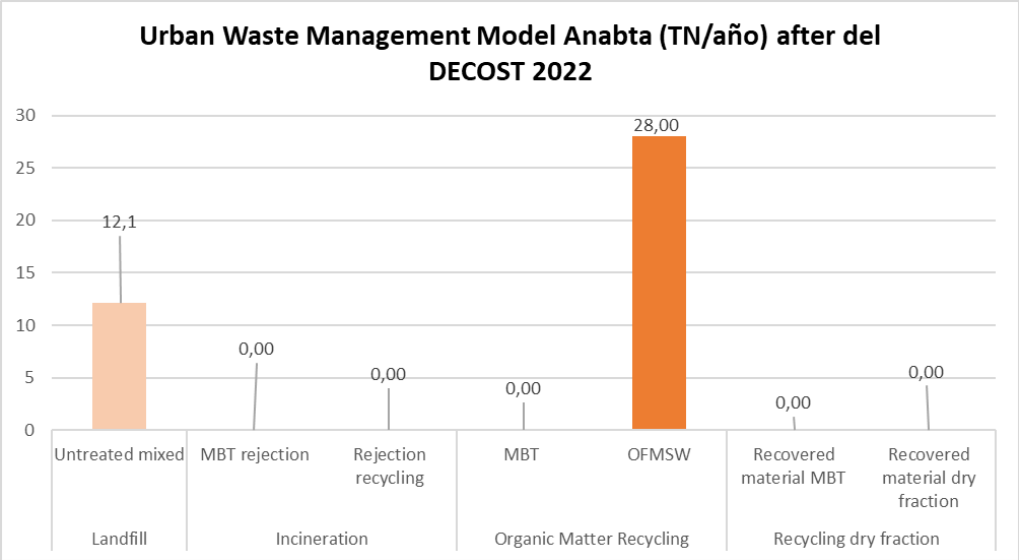

Figura 45 DISTRIBUTION OF TN/YEAR OF WASTE BY TREATMENT AFTER DECOST.
Data Source Provider: DECOST Project (UVIC-Beta Technology Center)

Tons of emissions avoided by chemical fertilizer substitution.

During the year 2022, 8.4 Tn of compost were obtained, the substitution of chemical fertilizers by compost can provide additional avoided emissions close to 85 kg CO2eq t-1 compost that is, in the case of Anabta-Palestine, 0.7 Tn CO2 eq were avoided.

RESULTS BEFORE AND AFTER DECOST

2021

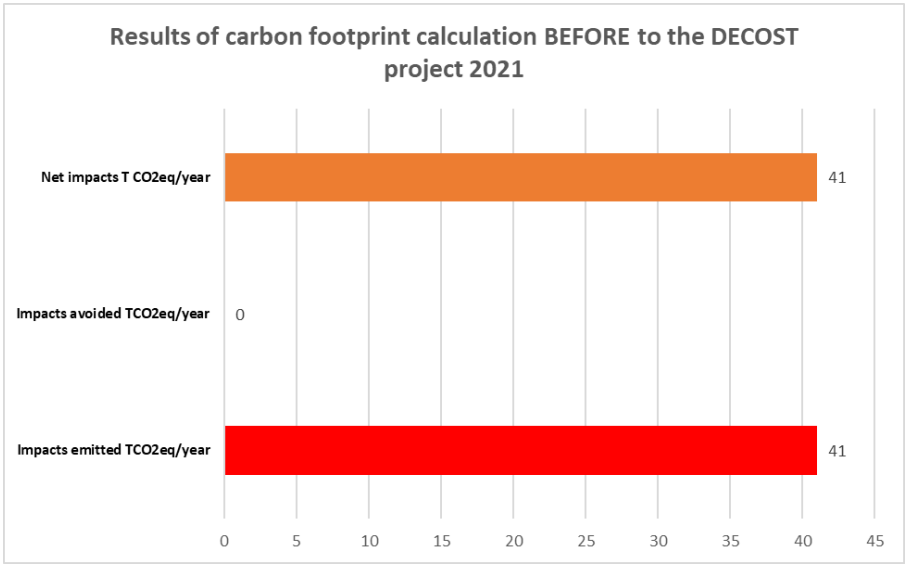

Figura 46. RESULT OF CARBON FOOTPRINT CALCULATION BEFORE DECOST.
Data Source Provider: DECOST Project (UVIC-Beta Technology Center)

2022

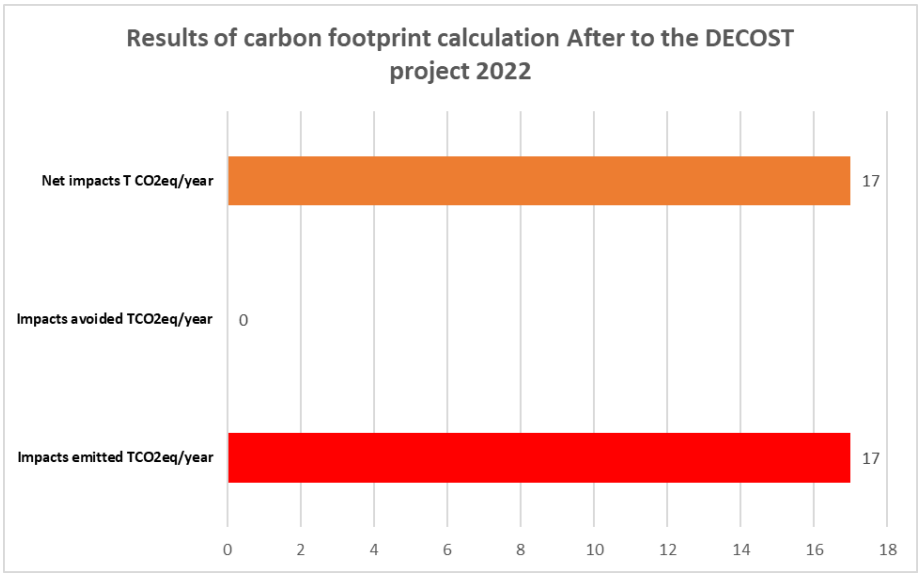

Figura 47 RESULT OF CARBON FOOTPRINT CALCULATION AFTER DECOST.
Data Source Provider: DECOST Project (UVIC-Beta Technology Center)

Although no avoided impacts are observed, there is a decrease in the impacts emitted in 2021 compared to 2022 of 24 Tn CO2 eq. This decrease is due to the implementation of the DECOST project for the treatment of 100% of the organic fraction generated by the target population.

ENI CBCMED
Cooperating across borders in the Mediterranean

Project funded by the EUROPEAN UNION

REGIONE AUTÒNOMA DE SARDIGNA
REGIONE AUTONOMA DELLA SARDEGNA

DECOST

Output 5.4

Sustainability Report

LCC: Life cycle cost

Pilots Italy-Jordan-Spain-Palestine

EXECUTIVE SUMMARY LCC: Life cycle cost

This report analyzes the economic impacts, including capital and operating costs, and thus calculates the cost per ton of organic matter treated.

All these activities developed through the DECOST project, allowed to benefit the municipalities and their citizens, which was one of the main objectives of the project, that the municipalities and citizens in the area of direct influence of the project were benefited through a tangible system such as the pilot systems installed, with infrastructures and long-term policies aimed at replacing the organic waste management system.

The following table summarizes the main objectives obtained in terms of avoided, emitted and net impacts before and after the DECOST project.

DECOST goal	DECOST final output
Technoeconomic assesment	**Operating costs (€/Tn of OFMS treated year)** SPAIN: **191** ITALY- ATELLA **118** ITALY-POTENZA: **217** JORDAN: **84** PALESTINE KURF RUMMAN: **0** PALESTINE ANABTA: **232**

2. Techno economic assesment.

Operating costs (€/Tn of OFMS treated year)
SPAIN: **191**
ITALY- ATELLA **118**
ITALY-POTENZA: **217**
JORDAN: **84**
PALESTINE KURF RUMMAN: **0**
PALESTINE ANABTA: **232**

In the planning phase of the DECOST Project, various budgets were analyzed aimed at the best alternatives in terms of initial investments related to infrastructures, composter models, necessary tools, among other investment costs. initial in capital (CAPEX) This same procedure was carried out for the execution of the pilots, thus elaborating the relationship of the permanent costs for the daily operation of the pilots (OPEX).

Each pilot has a different CAPEX and OPEX, since as explained in the Statistical Report the type of composter varies considering the management models of each country, amount of organic matter generated, logistical conditions, needs and problems of the community. These models were designed with a perspective of maintaining in the long term both technically and economically speaking above all from the operational point of view.

the table shows a summary of CAPEX, OPEX, ton / year of treated organic matter It is noteworthy that the initial investment costs (CAPEX) were financed by the DECOST project, and the operating costs (OPEX) continued to be assumed by the municipality through the fees paid by users and. subsidies per installed composter. Additionally, the operating costs are lower or in some cases as Palestine (KURF RUMMAN) reduced to zero, for the municipality, generating again as a positive effect the reduction of the user rate.

In the following table you can see the CAPEX AND OPEX of each pilot by country, as well as the calculation per ton of organic matter treated per **year.** The following chapters describe what each CAPEX and OPEX is composed of, as well as the calculation of tons of organic matter treated in one year.

SPAIN				
Tons of organic matter installed per year	Cost per ton of installed organic matter			Total CAPEX
102,17	€	1.196,49	€	122.245,00
Tons of organic matter treated per year	**Cost per ton of treated organic matter**			**Total OPEX**
102,17	**€**	**191**	**€**	**19.512,02**

ITALY-ATELLA				
Tons of organic matter installed per year	Cost per ton of installed organic matter			Total CAPEX
80	€	990,88	€	79.270,00
Tons of organic matter treated per year	Cost per ton of treated organic matter			Total OPEX
80	**€**	**118,44**	**€**	**9.475,00**

ITALY-POTENZA				
Tons of organic matter installed per year	Cost per ton of installed organic matter			Total CAPEX
40	€	1.250,00	€	50.000,00
Tons of organic matter treated per year	**Cost per ton of treated organic matter**			Total OPEX
40	**€**	**217,43**	**€**	**8.697,00**

JORDAN-AL SARROW				
Tons of organic matter installed per year	Cost per ton of installed organic matter			Total CAPEX
155	€	541,94	€	84.000,00
Tons of organic matter treated per year	**Cost per ton of treated organic matter**			Total OPEX
155	**€**	**84,00**	**€**	**13.020,00**

PALESTINE-KURF RUMMAN				
Tons of organic matter installed per year	Cost per ton of installed organic matter			Total CAPEX
337	€	430,39	€	145.040,00
Tons of organic matter treated per year	**Cost per ton of treated organic matter**			Total OPEX
€ -	**337**		**€**	**-**

PALESTINE-ANABTA				
Tons of organic matter installed per year	Cost per ton of installed organic matter			Total CAPEX
28	€	821,43	€	23.000,00
Tons of organic matter treated per year	**Cost per ton of treated organic matter**			Total OPEX
28	**€**	**232,14**	**€**	**6.500,00**

Tabla 19 Summary cost per ton installed and treated by country.
Data Source Provider: DECOST Project (UVIC-Centro Tecnológico Beta)

*For this calculation only the tons of Les Masies de Roda in Spain were considered, that is, the 42 tons of Vic are excluded.

2.1 CALCULATION OF OPEX Y CAPEX

Goal and scope

Calculate the cost per ton of installed and treated organic matter (CAPEX and OPEX) during the two years of the project for the municipalities developed by the DECOST project: Spain, Italy, Jordan, and Palestine.

Data collection

The information was obtained from the investments made in each project, such as infrastructure, civil works, among others, as well as operational expenses that include personnel salaries, energy consumption, maintenance, among others.

Analysis of information

Once the information was collected, it was classified by CAPEX and OPEX, it is noteworthy that the OPEX of each project varied, considering the information obtained in the field in relation to the day-to-day operation of the composters and the manner and frequency of carrying out certain activities such as operation and maintenance.

Result

For this report, the result of interest is the annual cost per ton of organic matter installed and treated.

2.1.1 TECHNOECONOMICAL ASSESSMENT SPAIN.

Next, it is explained what the CAPEX and OPEX of community composting in Spain consists of, considering the management model implemented and the tons (102 Tn/year) of organic matter treated through 63 community composters installed.

Capex

Capital expenditures for community composters in Spain considered the civil works, machinery, composters, clothing and work tools, the description of each item is shown in the following table, as well as the unit values, units and total costs. The Capex of community composting in Spain was **€ 1.196,49**

The following figure summarizes capital expenditures.

Figura 48 Capital Expenditures Community Composters Pilot Spain.
DECOST Project (UVIC-Centro Tecnológico Beta)

	Implementation Costs:	Unitary cost (€)	Units	Costs (€)
CAPEX	Composting sites civil work	€ 570,00	15	€ 8.550
	Composter 1000L Easy Install	€ 625,00	63	€ 39.375
	pruning box	€ 400,00	13	€ 5.200
	Centralized composting warehouse	€ 25.000,00	1	€ 25.000
	Centralized post-processing equipment	€ 15.000,00	1	€ 15.000
	Workwear	€ 248,24	4	€ 993
	Tools	€ 125,00	7	€ 18
	RollContainer	€ 185,00	5	€ 925
	Big bag with buckles	€ 27,00	30	€ 810
	Big bag with handles	€ 6,82	15	€ 102
	Mixer	€ 2.722,00	1	€ 2.722
	Camion	€ 10.000,00	1	€ 10.000
	Iron containers	€ 1.160,00	7	€ 8.120
	Shredde Machinery	€ 1.140,00	1	€ 1.140
	Household organic bins	€ 3,00	300	€ 900
	Pruning	€ 45,00	42	€ 1.890
	Compostable bags	€ 30.000,00	0,05	€ 1.500
Total		**€ 87.257,06**		**€ 122.245**

Tabla 20 CAPEX DECOST SPAIN.
Data Source Provider: DECOST Project (UVIC-Beta Technology Center)

*The truck has not been paid for under the project

OPEX

The operational costs were calculated considering the needs of daily operation and maintenance, which is summarized in personnel costs, energy and fuel consumption, maintenance, pest controls and pruning crushing in times such as spring that the volumes of this waste increase significantly.

The following figure summarizes the daily operation and maintenance activities, as well as the use of some tools such as iron containers, big bags and use of mixing machine. On the left side are the maintenance frequencies carried out in the week by neighborhood and composting points whose displacements were made in the vehicle destined for the project.

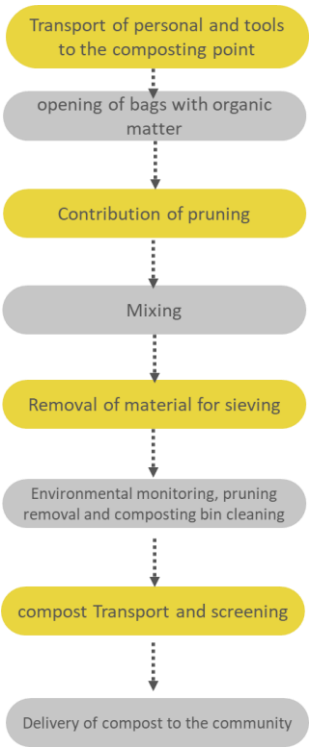

Figura 49 Activities carried out in the daily maintenance of community composters.

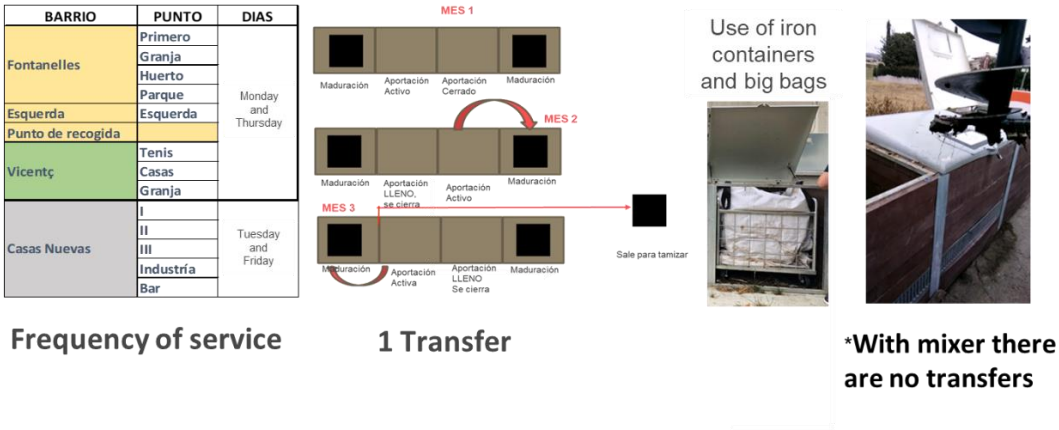

Figura 50 Example of some daily operation and transfers activities and tools.
Data Source Provider: DECOST Project (UVIC-Beta Technology Center)

The operating costs of pilot composters in Spain are **€ 19,512** per year.

Operational Costs		Monthly cost (€)	Costs (€)
OPEX Four times a week	Personnel Salaries (1 people per hour)	€ 1.411	€ 16.936
	Fuel consumption, maintenance and transfer frequencies	€ 77	€ 922
	Electrical consumtion	€ 5	€ 60
	Contract pruning shredder / year	€ 69	€ 832
	Pest control	€ 127	€ 762
Total		**€ 1.500**	**€ 19.512**

Tabla 21 OPEX DECOST SPAIN.
Data Source Provider: DECOST Project (UVIC-Beta Technology Center)

RESULTS

Taking into account that in Spain (Municipality of Les Masies de Roda), 102.90 Tn / year of organic matter were treated. The costs per ton installed per year are € 1.196,49, the expenses per ton treated per year are € 190,98

Tons of organic matter installed per year	Cost per ton of installed organic matter		Total CAPEX
102,17	**€ 1.196,49**	€	122.245,00

Tons of organic matter treated per year	Cost per ton of treated organic matter (year)		Total OPEX
102,17	**€ 190,98**	€	19.512,02

Tabla 22Results DECOST SPAIN.
Data Source Provider: DECOST Project (UVIC-Beta Technology Center)

2.1.2 TECHNOECONOMICAL ASSESSMENT IN ATELLA AND POTENZA-ITALY.

Next, it is explained what the CAPEX and OPEX of community composting in Italy consist of, considering the management model implemented. In Italy, a total of 3 electromechanical community composters were installed: 1 in Atella of 80 tons capacity and two in Potenza of 20 tons capacity each.

2.1.2.1 TECHNOECONOMICAL ASSESSMENT IN ATELLA -ITALY.

CAPEX

Capital expenditures for community composters in Atella Italy considered the civil works, like electrical system, machinery, composters and truck, the description of each item is shown in the following table, as well as the unit values, units, and total costs. The Capex of community composting in Atella was **€ 79.270,00.** The following figure summarizes capital expenditures.


Figura 51Capital Expenditures Community Composters Pilot Italy Atella.
DECOST Project (UVIC-Centro Tecnológico Beta)

Capital Cost					
Implementation Costs		**Unitary cost (€)**	**Units**		**Cost (€)**
Truck (Collection organic matter)	€	10.000,00	1	€	10.000,00
ATELLA -system - Urban Garden	€	65.000,00	1	€	65.000,00
Electrical system - Urban Garden	€	4.270,00	1	€	4.270,00
TOTAL				**€**	**79.270,00**

Tabla 23 Capital Expenditures Community Composters Pilot Italy-Atella.
DECOST Project (UVIC-Beta Technology Center)

*The truck has not been paid for under the project

OPEX

The operating costs of pilot composters in Atella Italy are **€ 9.475,20** per year. The operational costs were calculated considering the needs of daily operation and maintenance, which is summarized in personnel costs and energy consumption.

Operating cost				
Operating cost	**Monthly cost (€)**		**Cost (€)/year**	
Electricity consumption	€	129,60	€	1.555,20
Personnel Salaries	€	660,00	€	7.920,00
TOTAL	**€**	**789,60**	**€**	**9.475,20**

Tabla 24Capital Expenditures Community Composters Pilot Italy-Atella.
DECOST Project (UVIC-Beta Technology Center)

RESULTS

Taking into account that in Atella Italy 80 Tn / year of organic matter were treated. The costs per ton installed per year are € 990,88, the expenses per ton treated per year are € 118,44

Tons of organic matter installed per year	Cost per ton of installed organic matter		Total CAPEX	
80	€	990,88	€	79.270,00

Tons of organic matter treated per year	Cost per ton of treated organic matter		Total OPEX	
80	€	118,44	€	9.475,00

Tabla 25 OPEX Community Composters Pilot Italy-Atella.
DECOST Project (UVIC-Beta Technology Center)

2.1.2.2 TECHNOECONOMICAL ASSESSMENT POTENZA -ITALY.

CAPEX

Capital expenditures for community composters in Potenza Italy considered the composters, the description of each item is shown in the following table, as well as the unit values, units, and total costs. The Capex of community composting in Potenza was **€ 50.000,00.**

The following figure summarizes capital expenditures.

Figura 52Capital Expenditures Community Composters Pilot Potenza.
DECOST Project (UVIC-Centro Tecnológico Beta)

Capital Cost			
Implementation Costs	**Unitary cost (€)**	**Units**	**Cost (€)**
POTENZA Urban Garden - Scambiologico	25000	2	50000
TOTAL			**€ 50.000,00**

Tabla 26 CAPEX Community Composters Pilot Italy-Potenza.
DECOST Project (UVIC-Beta Technology Center)

OPEX

The operating costs of pilot composters in Potenza Italy are **€ 8.697,60** per year. The operational costs were calculated considering the needs of daily operation and maintenance, which is summarized in personnel costs and energy consumption.

Once the compost comes out of the electromechanical composter, it is placed in the form of maturing piles and then distributed to the community. These activities are carried out by contracted personnel. The following figure summarizes capital expenditures.

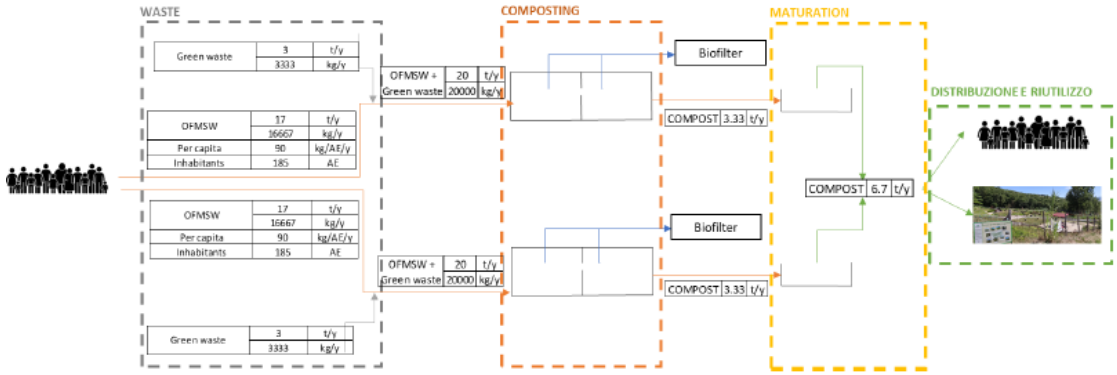

Figura 53 Example of some daily operation and maintenance activities and tools.
Data Source Provider: DECOST Project (UVIC-Beta Technology Center

Operating cost				
Operating cost	**Monthly cost (€)**		**Cost (€)/year**	
Electricity consumption	€	64,80	€	777,60
Personnel Salaries	€	660,00	€	7.920,00
TOTAL	**€**	**724,80**	**€**	**8.697,60**

Tabla 27 OPEX Community Composters Pilot Italy-Potenza.
DECOST Project (UVIC-Beta Technology Center)

RESULTS

Considering that in Atella Italy 40 Tn / year of organic matter were treated. The costs per ton installed per year are € 1.250,00, the expenses per ton treated per year are € 217,43 .

Tons of organic matter installed per year	Cost per ton of installed organic matter		Total CAPEX	
40	€	1.250,00	€	50.000,00

Tons of organic matter treated per year	Cost per ton of treated organic matter		Total OPEX	
40	€	217,43	€	8.697,00

Tabla 28Results DECOST Italy Atella.
Data Source Provider: DECOST Project (UVIC-Beta Technology Center)

2.1.3 TECHNOECONOMICAL ASSESSMENT IN JORDAN

Next, it is explained what the CAPEX and OPEX of community composting in Jordan Al Sarrow consist of, considering the management model implemented. In Jordan, a total of 100 home composters were installed.

CAPEX

Capital expenditures for community composters in Jordan Al Sarrow considered the civil works, like electrical system, machinery, composters and truck, the description of each item is shown in the following table, as well as the unit values, units, and total costs. The Capex of community composting in Jordan was **€ 84.000.**

The following figure summarizes capital expenditures.

Figura 54 Capital Expenditures Community Composters Pilot Jordan.
DECOST Project (UVIC-Centro Tecnológico Beta)

Capital Cost			
Implementation Costs	**Unitary cost (€)**	**Units**	**Cost (€)**
Aerobin Home Composter (400 Liter)	€ 180,00	100	18.000,00
Shredder	€ 140,00	100	14.000,00
Mixer	€ 10,00	100	1.000,00
Thermometer	€ 17,00	100	1.700,00
Moisture meter	€ 95,00	100	9.500,00
200 Liter Waste bin	€ 35,00	100	3.500,00
Biogas meter	€ 6.300,00	1	6.300,00
Urban Agriculture	€ 30.000,00	1	30.000,00
TOTAL	**€ 36.777,00**		**€ 84.000,00**

Tabla 29CAPEX DECOST JORDAN.
Data Source Provider: DECOST Project (UVIC-Beta Technology Center)

OPEX

The operating costs of pilot composters in Jordan-Al Sarrow are **€ 13.020** per year. The operational costs were calculated considering the needs of daily operation and maintenance, which is summarized in personnel costs, maintenance and transfer and energy consumption.

Operating cost	
Operating cost	**Cost (€)/year**
Personnel Salaries (2 people)	12.000,00
Fuel consumption, maintenance and transfer frequencies	960,00
Electrical consumtion	60,00
TOTAL	**€ 13.020,00**

Tabla 30 OPEX DECOST JORDAN.
Data Source Provider: DECOST Project (UVIC-Beta Technology Center)

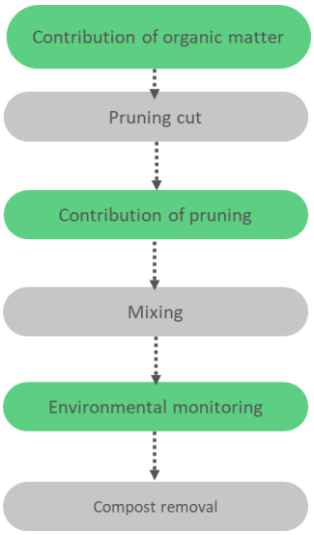

Figura 55 Activities carried out in the daily maintenance of community composters.

RESULTS

Considering that in Jordan 155 Tn / year of organic matter were treated. The costs per ton installed per year are € 541,94, the expenses per ton treated per year are € 84.

Tons of organic matter installed per year	Cost per ton of installed organic matter	Total CAPEX
155	€ 541,94	€ 84.000,00

Tons of organic matter treated per year	Cost per ton of treated organic matter	Total OPEX
155	€ 84,00	€ 13.020,00

Tabla 31 Results DECOST Jordan.

2.1.4 TECHNOECONOMICAL ASSESSMENT IN KURF RUMMAN AND ANABTA-PALESTINE

Next, it is explained what the CAPEX and OPEX of community composting in Palestine consist of, considering the management model implemented. In Palestine, a total of 392 Home composter in Kurf Rumman and one community composters were installed:in Anabta (337 tons and 28 tons capacity each).

2.1.4.1 TECHNOECONOMICAL ASSESSMENT KURF RUMMAN

CAPEX

Capital expenditures for community composters in Kurf Rumman Palestine considered the home composters, the description of each item is shown in the following table, as well as the unit values, units, and total costs. The Capex of community composting in Kurf Rumman Jordan was **€ 145.040.**

The following figure summarizes capital expenditures.

Figura 56 Capital Expenditures Community Composters Pilot Palestine. DECOST Project (UVIC-Centro Tecnológico Beta)

Capital Cost					
Implementation Costs		**Unitary cost (€)**	**Units**		**Cost (€)**
Home composters		370,00	392		145.040,00
Total	**€**	**370,00**		**€**	**145.040,00**

Tabla 32 Capital Expenditures Community Composters Pilot Palestine
DECOST Project (UVIC-Beta Technology Center)

OPEX

Considering that they are home composters and that the inhabitants themselves maintain them, the operating costs are reduced to zero.

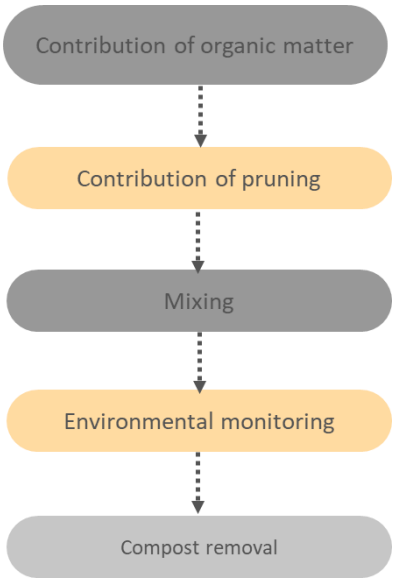

Figura 57 Activities carried out in the daily maintenance of community composters.

RESULTS

Taking into account that in Kurf Rumman 337 Tn / year of organic matter were treated. The costs per ton installed per year are € 430,39, the expenses per ton treated per year are € 0.

Tons of organic matter installed per year	Cost per ton of installed organic matter	Total CAPEX
337	€ 430,39	€ 145.040,00

Tons of organic matter treated per year	Cost per ton of treated organic matter	Total OPEX
337	€ -	€ -

Tabla 33OPEX Community Composters Pilot Palestine
DECOST Project (UVIC-Beta Technology Center)

2.1.4.2 TECHNOECONOMICAL ASSESSMENT ANABTA

CAPEX

Capital expenditures for community composters in Anabata Palestine considered the community composters, the description of each item is shown in the following table, as well as the unit values, units, and total costs. The Capex of community composting in Anabta Palestine was **€ 23.000.**

The following figure summarizes capital expenditures.

Figura 58 Capital Expenditures Community Composters Pilot Palestine-Anabta.
DECOST Project (UVIC-Centro Tecnológico Beta)

Capital Cost				
Implementation Costs	**Unitary cost (€)**	**Units**	**Cost (€)**	
Community composter 7m	23.000,00	1	23.000,00	
Total	**€ 23.000,00**		**€**	**23.000,00**

Tabla 34 Capital Expenditures Community Composters Pilot Palestine-Anabta.
DECOST Project (UVIC-Beta Technology Center)

OPEX

The operating costs of pilot composters in Palestine Anabta are **€ 6.500,00** per year. The operational costs were calculated considering the needs of daily operation and maintenance, which is summarized in personnel costs and energy consumption.

OPEX			
Implementation Costs	**Cost per month (€)**	**Units**	**Cost (€)**
Energy consumption	125	12	1500
Staff salaries	416,67	12	5000
Total	**€ 541,67**		**€ 6.500,00**

Tabla 35 Capital Expenditures Community Composters Pilot Palestine-Anabta.
DECOST Project (UVIC-Beta Technology Center)

RESULTS

Taking into account that in Palestine Anabta 28 Tn / year of organic matter were treated. The costs per ton installed per year are € 821,43, the expenses per ton treated per year are € 232,14

Tons of organic matter installed per year	Cost per ton of installed organic matter	Total CAPEX
28	€ 821,43	€ 23.000,00

Tons of organic matter treated per year	Cost per ton of treated organic matter	Total OPEX
28	€ 232,14	€ 6.500,00

Tabla 36 OPEX Community Composters Pilot Palestine Anabta.
DECOST Project (UVIC-Beta Technology Center)

ENI CBCMED
Cooperating across borders in the Mediterranean

Project funded by the EUROPEAN UNION

REGIONE AUTÒNOMA DE SARDIGNA
REGIONE AUTONOMA DELLA SARDEGNA

DECOST

Output 5.4

Sustainability Report

SLCA: Social Life cycle assessment

Pilots Italy-Jordan-Spain-Palestine

DECOST

EXECUTIVE SUMMARY

SLCA: Social Life cycle assessment

The DECOST project has succeeded in demonstrating the economic, social, and environmental well-being of the proposed system that promotes inclusive and sustainable urban and rural development, including equitable and sustainable access to basic local services for rural communities, fostering institutional, political and legal reforms for the effective incorporation of climate change responses and waste management into national and local development frameworks.

The H&CC system together with the urban agriculture program (to use the compost produced as fertilizer closing the OM cycle) allowed to increase economic, social and territorial cohesion while reducing pressures on the environment. Similarly, the operation of each pilot composter was made up of people from Universities and Municipalities of the region (partners) creating two new green jobs in each site (prioritizing the empowerment of women and youth employment) for daily field work. Each team was supervised/trained by UVIC experts, as well as carrying out ongoing campaigns and information activities to engage citizens in both the H&CC system and urban agriculture.

As for the social aspect, it highlights the major achievements in social cohesion and governance considering the methodology Sheets for subcategories in Social Life Cycle Assessment (S-LCA) supplement the Guidelines for Social Life Cycle Assessment of Products, (UNEP/SETAC, 2009), which defines different indicators from a social point of view.

The following table summarizes the main objectives obtained in terms of avoided, emitted and net impacts before and after the DECOST project.

DECOST goal	DECOST final output
Social assesment	Social indicators were identified where workers, local community, society, and consumers benefited. Additionally, two surveys were developed that allowed to know the acceptance and perception of the project, yielding a positive result of acceptance by the community involved.

3.Social assessment

Positive impacts oriented to:
Equality & no discrimination.
Local employment
Community Engagement
Access to material resources
Public committee to sustainability issues
Technology Development
Contribution to economic development
Health & Safety conditions
EoL responsability

The DECOST project generated great environmental, economic, and social benefits.

The main beneficiaries of these social impacts were workers, local community, society and consumers, the main categories show these positive impacts oriented to Equality & no discrimination, Local employment, Community Engagement, Access to material resources, public committee to sustainability issues, Technology Development, Contribution to economic development, Health & Safety conditions, EoL responsability.

In addition to the identification of these impacts, approaches with the community were also generated in the countries of Jordan and Spain through the application of a survey, which allows to demonstrate the positive effect generated by the project showing great acceptance and knowledge regarding the operation of the composters thus understanding the empowerment of the community in the project. These results are shown in subsequent chapters of this document.

The following table relates the definition of the social impacts generated, as well as the actors involved and the contribution of DECOST in each of these.

Stakeholder	Impact categories	Definition	DECOST INDICATOR
Workers	Equality & no discriminatio	Everybody deserves a "fair chance". It doesn´t matter what sex, race or age. Everybody has the right to be treated fairly and access to equal opportunities.	**Composters were also distributed to 16 NGOs including Female Charitable Societie**s and Youth Societies located in the pilot site in Jordan.
Local community	Local employment	Encourage local community development by training local employees in technical and transferable skills	**During the execution of the DECOST project, 68 trainings** were carried out for public administration personnel in relation to waste management strategies and operation, maintenance, and monitoring of the installed composters.
	Community Engagement	Organizations could should considerer these stakeholders in the development and implementation of business policies, particularly those that affect local environmental, health	**The DECOST project, developed and implemented 4 management plans in the countries of Palestine, Jordan, Italy and Spain**. In which a new waste management framework was implemented with emphasis on the treatment of the organic fraction.
	Acces to material resources	This includes management's attention to the sustainable use of natural resources, pollution prevention and waste recycling.	The development of the **four pilots composters** have allowed the prevention and recovery of waste generated in places where there was not even source-separation and in other contexts problems have been solved due to inadequate waste management and/or improvements in source-separation, whose benefits translate into social, economic, and environmental aspects as demonstrated in these reports.

Stakeholder	Impact categories	Definition	DECOST INDICATOR
Society	Public comitment to sustainability issues	Commitments relate to the contribution of organizations to the sustainable development of the community or society as the reduction of impacts from	**Through the DECOST Project, emissions were reduced from 716 Tn CO2eq/year to 209.13 Tn/year CO2eq** a reduction of 506.87 Tn CO2eq/year.
	Tecnology Development	Technology transfer is the process of using technology, expertise, know-how or facilities for a purpose not originally intended by the developing	**The DECOST project's Replicability and Transferability (R&T) Plan** provides guidelines and a methodological framework for quantifying economic, operational, environmental, social and legal aspects in order to examine the feasibility of Decentralized Composting (DC) projects at any location. The R&T plan provides a powerful decision-making tool based on the quantification of CD project characteristics and Benefit/Cost (B/C) ratio calculations, which take into account the various influencing variables.
	Contribution to economic development	To contributes to the economic development of the country , in many ways: To generate revenue, create jobs, provide education and training, make investments, or forward research.	During the implementation of the DECOST **project, 67 green jobs were created.** To give continuity to the project, **The participating pilot municipalities have created 7 long-term green jobs.**
Consumers	Health & Safety conditions	Efforts to address consumer health and safety across the organizations involved in the life cycle of a product and/or service	During the execution of the DECOST project, **around 850 tons of compost were obtained.** **More than 3750 people used the compost in their own gardens or in municipal/urban gardens.** In addition to the production of compost, as an additional result in **the operation of urban agriculture, irrigation systems were implemented in this model by capturing (harvesting) rainwater from the rooftop** of buildings of the houses.
	EoL responsability	In a product life cycle, end-of-life refers to product disposal, reuse or recycling. In an environmental context.	During the execution of the DECOST project, 4 pilots were installed with a total **annual OFMSW treatment capacity of 1353 Tons/year. More than 1,000 Tons/all DECOST PROYECT of OFMSW were treated.**

Tabla 37 Social impacts DECOST Project.
Data Source Provider DECOST Project (UVIC-Centro Tecnológico Beta)

3.1 CONTRIBUTIONS OF THE DECOST PROJECT TO THE SUSTAINABLE DEVELOPMENT GOALS

The following are the sustainable development goals to which the DECOST project contributed from the social point of view.

GOAL	DECOST PROJECT CONTRIBUTIONS
	Through the implementation of the DECOST project, 67 green jobs were created with fair wages.
	In countries such as Jordan, in addition to community composting, the irrigation system was implemented to improve urban agriculture projects, thus contributing to improving the acquisition of healthy food for the population.
	The DECOST project considered gender equality in all phases of the project, both in administrative and technical tasks, additionally in countries where the gender inequality gap is wide as in the case of Jordan, composters were also distributed to 16 NGOs including Female Charitable Societies and Youth Societies located in the pilot site in Jordan, thus promoting the empowerment and inclusion of the female gender.
	During the implementation of the DECOST project, 67 green jobs were created. To give continuity to the project, The participating pilot municipalities have created 7 long-term green jobs.
	During the execution of the DECOST project, 4 pilots were installed with a total annual OFMSW treatment capacity of 1,680 Tons/year. More than 1,000 Tons/year of OFMSW were treated.
	The DECOST project, developed and implemented, 3520 citizens participated in raising awareness campaigns on environmental issues, 92 educationalactivities with young people and kids in urban agriculture and gardening
	During the execution of the DECOST project, 4 pilots were installed with a total annual OFMSW treatment capacity of 1353 Tons/year. More than 1,000 Tons/all DECOST PROYECT of OFMSW were treated.
	Through the DECOST Project, emissions were reduced from 716 Tn CO_2eq/year to 209.13 Tn/year CO_2eq a reduction of 506.87 Tn CO_2eq/year.
	The DECOST project, developed and implemented: 4 management plans in the countries of Palestine, Jordan, Italy and Spain, in order to generate sustainable guidelines in waste management models with emphasis on the management of the organic fraction with home and community composting as the only way of management.

Figura 59 Relationship of sustainable development objectives versus DECOST project outputs.
DECOST Project (UVIC-Beta Technology Center)

The DECOST project made it possible to address relevant cross-cutting issues (democracy and human rights and gender equality) as it was designed with a people-centred approach, meaning that environmental activities were planned in accordance with social and economic objectives such as increasing social cohesion/inclusion, avoiding discrimination, creating green jobs, poverty eradication and gender equality. The specific programs made it possible to address poverty and the social inclusion of informal recycling during the development of the IMSWMP. Cohesion was fostered through the development of urban community agriculture projects and the development of institutional capacities by training municipalities and thus improving good governance. The project ensured that gender equality was considered at all stages; women and young people were considered when selecting the new green jobs for DECOST teams.

3.1 SURVEY APPLIED IN JORDAN

Before the implementation of the DECOST project, a survey was applied to the population to know their disposition in front of the project, reflecting a very strong need against the adequate disposal of waste, especially the organic fraction and at the same time benefit from the advantages of obtaining compost for use in their crops.

Below are the most relevant responses of the survey applied to 100 people, where firstly the need to implement sustainable measures against waste management is observed and secondly the acceptance of the project once implemented is shown.

Need to implement sustainable measures against waste management.

In this graph you can see how 78% of the surveyed population notes that their waste is burned in their area.

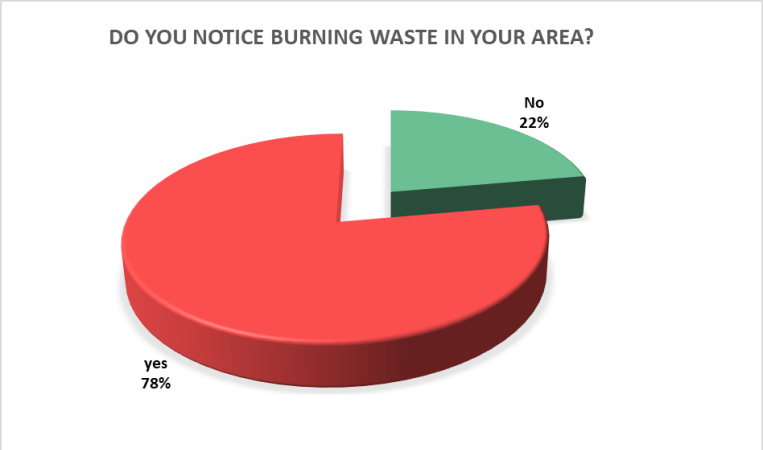

Figura 60 Survey conducted in Jordan.
DECOST Project (UVIC-Beta Technology Center)

In this graph you can see how 93% of the surveyed population They would like to participate in the composting of organic matter, just as they would like to separate the waste generated in their homes.

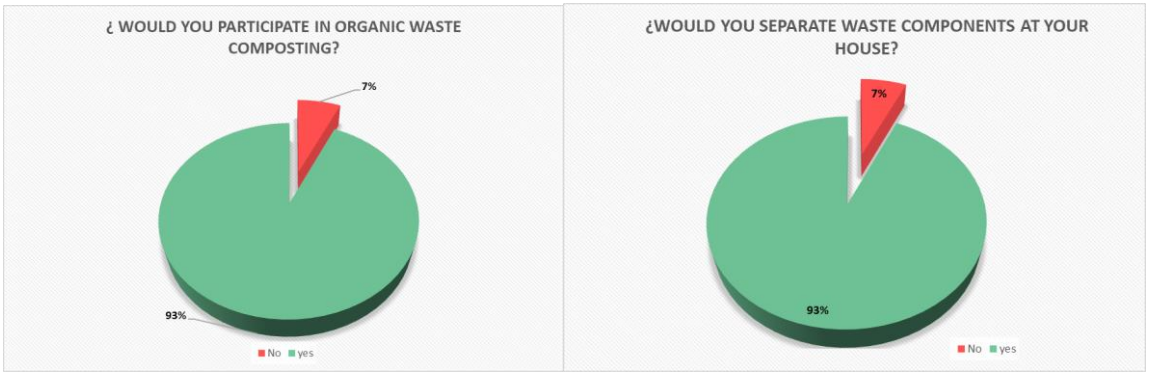

Figura 61Survey conducted in Jordan
DECOST Project (UVIC-Beta Technology Center)

In this graph you can see how 92% of the surveyed population They agree to put a composting bin in their garden.

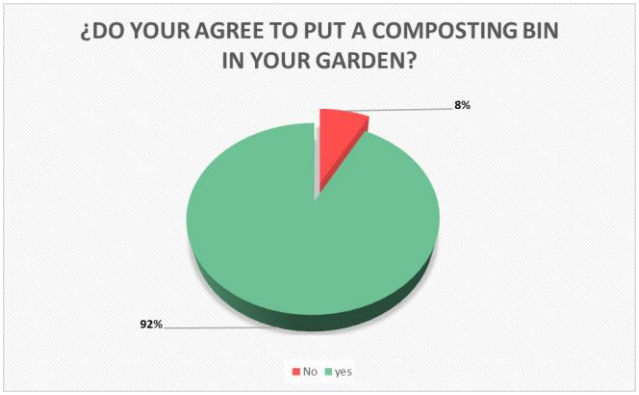

Figura 62Survey conducted in Jordan.
DECOST Project (UVIC-Beta Technology Center)

Acceptance of the project once implemented.

Results shown that most of the people found that composting does not require much effort or time (Figure 17). And Figure 18 show that many participants add compost 2 – 3 times per week to produce 10 - 15 kg of compost per cycle.

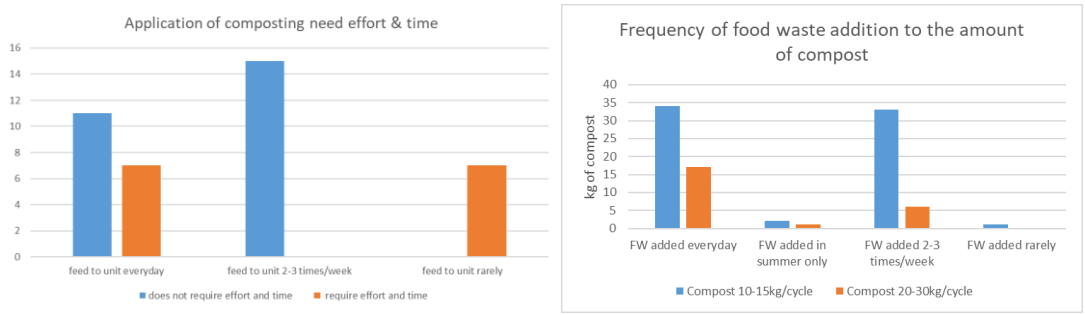

Figura 63 Survey conducted in Jordan..
DECOST Project (UVIC-Beta Technology Center)

Compost production minimized the purchase of chemical fertilizers (Figure 19). And Figure 20 shown the top priority for people to compost was to produce high quality compost then to minimize the wastes sent to landfills and then to produce a more cost-effective soil nutrient.

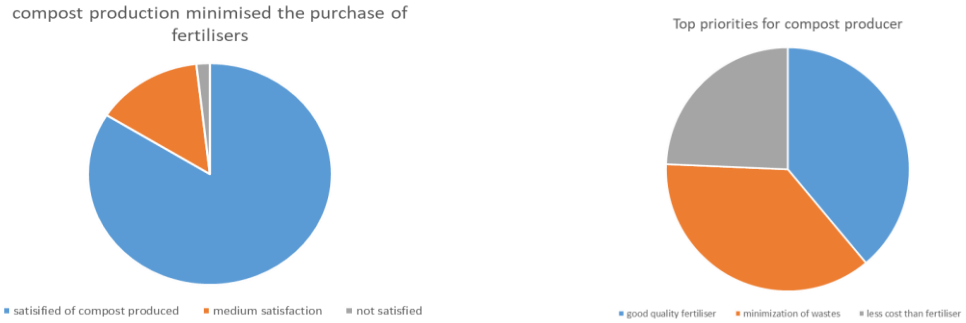

Figura 64 Survey conducted in Jordan
DECOST Project (UVIC-Beta Technology Center)

3.2 SURVEY APPLIED IN SPAIN

La encuesta aplicada en Les Masies de Roda se encuentra orienta en tres partes: Preguntas enfocadas al conocimiento acerca del nuevo sistema de gestión de residuos puerta a puerta y el compostaje comunitario de la materia orgánica, level of satisfaction and difficulties during the use of community composters for the treatment of organic matter and frequency of use of composters

Knowledge about the new waste management system

100% of the people surveyed know the new waste management and community composting system of the municipality Les Masies de Roda, 94% of the population considers that this new system is more efficient than the previous one, 97% of the population thinks that this new system

of community collection and composting contributes to keeping the town cleaner compared to the previously existing system.

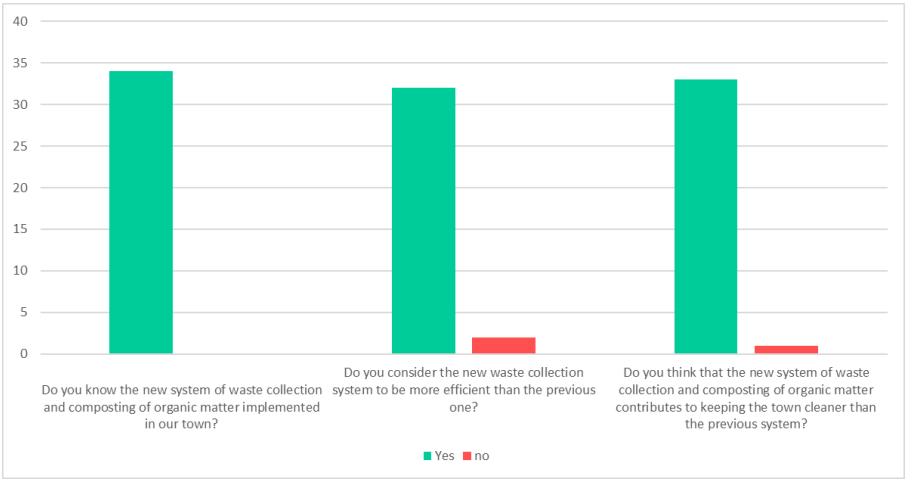

Figura 65 Survey LMR.
DECOST Project (UVIC-Beta Technology Center)

Level of satisfaction and difficulties during the use of community composters for the treatment of organic matter

94% of the population is satisfied with the current system of door-to-door collection and community composting, 91% believe that the new system of treatment of organic matter is more environmentally friendly than the previous system. The other hand, 94% of the population finds the instructions related to the new composting system easy to understand. And they also haven't had any problems or difficulties using the composting system for organic matter. Finally on a scale of 1 to 5, 97% of the population is between very satisfied and satisfied with the community composting service.

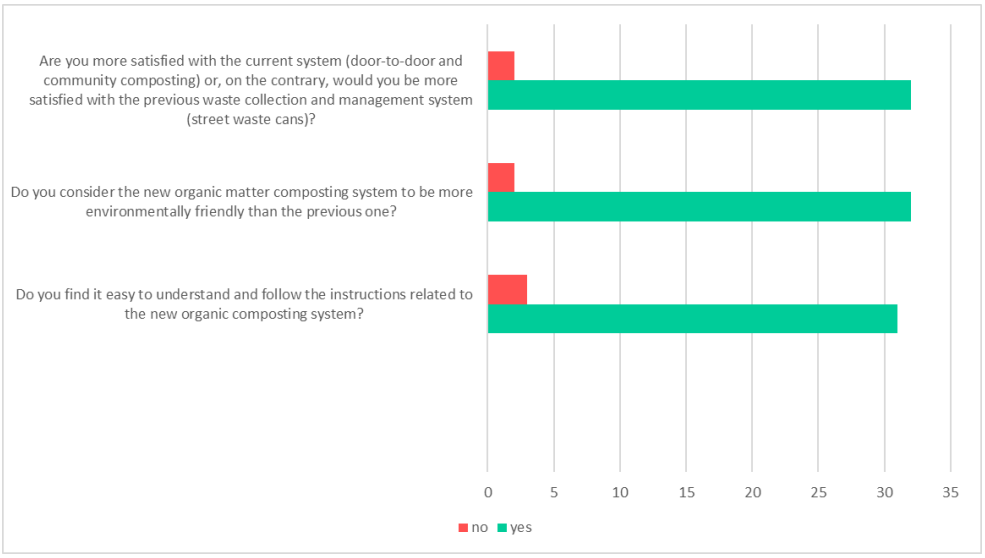

Figura 66 Survey LMR.
DECOST Project (UVIC-Beta Technology Center)

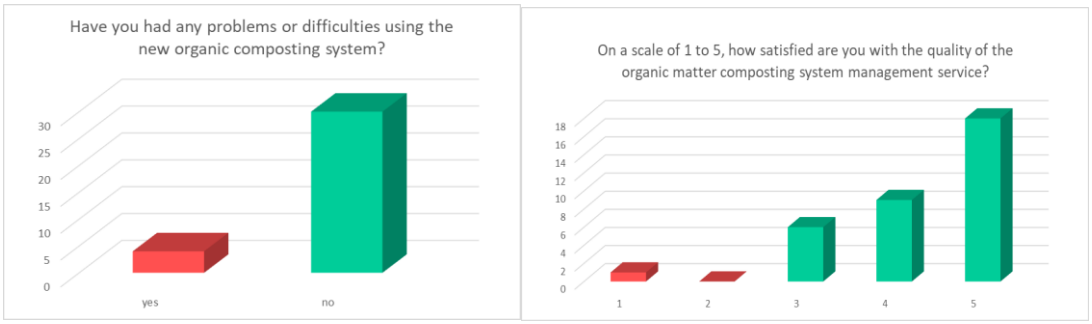

Figura 67 Survey LMR
DECOST Project (UVIC-Beta Technology Center)

Frequency of use of composters

18% use the composting system daily for the treatment of organic matter, 26% use it between 4 and 6 times a week, 36% between 2 and 3 times a week, 11% once a week and finally 9% use it less than once a week. Those who use the composting system daily and between 6 and 2 times a week, have the added value of always having the composters available, which is a plus for the user since they do not have to wait for the day of collection frequency to remove their organic matter and on the contrary, they can do it at the time they want.

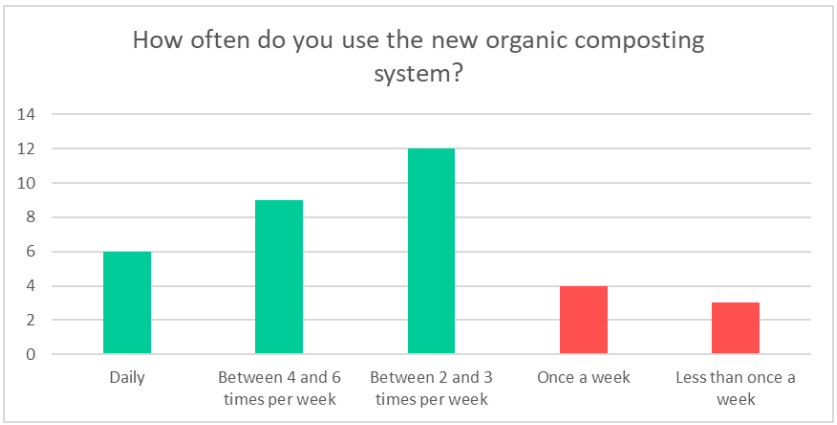

Figura 68 Survey frequency composting
DECOST Project (UVIC-Beta Technology Center)

Conclusions

- ✓ Community and/or home composting is an environmentally sound process as the only way to treat organic matter.
- ✓ Treatment of the organic fraction through community and/or home composting improves separation at the source by increasing the amounts of recycled material.
- ✓ Regarding the net impacts measured in COseq emissions, all the countries of the DECOST project achieved a reduction through the treatment of the organic fraction of community and/or home composting, which, emissions were reduced from 716 Tn CO2eq/year to 209.13 Tn/year CO2eq a reduction of 506.87 Tn CO2eq/year.
- ✓ During the one-year operation of the DECOST project, emissions avoided using compost obtained from community and home composting were around 19 Tn CO2eq/year avoided.
- ✓ The present study showed that in countries where the organic fraction is disposed directly in the landfill without recovery of methane gas, higher Tn CO2 eq are emitted, which does not allow impacts to be avoided. However, there is a notable decrease before and after DECOST in net impacts.
- ✓ The existing treatment systems for the organic fraction, such as stabilization of organic matter and recovery of methane gas are technologies that improve urban waste management systems in the sense of energy recovery and reduction of emissions of organic matter, which is relevant and notorious in the emissions of Tn CO2 eq before the DECOST project in European countries that have implemented this type of technologies. This does not mean that these can be improved as was done with the DECOST project, not only from the environmental point of view, but also from the social and economic point of view.
- ✓ The implementation of the DECOST project demonstrates that it is feasible to improve the municipal solid waste management framework through the management of organic matter through community composting as the only way of management in municipalities and / or cities with similar characteristics in terms of population and in some cases factors of difficult access of these wastes for their treatment, which is a valuable model to be replicated in places with similar characteristics.
- ✓ Community and home composting not only generates great environmental benefits but also economic and social benefits.
- ✓ The Operating costs (€/Tn of OFMS treated year) Spain: 191 , Italy- Atella 118,44 Italy-potenza: 217, Jordan: 84, Palestine Kurf Rumman: 0, Palestine Anabta: 232,16

This document/publication has been produced with the financial assistance of the European Union under the ENI CBC Mediterranean Sea Basin Program. The contents of this document are the sole responsibility of University of Vic – Central University of Catalonia and can under no circumstances be regarded as reflecting the position of the European Union or the Program management structures

✓ Social indicators were identified where workers, local community, society, and consumers benefited. Additionally, two surveys were developed that allowed to know the acceptance and perception of the project, yielding a positive result of acceptance by the community involved.
✓ From a social and economic point of view, the DECOST project contributed to the Sustainable Development Goals: No poverty, zero hunger, gender equality, clean water and sanitation, decent work and economic growth, industry, innovation and infrastructure, sustainable cities and communities, responsible production and consumption, climate action and partnerships to achieve the goals.
✓ The surveys applied in Jordan and Spain reflect a positive acceptance in the implementation of the waste management model, especially home and community composting as the only way of the organic fraction.
✓ The economic benefits are reflected in the generation of employment for people in the local community, with fair wages, considering the inclusion of gender and age.
✓ Community composting is an economically viable project, and the operating costs are reasonable, which can be maintained through the fees that the municipality receives from citizens and the reimbursements established in some countries for the installation of the composter.
✓The operating costs are variable depending on the type of composter installed and the context of each country, which allows to give a range of options for the replicability of these models in other countries whose problems are similar to the installed pilots.

Bibliography

AdminStateItaly. (2023). *Mappe, analisi e statistiche sulla popolazione residente*. Obtenido de https://ugeo.urbistat.com/AdminStat/it/it/demografia/famiglie/potenza/76063/4

Agencia de Residuos de Catalunya . (2020). *Agencia de Residuos de Catalunya* . Obtenido de Agencia de Residuos de Catalunya : http://residus.gencat.cat/web/.content/home/ambits_dactuacio/planificacio/precat20_resum_executiu_es.pdf

Agencia de Residuos de Catalunya. (2018). Obtenido de http://estadistiques.arc.cat/ARC/#

Agencia de Residuos de Catalunya. (2021). Obtenido de http://estadistiques.arc.cat/ARC/#

Ajuntament Les Masies de Roda. (2023). *Ajuntament Les Masies de Roda*. Obtenido de https://www.lesmasiesderoda.cat/

Ayuntamiento de Vic. (2020). *Memoria de Resultados de la recogida de residuos en Vic.* Vic.

Ayuntamiento de Vic. (2023). Obtenido de https://www.vic.cat

Beta, C. t. (2019). *GASEOUS COMPOUNDS SAMPLING PROCEDURE IN REACTOR.* Vic,Barcelona.

Comune di Potenza. (2018 - a). Delibera di Consiglio n. 7 del 26/02/2018. *Piano Finanziario Tassa Rifiuti*.

El orden mundial. (2021). *EOM*. Obtenido de https://elordenmundial.com/mapas-y-graficos/mapa-politico-italia/

Enquiol. (2019). *Curso de formación en olfatometría.* Vic,Barcelona.

European Enrionment Agency. (2016). *Municipal waste mangement.*

Eurostat. (08 de 02 de 2021). *Eurostat*. Obtenido de http://appsso.eurostat.ec.europa.eu/nui/submitViewTableAction.do

Giunta, Regione Basilicata. (2011). Deliberazione N° 1150 del 28/07/2011. *Giudizio Favorevole di Compatibilità ambientale ed aggiornamento dell'AIA, relativamente alla "Piattaforma integrata per lo smaltimento dei rifiuti non pericolosi sita in località Cafaro nel comune di Atella (PZ)"*.

González, D. (2019). *Study on the gaseous emissions during the biological treatment of sewage sludge Characterization of VOCs and odour emissions.* Barcelona.

I.Stat. (2023). *I.Stat*. Obtenido de http://dati.istat.it/Index.aspx?DataSetCode=DCIS_POPRES1#

Instituto Cartográfico de Catalunya. (2022). Obtenido de https://geografiabatxillerat.wordpress.com/material-addicional/mapa-de-comarques-de-catalunya/

ISPRA. (2019). *Rapporto Rifiuti Urbani.*

Istituto Superiore per la protezione e la ricerca ambientale. (2023). Obtenido de % of landfilled waste without pre-treatment in the Italian Regions

Ministerio para la transición ecológica y el reto demográfico. (2018). *Memoria anual de generación y gestión de residuos de competencia municipal .*

Ontheworldmap. (2023). *Ontheworldmap*. Obtenido de https://ontheworldmap.com/palestine/

UNEP/SETAC. (2009). *Life Cycle Assesment (S-LCA) supplement the Guidelines for Social Life Cycle Assesmente of Products .*

UVIC-Centro Tecnológico Beta. (s.f.). *Linea Base Escenario España.* 2020.

Vermican. (2020). Obtenido de https://ecompostaje.com/

Wikipedia. (2023). Obtenido de https://es.wikipedia.org/wiki/Osona


ENI
CBCMED
Cooperating across borders
in the Mediterranean


Project funded by the
EUROPEAN UNION


REGIONE AUTÒNOMA DE SARDIGNA
REGIONE AUTONOMA DELLA SARDEGNA


DECOST