



# WASTE MANAGEMENT CATALOGUE

This catalogue aims to provide an overview of successful practices, solutions and approaches in waste separation, collection, treatment, and recycling in the Mediterranean. It also highlights the lessons-learned that should be considered when replicating successes and avoiding pitfalls.

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# Thematic Categories

The different projects that are presented in this document have been classified according to the following themes based on their area of work and focus. In this catalogue, the different thematic categories on waste management are portrayed as the below symbols:



Integrated Municipal Waste Management Plans  
(MED-InA, CLIMA)



Innovative Sustainable Technologies  
(CEOMED, CLIMA)



Green skills & Capacity Building  
(MED-InA, REUSEMED, CLIMA, DECOST)



Treatment of Organic Waste/Composting  
(CEOMED, REUSEMED, CLIMA, DECOST)



Digitalization of the Waste Management Sector  
(CEOMED, REUSEMED)



Guidelines and good practices  
(MED-InA, REUSEMED)

## INTRODUCTION

### Mediterranean Dialogue for Waste Management Governance (Med4Waste)

Med4Waste is a project funded by the European Union under the ENICBC Med programme. It falls under priority B.4.2 “Reduce municipal waste generation and promote source separated collection and the optimal exploitation of its organic component.”

The project consortium is led by the Beta Technological Center at the University of Vic (Spain) and is made from 6 other project partners; MedCities (Spain), Mediterranean Information Office for the Environment Culture and Sustainable Development (Greece), BusinessMed (Tunisia), the Environment and Sustainable development unit at the American University of Beirut (Lebanon), EDAMA (Jordan) and COSPE (Italy).

Med4waste’s aim is to facilitate new governance models for integrated and efficient urban waste management policies across the Mediterranean, with particular emphasis on organic waste and circular economy. This is done by capitalizing on other ENI CBC Med projects that fall under the priority B.4.2. The Union for the Mediterranean (UfM) supports the development and implementation of this project within the 2030 GreenerMed Agenda.

### Aim of the catalogue

This catalogue’s purpose is to give waste management experts and decision makers an overview of the most promising achievements of the capitalized projects that are worth replicating in the Mediterranean region, and beyond. It describes their implemented activities while highlighting success stories and lessons learnt. It also analyses the enabling factors to ensure proper transferability of the identified outputs.

### Structure

In this catalogue, the outputs of each project that need to be replicated are categorized into different themes, as mentioned above. This catalogue follows a chapter-basis format; each project has a specific chapter dedicated to it. This introductory chapter describes the

Med4waste project and the applied methodology to collect the information. The following chapters are dedicated to the aim of each project, its achievements, outputs' risks, and recommendations. The catalogue closes with a summary of all identified achievements, successes, challenges, and recommendations. All chapters were developed by AUB, with the exception DECOST which was written by COSPE.

### Methodology for the collection of information

The five selected projects for the capitalization process, are the following:

- 1) CEOMED, Employing circular economy approach for OFMSW management
- 2) MED-InA, A Mediterranean Integrated Alliance on Waste for cities and citizens
- 3) REUSEMED, Mediterranean Basin Reuses
- 4) CLIMA, Cleaning Innovative Mediterranean Action
- 5) DECOST, Decentralised Composting in Small Towns

To gather all the necessary information two types of questionnaires were developed; a general and a more specific one. The general consisted of five sections: 1) General information, 2) Macro-Activities, 3) Success Stories, 4) Outputs and 5) Transferability and Replicability, and was disseminated using the KOBO toolbox platform. The latter was developed based on the responses of the general questionnaire. Bilateral meetings were then held with all five projects in order to interview them and get their insights in a more detailed manner. The interviews were conducted by waste management experts from AUB and COSPE. AUB was responsible for the communication with CEOMED, REUSEMED and MED-InA while COSPE led CLIMA's and DECOST's. The Med4Waste team consulted open sources and used the information collected during the project's meetings and events to enrich and verify the catalogue.



<https://www.enicbcmmed.eu/projects/ceomed>

### **Employing circular economy approach for organic fraction of municipal solid waste management within the Mediterranean countries**

Local open markets are a staple of Mediterranean communities with hundreds distributed across the region. Local open market waste management represents a big challenge for the region and is directly linked to population growth, urbanization, and tourism. In view of the large influx of inhabitants expected in urban areas (72% of the population of the Mediterranean region will probably be living in urban areas in 2025) and the variations in waste flow rates in the open markets of Tunisia and Jordan (rates vary from 3 to 5 and 10 to 12 tons per day respectively), the sustainable management of waste in food markets is now, more than ever, a priority. CEOMED aims to reduce municipal waste generation, promote source-separated collection and the optimal exploitation of the organic component by recovering energy and recycling nutrients. An additional core objective of the project is to increase knowledge capacity of local stakeholders, i.e., consumers, sellers, the informal sector of waste collecting, scholars, farmers, technical and administrative staff, through trainings to make sure they have the right skills to contribute to improved waste management. CEOMED was implemented in five countries and by six partners: Democritus University of Thrace - Department of Environmental Engineering (Greece), Optimization oriented towards

sustainability and Spanish National Research Council (Spain), University of Naples Federico II (Italy), The University of Jordan (Jordan), and Centre of Biotechnology of Sfax (Tunisia) from 2019 till 2023 with a budget of € 1,887,741,19.

Project partners of the CEOMED project



## OBJECTIVES

To develop solutions for the separated collection and valorisation of the organic waste component that are specifically tailored to the needs of open markets in the Mediterranean region.

## WHAT WILL BE IMPROVED?

- ♻️ Design of new waste management plans for the cities of Amman and Sfax which focus and address separately the waste produced from fruits and vegetables in wholesale markets.
- ♻️ Following a circular approach, the organic fraction of waste from the markets was treated by a biological process (anaerobic digestion) using the digestate (the fertilizer output of anaerobic digestion) as a fertilizer in the farms that provide fresh products to the local markets.

## WHO WILL BENEFIT?

- ♻️ Managers of local markets.
- ♻️ Businesses using the markets daily to buy and sell fresh products.
- ♻️ Daily customers.
- ♻️ Technical and administrative staff from the municipalities of Amman and Sfax.
- ♻️ Local farmers.

## ACHIEVEMENTS

### PILOTING NEW TECHNOLOGY



During the first period of implementation, the three European partners of the project tested different types of anaerobic digestion.

Within the framework of CEOMED, the research partner has conducted a research to optimize the anaerobic digestion process to the waste characterization present in open-air markets by using biochemical methane potential (BMP) tests and lab-scale reactors. In Spain, one-step digestion (process that breaks down organic matter into biogas and digestate in a single tank) was tested, in Italy two-step digestion (process that breaks down organic matter into biogas and digestate in two separate tanks) was tested while in Greece dry fermentation (process that breaks down organic matter into biogas and digestate in a single tank, but without the addition of water) was tested. All three processes reduce food waste by breaking down organic matter into biogas and digestate, which can be used as a fertilizer or energy source.

The piloted technologies offer the opportunity to optimize the anaerobic digestion process and to build a virtual twin with all the technologies. This would give the stakeholders the possibility to design their own pilot plan according to the waste characterization and the three types of technologies.

### DEVELOPING GUIDELINES FOR MARKET WASTE VALORIZATION



Based on interviews with the community of open markets to ensure there is a common understanding on the problem and receive their support, a guideline document for implementing separate waste collection and valorising organic waste in both markets was developed. The guideline includes information on collecting the organic fraction of the waste separately, processing the organic fraction through anaerobic digestion, transporting the treated waste to generate energy (biogas) and fertilizers, and using the biogas and fertilizers to grow the fruit and vegetable crops sold in the markets.

### DEVELOPING A DIGITAL TWIN OF PILOTED TECHNOLOGIES



A digital twin of the piloted anaerobic digestion technologies will be hosted in a website in English, French, and Arabic adapted for mobile use. The digital twin platform will allow stakeholders to design their own pilot plan according to the waste characterization and according to two types of technologies: one-step anaerobic digestion, and two-step anaerobic digestion simulate the process and provide data about the amount of waste that can be valorised using a particular technology, the size of the pilot needed, and the quantity of biogas and fertilizer that can be produced.

Additionally, it will also include a calculator that helps farmers determine how much digestate to use on their crops. The process takes into consideration the type of crop, the size of the farm, and the amount of biogas and fertilizer that will be produced.

## CHALLENGES AND RECOMMENDATIONS

### ADMINISTRATIVE AND BUREAUCRATIC ISSUES

The main administrative and bureaucratic issue encountered were related to obtaining the necessary permits and approvals from the local governments for every step of the project that had to be followed, which resulted in delays in the planned project activities. In response, the team arranged weekly or bi-weekly meetings to gather the required information as soon as possible.

Additionally, the team had to meet representatives of local governments to ensure that the project would be implemented in accordance with the local regulations and laws.

### INABILITY TO FIND CONTRACTORS

The administrative and bureaucratic challenges were exacerbated by the COVID-19 pandemic. The team had to delay the pilot tests and the eventual implementation of the project in the two cities. Eventually, and due to the prevailing circumstances of the pandemic, the team was not able to find a contractor to build the pilot plants in the two cities. As it was not possible to build the pilot plants, an integral part of the outcomes, the team had to rethink their approach to successfully complete the project within the available time frame.

After negotiations, the redesigned project developed new activities, such as midscale pilot plant experimentation, info days, training days, and awareness campaigns, and digital tools to account for the changing regulations and restrictions due to the pandemic.

### ENGAGING WITH THE MUNICIPALITIES

The team held several events with the municipalities and Ministers of Agriculture to confirm their commitment to the implementation of the pilot plants. This effort should be facilitated in order not to lose momentum and be able to implement the pilots at the needed scale for future interventions.

### SEEKING FURTHER FUNDING

Similarly, the local partners should be supported in their efforts to pursue additional funding schemes to sustain the pilot plants and develop new ones based on the findings of the lab-scale and midscale experiments conducted in this project.



<https://www.enicbcmed.eu/projects/med-ina>

## **A Mediterranean Integrated Alliance on Waste for cities and citizens**

The main aim of the MED-InA project is to promote the Zero Waste approach. The latter is an approach that falls under the circular economy scope and is defined as *“the conservation of all resources by means of responsible production, consumption, reuse and recovery of products, packaging and materials without burning and with no discharges to land, water or air that threaten the environment or human health”*, by the Zero Waste International Alliance.

MED-InA was implemented in five countries and seven partners: France (E3D-Environment and AVITEM), Jordan (Greater Irbid municipality and Jordan University of Science and Technology), Tunisia (municipality of La Marsa), Spain (Ribera Consortium – Sustainable energy department) and Lebanon (American University of Beirut) from 2019 till 2023 and a budget of € 2,381,221,51.

To implement this approach, MED-InA addressed three main levels.

-At the public level, capacity building sessions, knowledge exchange and mentorship were provided to municipal staff which assist them in their efforts to develop zero-waste

integrated solid waste management plans. At the private level, innovation was supported through the incubation of 12 groups of entrepreneurs. At the individual level, the adopted GD6D behavioral approach – which aims at changing habits towards more sustainable behaviors by targeting behavioral sciences, digital and human interaction – deemed successful in contributing to reducing waste generation in 6,000 households.

Overall, the project will place the citizens at the heart of the process and will strongly value a “low tech-low cost” approach by promoting in the South countries of the Mediterranean and reintegrating in the North traditional practices that generate little quantity of waste.

Replicable Outputs identified through the Med4Waste mapping exercise include:

- 1) Developing policy guidelines: They are based on the MED-InA experience throughout the project and will serve as a starting point for the development of efficient waste management strategies. It is good to note that these recommendations are general and need to be adapted to each local context. In order to assure their success, governmental support within the implementation and monitoring phases is a necessary precondition.
- 2) Developing the MED-InA Zero Waste catalogue: An analysis of waste generation and management in the Mediterranean region was first introduced. Following, a three-phase recommendation was set for the effective design of a solid waste management plan.

It consists of:

- 1) capturing and analyzing the most updated local waste management data through 10 thematic questions,
- 2) engaging the community to ensure they feel part of the zero-waste journey and
- 3) setting quantitative goals in the short, mid and long term.

Project partners of the MED-InA project:



## OBJECTIVES

To develop and roll out a methodology for a “Zero Waste” policies that fosters citizen-centered waste reduction, reuse, and recycling in Mediterranean cities.

### WHAT WILL BE IMPROVED?

- ♻ Transform municipalities waste management practices from “*treating always more waste*” to “*treating less by preventing waste*” by focusing on citizen behaviour change
- ♻ Through a dedicated coaching service, massive door-to-door campaigns and regular phone/email contacts, allowing this way a direct connection with citizens and local businesses to support them in reducing the production of waste that cannot be recycled or reused.
- ♻ Testing pilots in selected neighbourhoods of La Marsa (Tunisia), Irbid (Jordan) and Ribera (Spain).
- ♻ Work is linked to concrete updates of Municipal Waste Management Plans and support innovative circular economy businesses to act at a multi-level stage and create synergies.

### WHO WILL BENEFIT?

- ♻ Municipal representatives/staff.
- ♻ Regional and national authorities in charge of waste management.
- ♻ Households of La Marsa (Tunisia), Irbid (Jordan) and Ribera (Spain).

## ACHIEVEMENTS

### ZERO WASTE GUIDEBOOK



The guidebook is designed by experts of Zero Waste Europe and adapted to the context of Mediterranean cities. It presents the Zero Waste approach including an overview of the context of waste management in the Mediterranean, and case studies in Mediterranean municipalities.

In its second part, the guide lists 10 fields of questions that should enable decision-makers to identify their needs, before providing specific tools and steps to follow to set up an adapted zero waste strategy. It is available in French, English, Arabic and Spanish.

### DEVELOPING INTEGRATED MUNICIPAL WASTE MANAGEMENT PLANS



The Jordan University of Sciences and Technology (JUST) is helping municipalities in Jordan to develop Integrated Municipal Waste Management Plans (ISWMPs), it coordinates the synergies between the three municipalities, as well as the scientific follow-up, monitoring, and evaluation. These plans include solutions for organic and plastic waste sorting and treatment, such as separate collection of organic waste (food and green waste) to be composted, and collection of plastic packaging waste.

Additionally, the plans involve initiatives to reduce waste and waste prevention measures when organizing local public events.

The plans also include setting up the polluter pays principle, placing adapted types of

bins in public spaces, increasing the frequency of collection of plastic packaging, and involving schools and other educational centers to tackle the current waste generation issue.

## IMPLEMENTING CAPACITY-BUILDING PLANS AND TRAINING PROGRAMS FOR MUNICIPAL STAFF



The MED-InA project is providing capacity-building plans and training programs for municipal staffs and elected members to help them shift the paradigm towards a zero waste approach.

This scheme included workshops and study visits in early 2020, mentoring sessions and field visits in late 2022 and early 2023, and a monitoring and evaluation plan designed by the Jordan University of Science and Technology (JUST) to measure progress. In 2020, two separate capacity-building sessions were held for the municipal staff of partner municipalities focusing on good practices from cities on waste reduction.

## INNOVATIVE AWARENESS RAISING



The project implemented a social approach based on a methodology developed, named GD6D, to induce a change in citizens' behaviour as well as raise their awareness through Zero waste challenges and programmes.

The GD6D methodology combines three elements: behavioural sciences, digital tools, and human interaction, to help people change their habits towards more sustainable behaviours. It works by sending ambassadors to neighbourhoods to conduct interviews and invite people to commit to 3 actions adapted to their level of commitment. Field diagnoses were conducted to determine the urban characteristics, pre-diagnosis on local waste management, and cultural questions to determine which levers of change to use. Through this process, citizens are provided with individual support to help them witness the impact of their actions at the city level. The Italian Zero Waste Champion City Capannori, was able to reduce the average amount of residual waste from zero waste challenge families to just 3.8 kg per person per year, compared to the average of 88 kg. Inspired by this success, a Zero Waste challenge was recommended by the project as another novel method of awareness raising. The Zero Waste challenge is designed to promote responsible consumption patterns by supporting citizens in reducing their household waste. Families participating in the challenge are usually equipped with zero waste reusables and are guided by zero waste experts.

## SUPPORTING CIRCULAR ECONOMY STARTUPS



The MED-InA project selected three incubators in Jordan, Spain, and Tunisia to receive a sub-grant. These incubators then selected twelve circular economy projects to develop and deploy innovative waste management services and products.

The AUB team provided coaching actions to awarded projects in Jordan, Spain, and Tunisia that included vermicompost, energy recovery equipment, recycled materials, and hydroponic solutions. The MED-InA project has provided an opportunity for these twelve projects to develop and deploy innovative waste management services and products centered around circular economy in each territory.

## CHALLENGES AND RECOMMENDATIONS

### COORDINATION AND COMPLEMENTARITY

The lack of coordination and complementarity between public, private and citizen actions can be a major risk for any project. Without proper coordination, the different actions may not be able to work together to create a multiplier effect, and the project may not be able to reach its goals.

To mitigate these issues, the project has tried to work on creating ties of cooperation and that the right participatory processes are in place to involve all relevant public and private stakeholders.

### FACILITATE DATA COLLECTION

The risk in not pursuing the collection of supporting data is that it might negatively affect the ownership of the policy guidelines produced in the framework of the project. Additionally, the project may not have enough evidence to back up its claims and conclusions. Without the data, it will be difficult to prove the effectiveness of the project and its impact on waste management practices.



<https://www.enicbcmmed.eu/projects/reusemed>

## **Mediterranean Basin Reuses**

The REUSEMED project's aim is to promote the "reuse" culture in the Mediterranean region. This is done through the integration of reuse circuits within municipal strategies through composting facilities, food collection points and repair and reuse centers, among other initiatives. This promotes the shift of the local economy from a "take-make-dispose" approach to a more circular one.

REUSEMED was implemented in four countries and with eight partners: Spain (Saneamientos de Cordoba S.A. and Asociacion Nacional de Empresas Publicas de Medio Ambiente) Jordan (Ministry of Local Administration and Deir Allaa Municipality), Tunisia (Sakiet Ezzit Municipality and Agence Nationale de Gestion des Dechets), and Italy (Comune di Capannori and Fondazione Reggio Children – Centro Loris Malaguzzi) from 2020 till 2023 with a budget of € 3,281,432.27.

Replicable Outputs identified through the Med4Waste mapping exercise include:  
1) The creation of Reuse circuits: Reuse Circuits are designed following the circular

economy methodology. They consist of cycle masterplans designed to reuse the different solid waste components including home appliances, furniture, books, clothes, waste electrical and electronic equipment and food. On the mid-term, these circuits are expected to become self-sustained. Tailoring the circuits to fit the local needs is an important precondition in order to achieve maximum efficiency and public acceptance.

2) The creation of the Reuse centers: These centers are key parts of the reuse circuits. They consist of stations where unwanted material is made available for further use.

3) The development of a mobile application: An application is being created in order to facilitate the flow of the reuse circuits. Through it, users are able to find what products are available to be reused. It will also facilitate the collection process of unwanted items. In terms of collection, two methodologies are being adopted: 1) a door-to-door collection and 2) municipal collection. The former is more complex. It will be managed by a subcontractor chosen and monitored by the municipality.

REUSEMED has been working closely cross-fertilizing with 2Lifes, a project under the Interreg Europe programme aiming at implementing reuse activities at the public sector's level. This knowledge exchange revolving around circular economy, among others, has helped them increase the project's success and contributed to several outputs such as the mobile application development. Given involvement of local stakeholder organizations, it is expected that the reuse networks can become self-sustainable in the mid-term, when revenues out of the sales of repaired products can finance the human resources and the maintenance of the infrastructures.

Project partners of the RESUEMED project:



## OBJECTIVE

To contribute to the environmental protection of the Mediterranean region through the reduction of all fractions of municipal waste, via reuse networks, inducing behavioral changes in regards to unsustainable consumption patterns and improved waste management policies.

## WHAT WILL BE IMPROVED?

- ♻️ Mutual learning and improvement of local waste management plans through capacity-building around reuse. Reinforcement of the technical and operational capacities of partner municipalities and stakeholders, improve citizens' awareness about unsustainable consumption.
- ♻️ Creation of new green jobs and increase of local employment thanks to the implemented trainings on repair, reuse and composting delivered during the project.
- ♻️ Enhancement of residents' skill in terms of individual and community composting.

## WHO WILL BENEFIT?

- ♻️ Residents and visitors.
- ♻️ District associations.
- ♻️ Local businesses, markets, and hotels.
- ♻️ NGOs and associations.
- ♻️ Public authorities in charge of waste management in the partner cities.

## ACHIEVEMENTS

### MAPPING OF RESOURCES FOR REUSE

The mapping process of resources for reuse involved identifying existing second-hand resources. The partners of the project contacted other companies and had an initial database based on previous initiatives.

4 maps were produced for Cordoba (Spain), Capannori (Italy), Deir Alla (Jordan), and Sfax (Tunisia).

Mapping focused on identifying entities that already deal with the sale, rental, loaning, and exchange of books, cloths, small and large appliances, tools, and furniture.

The mapping spanned public, private, and not-for-profit sector.

### IMPROVING THE UNDERSTANDING OF THE BARRIERS TO REUSE

The "Barriers for Reuse" survey was conducted among the partner countries of the project to identify barriers to reuse in the 4 pilot cities. It included questions about cultural and behavioral aspects and was used to inform the design of an mobile application and to promote reuse in the municipalities.

The survey results showed that 97% of the respondents in Jordan and Tunisia wanted to promote the reuse sector in their city and would make use of the means and infrastructures available for this purpose. In Cordoba, most residents were not familiar with the term "circular economy" and the "3Rs" while in Capannori, 56% of respondents wanted more infrastructure, stores, and reuse centres in their locality, while 73% of those

surveyed had acquired some second-hand item in the past.



## DEVELOPMENT OF REUSE CIRCUITS AND SUPPORTING INFRASTRUCTURE

A reuse circuit is a municipal network based on reuse for home appliances, furniture, books, clothes, e-waste, and food. It includes composting installations, food collection points in markets, repair and reuse centres, reuse corners in shops and repairing cafes. It aims to help develop a new system of waste management by promoting the culture of reuse for environmental sustainability, green employment, and solidarity.

The project developed reuse circuits in four cities across Europe and the Middle East: Cordoba (Spain), Capanori (Italy), Deir Alla (Jordan) and Sfax (Tunisia). These 4 cities designed and tested composting installations, food collection points in markets, repair and reuse centres, reuse corners in shops and repairing cafés.



## COMPILATION OF GOOD REUSE PRACTICES

The guide of good practices aims to promote the reuse culture. The guide includes 15 good practices identified by entities from the four countries involved in the project. These practices present reuse or preparation for reuse projects involving public-private collaboration.

Some examples of the practices include a second-hand textbook market in Italy, a Jordanian project to reuse wool yarns to produce new garments, a project in Spain to identify municipal networks to give a second life to old clothes, a project in Tunisia to promote the reduction of organic waste at household level, and a project in Italy to highlight Daccapo, a public-private partnership that reuses more than 50 tons of clothing, furniture and other goods per year.



## ENHANCING DIGITALISATION TO CONNECT USERS OF THE REUSE CIRCUITS

A mobile application was developed by the project and is designed to interconnect users and managers of the different reuse circuits in Spain, Italy, Jordan, and Tunisia.

The mobile application will have three main modes:

♻️ one to collect goods that are no longer wanted by citizens.

♻️ one for door-to-door collection.

♻️ and one for collection in a project or municipal infrastructure.

It will also have a model to show the map of resources for reuse in every city.

## CHALLENGES AND RECOMMENDATIONS

### ABSENCE OF AN EFFECTIVE LEGAL FRAMEWORK

To integrate reuse into existing waste management plans, the project partners are working on revising local national and sub-national legislation to include details about reuse. They are also trying to revise existing plans in the system to see what can be implemented or achieved at the local policy level.

However, it is complex in areas that don't have any regulations, so the project partners are working on a plan to advocate for new regulations.

## SMALL MARKET FOR REUSE

Recovering products can be a challenge if there is no way to dispatch them. Without an outlet, it can be difficult to find a target to give them the recovered items. This would create a mentality concerning such items being not good enough. To break this cycle, awareness campaigns are needed to reach people who are interested in the cause.

## CLIMA



<https://www.enicbcmmed.eu/projects/clima>

### **Cleaning Innovative Mediterranean Action: reducing waste to boost economies**

The CLIMA project aims at mitigating the poor management of organic waste in the Mediterranean region, hence attenuating the environmental, economic and social impact caused by this ongoing challenge. An effective way to counteract this, is by developing public policy tools such as integrated municipal waste management plans. CLIMA works on three main axes: supporting municipalities, promoting small businesses and raising awareness at the citizen level to promote the “zero waste” culture.

The project was implemented in three countries and with six partners: Italy (Municipality of Sestri Levante and Cooperation for the Development of Emerging Countries), Tunisia (Tunis International Centre for Environmental

Technologies and Municipality of Mahdia) and Lebanon (ARCENCIEL, and Municipalities of Bikfaya and Tanaayel) from 2019 till 2023 with a budget of € 2,836,741.72.

Replicable Outputs identified through the Med4Waste mapping exercise include:

- 1) Setting an Integrated Municipal Waste Management Plan: It is a participatory process that aims at creating efficient municipal solid waste management plans by taking into consideration the main challenges faced by citizens, experts and key stakeholders.
- 2) Pay-as-you-throw Tax: It is a fiscal system that serves to incentivise waste sorting by charging the tax rate based on the quantity of waste sorted by each household. This methodology supports environmental and economic sustainability as well as equity.

### ♻️ Mapping of preliminary stakeholders

Through the project, around 80,000 citizens in 3 municipalities will benefit from the reduction of waste production due to the increase of treated organic waste.

Project partners of the CLIMA project



## OBJECTIVE

To upgrade the waste cycle management in pilot municipal areas of Italy, Lebanon and Tunisia with increased sorting and economic valorisation of the organic component as secondary raw material.

## WHAT WILL BE IMPROVED?

- ♻️ Defining a multiannual strategy at the municipal level.
- ♻️ Fostering cross-border exchanges of experiences.
- ♻️ Transfer of innovation in treating and recovering high quality organic component
- ♻️ Positively impact the 3 targeted territories: Reducing the risk of unsafe or illegal disposal of waste.
- ♻️ Creating new opportunities for businesses using organic waste as secondary raw material.

## WHO WILL BENEFIT?

- ♻️ Institutions and local authorities directly involved in the realisation of the project activities.
- ♻️ Firms and economic actors interested in affordable supply of high quality secondary raw materials.
- ♻️ People among citizens and decision-makers aware on the necessity of a circular and sustainable waste collection and management.
- ♻️ Partners' staff experts benefiting from technical trainings and exchange visits.
- ♻️ Citizens and key stakeholders reached by the regional education and awareness-raising campaigns at the Mediterranean level.

## ACHIEVEMENTS

### SUPPORTING A PAY-AS-YOU-THROW POLICY



The Pay-As-You-Throw system (PAYT) is a way of using the “polluter pays” principle at the municipal level.

It has been proved as an effective policy for reducing the amount of residual waste and increase the amount of recycled waste. The technical implementation of PAYT involves identifying the waste generator, measuring the amount of waste to be treated, and charging a unit price per kg.

The project supported the piloting of this initiative, bringing a complete change of the waste management plan in Sestri Levante. It is now at the testing phase, after a one-and-a-half-year study conducted by an external agency.

### DEVELOPING INTEGRATED MUNICIPAL WASTE MANAGEMENT PLANS



At the international forum hosted by CLIMA in January 2021, one of the primary objectives was to obtain feedback and suggestions regarding the assessment of the Municipal Waste Management Plans of the three municipalities involved in the project.

The partners took advantage of the opportunity to compare the advantages, disadvantages, and possibilities associated with the MWMPs by reviewing feedback from the three separate forums held in Italy, Tunisia, and Lebanon.

Now municipal waste management plans are in place in all three countries. Regarding Bikfaya (Lebanon), its MWMP was the first one drafted for the municipality, while for the other two it was upgraded the already existing plan.

### INNOVATIVE COMPOSTING TECHNOLOGIES



The compost membrane technology is composed of three layers that cover the collected organic waste and green leaves, allowing for decomposition while retaining odours, germs and dust and preventing rainwater penetration.

This technology is piloted in the compost site in Bickfaya and can provide a solution to the organic waste management of the 6,000 citizens of Bickfaya and the 4 surrounding villages and can facilitate the production of up to 450 tons per year of good fertiliser to sell to the market.

The pilot compost site implemented in Mahdia (Tunisia) can support organic waste management and have an impact on the waste management of the city and in particular. The pilot neighborhood of Jbel Dar Weja, benefits of the pilot initiative of separated waste collection not only for the organic part, but also plastic and aluminium. In parallel, the Centre International des Technologies et de l'Environnement de Tunis (CITET) has been conducting experiments for a vermicomposting unit which will be also piloted in the Mahdia municipal composting site.

### SUPPORTING SOCIAL ENTERPRISES

The project has allocated funds to promote circular economy initiatives, by awarding grants of up to 5,000€ to green social enterprises. All in all, the project awarded 9 green SMEs and 1 association. The initiative will also provide access to expert technical support and mentoring, helping to increase the capability of start-ups and businesses.

## CHALLENGES AND RECOMMENDATIONS

### LOGISTICAL AND SUPPLY ISSUES

Despite some initial challenges, CLIMA was able to successfully tackle several challenges in Tunisia and finally both municipalities officially select the location for the compost site and identify a company able to terminate the site construction works within the limited budget foreseen for this activity. However, through the support of all partners, including a financial contribution by the municipality, the activity was able to move forward. The fuel and energy crisis in Lebanon has posed a major challenge, preventing experts from travelling to the sites and hindering the proper operation of the blowers, pumps, and sensors. A budget reallocation allowed the purchase of two solar panel systems, allowing for a more sustainable operation of the 2 facilities.



<https://www.enicbcmmed.eu/projects/decost>

### **Decentralized Composting in Small Towns**

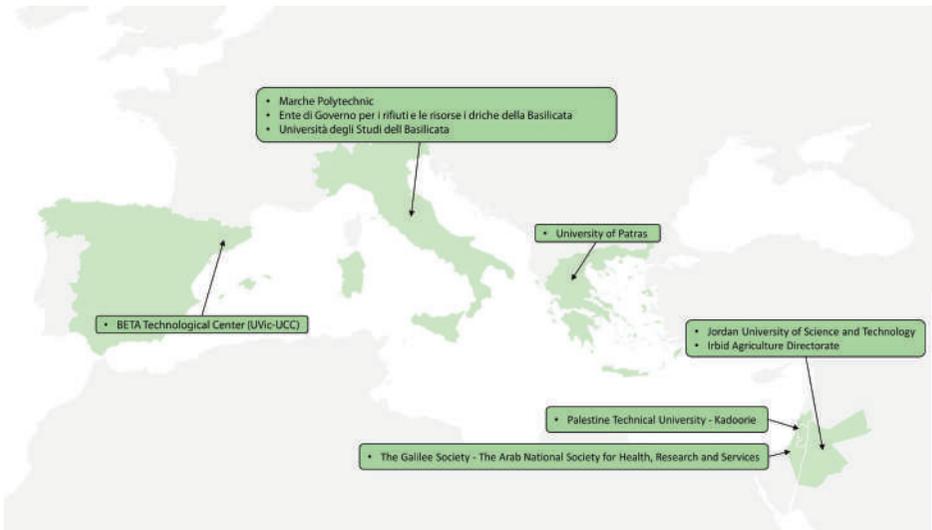
The DECOST project aims to develop new frameworks of waste management, building a closed-loop system of organic waste valorization, reducing food waste by integrating decentralized home and community composting systems in urban areas. The project supports circular economy initiatives using a people-centered approach by strengthening the civil society and increase the capacity of institutions to achieve its objectives

DECOST was implemented in 6 countries with 9 partners: Spain (Fundació Universitària Balmes), Italy (Polytechnic University of Marche, Ente di Governo per i Rifiuti e le Risorse Idriche della Basilicata, University of Basilicata), Palestine (Palestine Technical University – Kadoorie), Jordan (Irbid Agriculture Directorate, Jordan University of Science and Technology), Israel (The Galilee Society, Institute of Applied Research) and Greece (University of Patras) from 2019 till 2023 with a budget of € 3,011,231.44.

## Replicable Outputs identified through the Med4Waste mapping exercise include:

- 1) The creation of a functional and externalized waste management system mixing municipality composting and door-to-door collecting system, capable of managing 100% of the organic matter of the town involved, representing an effective alternative to the centralized waste treatment, efficient in terms of economic and technical performance.
- 2) Parallel outputs represented by (i) the development of a techno-economic assessment to foster the long-term economic viability of the recycling system developed; (ii) creation of waste management guidelines and (iii) creation of a web and smartphone applications allowing citizens to monitor their environmental performance in terms of waste sorting and recycling.

Project partners of the DECOST project



## OBJECTIVE

To develop a new framework of waste management, building a closed-loop system of organic waste valorisation, integrating decentralised home and community composting systems with urban agriculture.

## WHAT WILL BE IMPROVED?

Besides diverting a significant amount of organic waste from being disposed of in landfills, the DECOST project will foster food security and accessibility thanks to the support of urban agriculture initiatives. Citizens, especially children, and households, will be encouraged to adopt sustainable behaviors through IT tools and big data analysis.

## WHO WILL BENEFIT?

-  Managers and technical staff of the municipalities involved in Jordan, Israel, Palestine, Italy, and Spain.
-  People living in the target areas/neighborhoods of the pilot municipalities, civil associations, NGOs, and waste management agencies.

## ACHIEVEMENTS

### INNOVATIVE COMPOSTING TECHNOLOGIES



The project has successfully implemented a system to manage 100% of the organic matter in the pilot town of Las Maies de Roda in Catalonia. By introducing municipality composting and combining it with the existing door-to-door collection system for packaging waste, mixed waste, glass, etc., the project was able to overcome the challenges associated with managing organic waste.

The pilot plant is now managed by the municipality, with composters being internally managed by municipal workers responsible for street cleaning and general maintenance. The integration of the new system has led to significant changes in the waste management system of the town, resulting in a recycling rate increase from 35-40% to 80% in nearby villages. This project is an excellent example of how a new, integrated approach to waste management can lead to significant improvements in recycling rates and overall sustainability.

### DEVELOPMENT OF A SMARTPHONE APP TO MONITOR CITIZENS' ENVIRONMENTAL PERFORMANCE



DECOST combined the community composting system with an IT tool called iWASTE linked to a smartphone application. The aim of the iWASTE tool is to encourage and assist users to correctly use the composting system. The DECOST iWASTE tool works as a data collection system for statistical reports, thereby increasing scientific and management knowledge. Additionally, the tool promotes citizen engagement, with a user-friendly app that reports an "Environmental score" calculated based on individual vs. community environmental performance. The app is targeted towards children and families, turning waste management into a game or family experience that encourages active participation of the civil society.

### CAPACITY BUILDING FOR MUNICIPALITY STAFF



DECOST project staff provided maintenance training to municipal technicians in the areas of implementation, which empowered them to take care of the system independently. Currently, the composters are managed internally by the municipality, with the same workers responsible for cleaning the streets and maintaining the area also managing the composting system. Through this arrangement, the municipality has been able to avoid collection costs outsourcing the system to an external company. Major events to disseminate the advantages of composting as the main method of municipal organic waste management were organized with the public administrations in the countries of implementation, where technical and practical presentation of the system adopted was given.

## DEVELOPMENT OF A TECHNO-ECONOMIC ASSESSMENT TO FOSTER LONG-TERM ECONOMIC VIABILITY OF THE SYSTEM

Instead of developing a business model, a techno-economic assessment was conducted for the DECOST project. This involved evaluating the costs of the system for the municipality and ensuring that it was within a reasonable range, comparable to the previous waste management system implemented. By managing the composters, the municipality was able to avoid collection and treatment costs, but the personnel costs were higher. Despite this, the balance is equivalent to the previous system and is feasible from a technical perspective. Additionally, the citizens are satisfied with the new system.

### SUPPORT OF CIRCULAR ECONOMY INITIATIVES



DECOST is centered on promoting a circular economy by closing the loop on organic waste and organic matter in rural towns, where residents grow vegetables and generate organic waste. Through proper management of organic waste, compost can be produced and circulated back into the gardens. This creates a self-contained and localized system where organic waste is generated, treated, and reused within the town. Although not all the organic waste comes solely from the vegetables grown in municipal households (as citizens also purchase food from supermarkets and other suppliers), DECOST has successfully established a closed circular system for organic matter at the local level.

## CHALLENGES AND RECOMMENDATIONS

### ENGAGING WITH THE MUNICIPALITIES

The DECOST project has successfully expanded beyond Catalonia by promoting community composting experiences in Palestine, Jordan, and the Italian region of Basilicata. Despite facing similar challenges, each pilot test was unique due to the diverse realities and contexts across the Mediterranean area. To provide an effective and customized response to each country, the project worked closely with local municipal administrations to design community composter systems that are tailored to the specific social and climatic conditions of each context.

At the operational level, the project team met with mayors and municipal staff to ensure the feasibility of the system from an economic perspective and to equip them with the necessary knowledge to manage the system effectively. Main findings indicate that sustainability, transferability, and replicability of the community-based composting projects require the integration of the quadruple helix of community, government, business, and technology.

The project was successful at the micro administrative level with small municipalities, receiving positive feedback from the communities and interest from the authorities in charge.

## SUMMARY SHEET

### PROJECT DESCRIPTIONS

CEOMED	CEOMED is designing new waste management plans for the cities of Amman (Jordan) and Sfax (Tunisia), focusing on the waste produced from fruits and vegetables wholesale markets. Following a circular approach, the project explored organic waste treatment by anaerobic digestion, with the digestate used as a fertilizer in local farms. The project also trained local stakeholders to ensure they had the knowledge and skills to improve waste management. This project is making its technical findings accessible through a digital twin to facilitate adoption of these technologies.
MED-InA	MED-InA aims to transform municipalities' waste management practices from "treating always more waste" to "treating less by preventing waste". To do so, the project used an innovative methodology, and testing pilots were organised in selected neighbourhoods of La Marsa (Tunisia), Irbid (Jordan) and Ribera (Spain) to show the commitments of public authorities in keeping cities clean. The Zero Waste approach was developed and rolled out as an exemplary and participatory approach for waste reduction, reuse, and recycling. It placed citizens at the heart of the process and promoted "low tech-low cost" approaches.
REUSEMED	REUSEMED promotes the culture of reuse for environmental sustainability, green employment, and solidarity in the Mediterranean area. It created municipal networks based on reuse circuits for home appliances, furniture, books, clothes, e-Waste, and food. The project reinforced the technical and operational capacities of partner municipalities and stakeholders, improve citizens' awareness about unsustainable consumption and create new green jobs.
CLIMA	CLIMA aimed to reduce environmental, economic, and social problems of organic waste mismanagement in three Mediterranean countries. It developed policy tools, innovative technical solutions and supported local businesses active in the circular economy sector. Citizens of 3 municipalities benefited from the reduction of waste production due to an increase of treated organic waste.
DECOST	DECOST's objective was to establish a new waste management framework that establishes a closed-loop system for organic waste valorization. This was to be accomplished by integrating decentralized home and community composting systems with urban agriculture, with the aim of reducing food waste. A peoplecentered approach was followed to achieve this goal, with civil society empowerment and increased institutional capacity building key factors in realizing the project.

## PROJECT ACHIEVEMENTS

<p>CEOMED</p>	<ul style="list-style-type: none"> <li> The project tested different types of anaerobic digestion to optimize the process for waste characterization present in open-air markets.</li> <li> A guideline will be developed to implement separate waste collection and valorise organic waste in markets to produce biogas and fertilizers.</li> <li> A digital twin platform will be hosted to simulate the process and provide data about the amount of waste that can be valorised in a particular technology.</li> </ul>
<p>MED-InA</p>	<ul style="list-style-type: none"> <li> Publishing the Zero Waste Guidebook to help Mediterranean cities adapt the Zero Waste approach.</li> <li> Developing Integrated Municipal Waste Management Plans for Jordan municipalities.</li> <li> Implementing capacity-building plans and training programs for municipal sta .</li> <li> Raising awareness through innovative initiatives such as the Zero Waste Challenge.</li> <li> Supporting circular economy start-ups in Jordan, Spain, and Tunisia</li> </ul>
<p>REUSEMED</p>	<ul style="list-style-type: none"> <li> Mapping of resources for reuse was conducted to identify existing second-hand resources in four cities.</li> <li> A survey was conducted to identify barriers to reuse in the four pilot cities.</li> <li> Reuse circuits were developed in four cities to promote reuse for home appliances, furniture, books, clothes, Waste Electrical &amp; Electronic Equipment, and food.</li> <li> A guide of good practices was compiled to promote the reuse culture.</li> <li> A phone app was developed to connect users and managers of the reuse circuits.</li> </ul>
<p>CLIMA</p>	<ul style="list-style-type: none"> <li> The project supported the piloting of a Pay-As-You-Throw system, reducing residual waste and increasing recycled waste.</li> <li> The Municipal Waste Management Plans of the three municipalities involved in the project were assessed and are now in various stages of completion and adoption.</li> <li> Innovative composting technologies were piloted in Bikfaya and Mahdia, capable of providing solutions to organic waste and producing good fertiliser.</li> <li> Grants were awarded to green social enterprises, providing access to expert technical support and mentoring.</li> </ul>
<p>DECOST</p>	<ul style="list-style-type: none"> <li> Four new Integrated Municipal Waste Management Plans were introduced across four different municipalities.</li> <li> The project created four composting plants.</li> <li> A smartphone application was developed to allow citizens to monitor their environmental performance in terms of waste sorting and recycling.</li> <li> Municipal staff trained.</li> <li> A business plan to foster the long-term economic viability of the recycling system was developed.</li> </ul>

## FINDINGS, RECOMMENDATIONS, PRECONDITIONS FOR SUCCESS

<p>CEOMED</p>	<ul style="list-style-type: none"> <li>♻️ Regulations: ensure that they are implemented in accordance with the local regulations and laws. Enough time should be allocated to obtain the necessary permits and approvals from the local governments to continue the project.</li> <li>♻️ Human resources: a team of experts and professionals with the necessary skills and knowledge to carry out the project activities. This includes researchers, engineers, technicians, and other personnel.</li> <li>♻️ Adequate funding: adequate funding to cover the costs of the pilot tests, the construction of waste management facilities and the development of the digital twin platform.</li> <li>♻️ Technical assistance: include components to support local partners in seeking additional funding to build pilot plants in accordance with the specific research out-puts of the project and in alignment with the recommendations of the digital twin</li> </ul>
<p>MED-InA</p>	<ul style="list-style-type: none"> <li>♻️ Adequate funding: Sufficient funding is needed to cover the costs of capacity building, training, and awareness raising.</li> <li>♻️ Coordination and complementarity: Coordination and complementarity between public, private, and citizen actions is necessary to create a multiplier effect.</li> <li>♻️ Supporting data: Supporting data must be collected to assess the impact of the policy guidelines and identify any potential issues or areas for improvement.</li> <li>♻️ Innovative awareness raising: Innovative awareness raising initiatives should be implemented to promote responsible consumption patterns and reduce household waste.</li> <li>♻️ Capacity building plans and training programs: Capacity building plans and training programs should be developed for municipal staff and elected members to help them shift the paradigm towards zero waste implementation</li> </ul>
<p>REUSEMED</p>	<ul style="list-style-type: none"> <li>♻️ Adequate funding: To ensure success, adequate funding is needed to cover the costs of mapping resources, developing the reuse circuits, creating the App, and compiling the guide of good practices.</li> <li>♻️ Human resources: A team of dedicated professionals with expertise in the Field of reuse, circular economy, and waste management is required. This team should include people with knowledge of the local context and culture, as well as people with technical and legal skills.</li> <li>♻️ Partnerships: Involving public, private, and not-for-profit sector partners is necessary to ensure success.</li> <li>♻️ Regulations: Analysis of regulations - and ideally advocacy - should be included to ensure success.</li> <li>♻️ Awareness campaigns: To break the cycle of people not wanting to use recovered items, more awareness campaigns are needed to reach people who are interested in the cause</li> </ul>

## FINDINGS, RECOMMENDATIONS, PRECONDITIONS FOR SUCCESS

CLIMA	<ul style="list-style-type: none"><li>♻️ Skilled Personnel: Access to skilled personnel is essential for successful implementation of waste management initiatives. This includes experts in waste management, engineering, and environmental sciences.</li><li>♻️ Reliable Energy Sources: Reliable energy sources are necessary for proper functioning of compost sites and other waste management initiatives. This includes access to renewable energy sources such as solar power.</li><li>♻️ Funding: Adequate funding components are necessary for successful implementation of waste management initiatives. This includes access to grants and other forms of Financial support.</li><li>♻️ Regulatory Eligibility: Ensuring regulatory eligibility is essential for successful implementation of waste management initiatives. This includes regulatory compliance with ENI CBC MED regulations and other relevant laws and regulations</li></ul>
CLIMA	<ul style="list-style-type: none"><li>♻️ To facilitate the replication of community composting initiatives across diverse regions, close collaboration with local authorities has been crucial in devising customized and effective solutions for each country and setting.</li><li>♻️ The success and replicability of community-driven composting projects hinge on the involvement of the four key stakeholders - the community, government, business, and technology - working together to ensure sustainability.</li><li>♻️ The project was successful at the micro administrative level (small communities), receiving positive feedback; at the macro governmental level, however, there was no interest from the authorities.</li></ul>



## Med4Waste

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