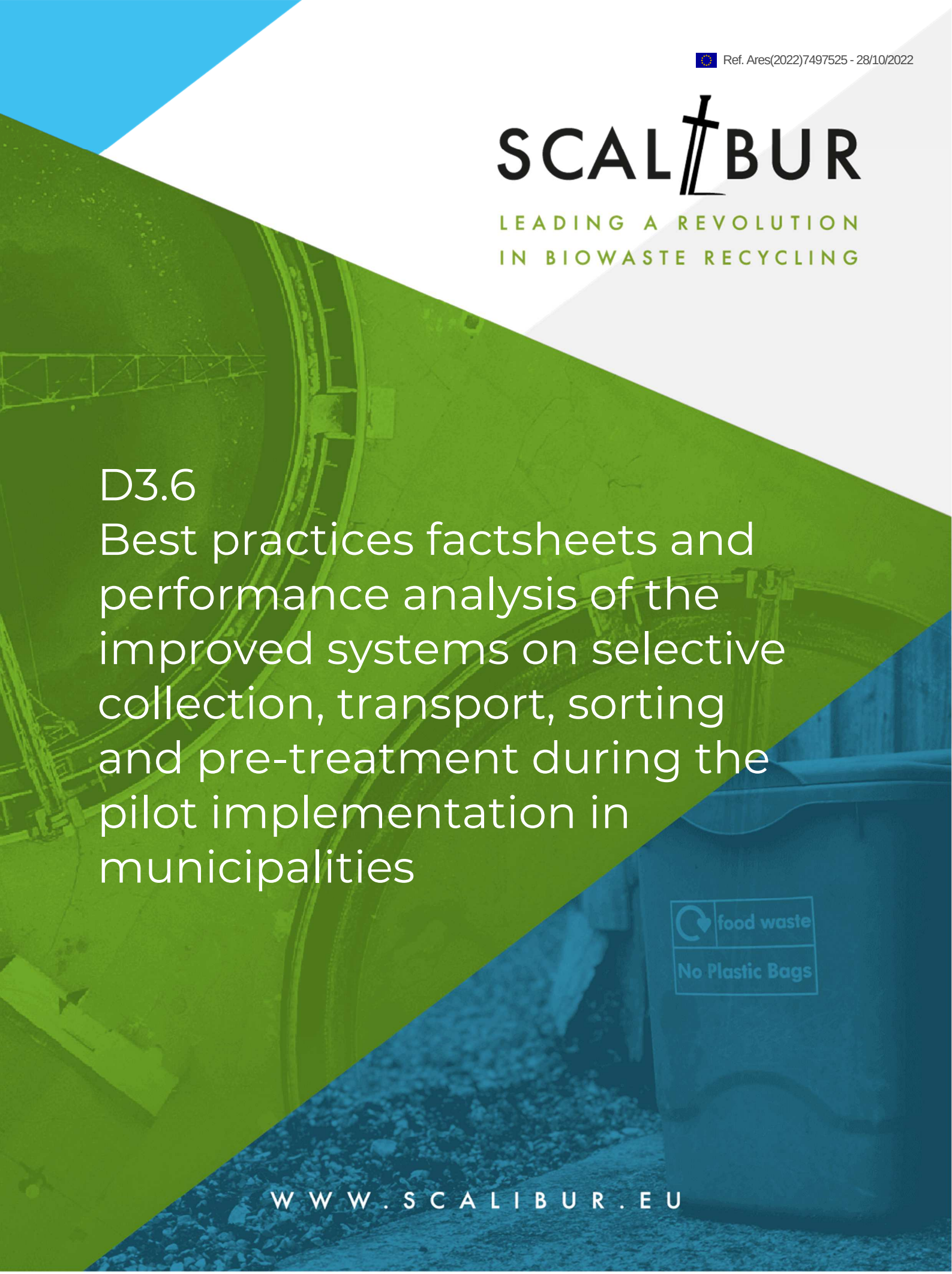
SCALIBUR

LEADING A REVOLUTION
IN BIOWASTE RECYCLING

D3.6
Best practices factsheets and performance analysis of the improved systems on selective collection, transport, sorting and pre-treatment during the pilot implementation in municipalities



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Authors	Francisco Sánchez, Juan Belda, Carla Bartolomé, Sergio Güerri, Ernesto González, Blanca Pozuelo and Noelia Millas
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ABSTRACT

The main purpose of the Deliverable 3.6 called "*Best practices factsheets and performance analysis of the improved systems on selective collection, transport, sorting and pre-treatment during the pilot implementation in municipalities*" is to identify the initiatives selected to be implemented in the pilot cities of the project, based on the analysis of the current situation, and then, to present the details and explanations of the pilot cities, of course, with some examples and the corresponding illustrative images and tables.

On the one hand, a list of best practices is analyzed with an exhaustive study, and then the selection made for the pilot municipalities is presented and justified, that is, among the list of the best practices which of them have been selected to be implemented in the current project and why this selection has been made.

On the other hand, the pilots implemented in three cities are explained with details, including initiatives related to collection, transport and characterization of waste. In each city the status before the pilots is described, with the corresponding KPIs. After that, the main results due to the SCALIBUR project are explained in the same way too. And to finish, both stages are compared to be aware of the saving in each city due to the project, for instance, CO_2, fuel, time, and distance savings are illustrated.

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CONTENTS

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PUBLISHABLE SUMMARY

The main purpose of this document is to present the selection of best practices which have been made for the current project, and then, the details of the three selected pilot cities where the SCALIBUR techniques have been implemented.

In the first part of the document, a list of best practices is explained, they have been analyzed after a study, and they are all presented with images, tables, and data about their success in some cities where they have been set up.

The second part of the document is related to the three selected cities where the pilots have been carried out. They are the following: Madrid (Spain), Kozani (Greece) and Albano Laziale (Italy).

In these three cities the summarized process has been as follows: identification of the issues to improve in each city, selection of best practices to improve in each one among the list previously explained, the planning of the pilot, and finally the implementation of the pilot in each of the cities.

In these cities, before the pilot, the route followed by trucks was not optimized neither in terms of fuel (per kilometers) nor in terms of the filled containers, that is, if a container is almost empty, the trucks stopped and collected it. The same occurred with the degradation of the waste, containers were collected regardless of if it was in its optimal point to be revalorized or not.

The novelty of the SCALIBUR project is the development and deployment of system to optimize the waste collection and transport. The system consists of IoT sensor equipment, a platform for managing the information provided by the sensors, as well as a route optimization module included in the platform.

Specifically, the sensor developed is capable of measure not only the filling level of the containers, but also the status of the matter with the gas emissions, and thus to know when the matter is in its optimal point to be revalorized into value-add goods (like fertilizers and so on). All this information is stored in the platform, allowing the generation of operational and performance reports.

As mentioned, a route optimization module has been developed too. That is, taking into account the information collected by the sensors, the collection trucks only would have to pick up the containers with the proper filling level and gas emissions. This way, cost will be reduced

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in terms of fuel consumption of collection trucks collection trucks, CO_2 emissions, collection times, kilometers done by the trucks and so on.

Finally, real examples of the SCALIBUR technologies implementation are detailed including the results obtained in each city.

To conclude, a comparison between the status of these cities before the pilots and after is done; thus, the real improvements due to the SCALIBUR technologies can be estimated.

1. INTRODUCTION

The SCALIBUR project aims at helping implement Circular Economy in the European Union. Within WP3, all the pilot actions will increase and improve the quantity and quality of urban biowaste by implementing best practices, to later characterize and pre-treat to produce high-value products in WP4-6. This will consist in optimizing collection methods of OFMSW and HORECA waste, enhancing transport and logistic operations and improving characterization processes. Hence, Deliverable 3.6 presents the best practices selected for the project and their justification, and then, the three pilot cities are presented in detail, including a deep description of the improvements that SCALIBUR technologies and developments have achieved because of their deployment.

In this regard, the implementation of waste management system that designs collection operations according to the volume of containers filled and the level of waste degradation, together with the implementation of a route optimization tool based on the containers to be collected, improves the operation efficiency (cost and time reduction) and sustainability (emissions reduction). As a precedent, several European cities have been beneficiated by the implementation of a route optimization system, e. g., Valencia, Utrecht and Alba Iulia, which achieved savings[1] of 34%, 28% and 15% in operation distance travelled, time spent and fuel consumption, respectively.

Specifically, the SCALIBUR routing have been applied in Kozani (Greece) and Albano (Italy) focused on the urban biowaste collection. This routing system is based on two different types of data:

1. On demand HORECA biowaste collection based on the schedules, transport routes and collection needs.
2. Level of decomposition of urban biowaste gathered through sensors installed on the household containers.

[1] Saving information obtained from PlastiCircle project

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This deliverable aims to present the best practices selected to be implemented in the pilot cities of the project, and then, to describe in depth the activities and technologies developed and deployed, including examples and illustrative images and tables.

To this end, first, a list of best practices is analyzed with an exhaustive study, and then the selection made for the project is presented and justified, that is, among the list of the best practices which of them have been selected to be implemented in the current project and why this selection has been made.

Subsequently, the pilots implemented in three cities are explained with details. In each city the status before the pilots is described, with the corresponding KPIs. After that, the obtained results due to the SCALIBUR project are explained in the same way too. And to finish, both stages are compared to be aware of the saving in each city due to the project, for instance, CO_2, fuel, time, and distance savings are illustrated.

2. SUMMARY OF INITIAL PROBLEMS OF THE CITIES INVOLVED

Improved methods of selective collection, transport, sorting and pre-treatment will be implemented in the three pilot cities: Albano (Italy), Kozani (Greece) and Madrid (Spain). These methods will be applied to the pilot cities in order to improve the situation of the three cities. Therefore, for this purpose initial problems of the cities involved were identified.

<u>Albano</u>

Albano Laziale is a municipality located in the Lazio region, province of Rome. This municipality has a population of 41.715 inhabitants. The annual cost per capita of waste is about 154 € (Source: Italian Ministry of the Interior). The company "Volsca Ambiente e Servizi" manages the waste collection service.

In the city of Albano, waste is separated and collected into different fractions, namely wet fraction, plastic, paper and cardboard, metal and glass packaging, paper and cardboard, road cleaning residues and undifferentiated waste (dry, non-recyclable). The collection system is

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managed by VOLSCA AMBIENTE. Specifically, biowaste is collected, sorted and pre-treated in an automated system, using magnets and screens. In Albano, the wet fraction of biowaste is also used to produce compost and for anaerobic digestion.

The action plan intends to reduce the production of waste and enhance separate collection "door to door". As indicate in the GA, the current rate of the organic fraction is 75% and with the project the intention is to increase this rate to 90%. The city of Albano currently produces 12 tons/Day of organic material.

It is important to underline that the introduction of the punctual tariff in Albano Laziale Municipality "TARIP" ('pay as you throw') that came into force on 1st May 2019, marks an important innovation and a step forward for the reduction of waste, including for the organic and for making citizens aware of the issue.

In Table 1 are indicated the initial problems of the city of Albano that have been identified. The identification of these initial problems has led to the implementation of the best practices that are defined in section 3.

Kozani

The city of Kozani is a municipality in the region of Western Macedonia, which is located in northwestern Greece and has a population over 41.066 inhabitants. The issue of the management of biodegradable waste and biowaste is a key point for the management of solid waste in Greece. It should be highlighted that the taxes on waste are paid based on m^2 of each household, regardless of how many people live in each house or how well they recycle.

Household waste is collected twice per week. There are two main categories for waste collection: short and large. While short collection refers to the logistics of small amounts of waste from the city to the Local Waste Management Units (LWMU), large collection is the collection and transference from LWMU to Mechanical and Biological Treatment plant (MBT). Initially, the municipal council manages the short collection, while large collections are managed by DIADYMA S.A. However, in some cases, short collections can be performed by DIADYMA as

well. The biowaste is put in plastic bags and separate brown bins per house or block are provided.

The legislation focuses on implementing a separate collection of biowaste, minimizing the landfilled waste, implementing new biowaste treatments such as compost, anaerobic digestion or incineration. As a result of this legislation, the biowaste management system has significantly changed in Kozani.

In Kozani, the current rates of organic fraction collected selectively are 19% and this municipality aims to reach 50% of separate collection. In Table 1 are indicated the initial problems that led to the implementation of the best practices.

Madrid

The city of Madrid, which is the capital of Spain, has 3.182.175 inhabitants. The total waste production reach more than 1.2 million tons/year. To deal with this amount of waste the city has a comprehensive system that includes containerization through a color code, of five different fractions: packaging, glass, paper & cardboard, mixed waste and biowaste. They are sorted into different containers, following a colour code and mainly collected on a daily basis. **The collection system is based on surface containers and a door-to-door system.** The collection and the transport are performed by private collectors hired by the City Council. In this case, one of the companies hired for the purpose is FCC. **All the waste collected in Madrid is treated in a waste treatment system**, Valdemingomez Technology Park. From there, all the biowaste fraction collected is treated in Las Dehesas Anaerobic Digestion Plant. The valorisation process is achieved in two different ways:

- Biogas production, to produce biomethane or power.
- Digestate production, to obtain fertiliser.

Also, it should be highlighted that the **taxes are paid regardless of how well citizens separate or recycle (the system is a voluntary system that relies on the citizen's confidence).** Secondly, **end consumers for the compost** produced in the composting plant **are still unidentified due to the lack of information on the quality of the compost produced**

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Table 1. Initial problems of the cities involved

	Albano	Kozani	Madrid
Collection	Collection of Horeca Waste	Bad waste quality	No unifromity in containers
	Illegal dumping	Collection of Horeca waste	Overfilling of the containers before collection of waste
	Lack of a biowaste collection centre		
Transport	High cost of transport	No optimization of the collection routes	No optimization of the collection routes
Social Awareness	A door-to-door collection system for OFMSW from housing is implemented since 2019, including a "Pay as you Throw" (PAYT) model. The objective is to progress in this direction for HORECA waste	Lack of knowledge of the people on how to correctly recycle	No motivation to recycle
		Waste tax is based on the m2 of the household and no connection is made with the quality of the waste collected	No reward mechanism, the taxes to the municipality are paid regardless how well citizens separate or recycle
			There is a lack of knowledge on how to separate waste

The identified problems (the ones in the table above), are the ones that are going to be solved with the best practices implementation. The best practices are the solution for these problems.

3. DEFINITION OF BEST PRACTICE FACTSHEETS

A selection of best practices has been done in order to solve the problems explained in the section above. These best practices will solve the identified problems in the cities.

In this section, a summary of the best practices related to collection, transport, social awareness, and characterization, that were identified, is included.

As a summary of best practice per type a table has been included in order to make easier to the reader the comprehension of them (Table 2). In this table each best practice has been named with letters and numbers to identify each one easier and faster, the same nomenclature will be used in the whole deliverable (Table 2, summary of each best practice and Annex 1).

Moreover, at the end of the deliverable, at "Annex 1", every best practice will be explained into details. It has been done a sheet per best practice, and each sheet/best practice includes: the explained problem, the benefits obtained from the best practice applied, some examples and so on…

The goal of the best practices sheet is to give the complete information to the easy implementation of the BBPP in the cities.

Table 2. Summary of best practices

Collection		Transport		Social awareness		Characterization	
C1	Homogeneous bring banks around the country	T1	Software designed optimized waste collection route	SA1	Clear instructions on the containers and bags	CH1	Data collection and monitoring quality parameters
C2	Implementation of an underground container system	T2	Compacting collection trucks	SA2	Pay as you throw principle for fee calculation	CH2	Monitoring and control of the composition of residual waste in other recycling streams
C3	App for on-demand collection from HORECA	T3	Using electric trucks to collect waste	SA3	Educational areas in recycling yards		**Sorting and pre-treatment**
C4	Containers with chip to register filing levels	T4	Truck traceability	SA4	Events, roadshows and workshops	SP1	Live characterization with IRIS system
C5	Use of biodegradable and bio compostable bags for collection	T5	Eco-driving in waste collection trucks	SA5	Competition rewarding the best performance in biowaste collection	SP2	Improvements on pre-treatments to raise the OFMSW quality
C6	Start biowaste collection at schools			SA6	Schools campaign		
C7	Specific collection system adapted to each situation			SA7	Publication of positive recycling news as TV advertisement		
C8	Efficient collection during summer			SA8	Include citizens actively in the information loop		
C9	Selective collection of biowaste from the HORECA waste			SA9	Waste ambassadors		
C10	Collection of open market biowaste			SA10	Website on biowaste and recycling		
C11	User-friendly collection containers			SA11	Association of citizens providing direct feedback to municipalities		
C12	Volunteer collection of biowaste			SA12	Targeted communication campaigns		
C13	Anaerobic digestion plant			SA13	Dissemination of the environmental and economic benefits of biowaste recycling		

3.1 Summary of BBPPs by tipology

3.1.1 Collection

Thirteen Best practices were identified in collection (C1, C2…C13). In this section, a summary of all of them is made. The complete Best Practice Fact sheets are included in the annexes.

- C1 - Homogeneous bring banks around the country: The size and shape of the containers is really important, as no uniformity can later conditionate transport, making it more difficult. Therefore, the action will be to use the same colour in the containers for the selective collection of organic waste in all the region or country.
- C2 - Implementation of an underground container system: In this sense, it is common that in some cases containers are too small, and consequently, they become overcrowded, littering the city and causing odors, visual impact, and reducing the

quality of the urban environment. The action will be the implementation of an underground collection system to collect biowaste in order to establish cleaner surroundings and improve the collection efficiency.

- C3 - App for on-demand collection from HORECA: It is usual in the HORECA sector that the waste bins are filled before the collection date, avoiding more waste to be collected. When the opposite happens, bins are not completely full, the collection is not optimised. The action will be the implementation of an app that allows the HORECA sector to have on-demand collection when needed.
- C4 - Containers with chip to register filing levels: In many cases, the overflowing of the containers is a problem for the municipality. However, in other cases, containers are in places where the filling occurs slower than in other areas which if not controlled, may result in inefficient collection routes. The information about filling level of containers allows waste resource managers to plan optimized collection routes for waste and recyclables collection. The action will be the implementation of a system to control filling level of containers to monitor collection rates and improve planning procedures.
- C5 - Use of biodegradable and bio compostable bags for collection.: The Austrian compost and biogas association KBVÖ (Kompost- und Biogasverband Österreich) reported that 80-90% of impurities in the organic waste collected from households are conventional, non-biodegradable bags. To tackle this problem and reduce impurities, biodegradable and biocompostable bags can be used to collect biowaste. The action will be to Implement the use of biodegradable and biocompostable bags for biowaste collection.
- C6 - Start biowaste collection at schools: Getting students and teachers involved in recycling at school is good for the environment, educational and can be a lot of fun. Educating our children about the importance of recycling provides the country with a path to a greener future. As children learn about recycling, they will be more likely to carry these habits into their adult years. They also will learn how their personal actions can affect the future. The action will be an educational project promoting the collection of biowaste in schools, where they will be a starting point to collect organic waste.
- C7 - Specific collection system adapted to each situation: Adapting the collection scheme to the territory, in particular regarding to the frequency, the type of collection

(door-to door, bring scheme) and the collection vehicle, and testing the scheme at a pilot level before implementing it full scale, by enlarging progressively the territory and promoting biowaste prevention in areas where there is low quantity/potential.

- C8 - Efficient collection during summer: in the summer months odour nuisance is a problem. In order to overcome this problem, the organization of the collection must be very effective in order to avoid problems related to odours, flies, etc.
- C9 - Selective collection of biowaste from the HORECA waste: small-scale shops generate kitchen waste comparable in its composition to that of a common household and, therefore, synergies can be realised through combined collection and treatment of the waste from the two sources. The action will be the selective collection of biowaste (i.e., food waste plus green waste) from hotels and restaurants through door-to-door collection or bring banks systems.
- C10- Collection of open market biowaste: The amount of food thrown away is a waste of resources as energy, water and packaging used for food production, transportation and storage. All this goes to waste when we throw away edible food. Therefore, the selective collection of biowaste to open markets could help to solve this problem.
- C11 - User-friendly collection containers: Use of containers with ergonomic design adapted to different kind of users such as, children, elderly people or disabled citizens.
- C12 - Volunteer collection of biowaste: Volunteer collection is an initiative that public or private organization (e.g., schools, sports, clubs, charity organizations, etc.) at local level (neighborhoods, sports clubs, etc.) can implement in a municipality by collecting paper and board separately
- C13 - Anaerobic digestion plant: The Directive prescribes in Article 22 that Member States shall take appropriate measures to encourage the separate collection of bio-waste with a view to their composting and anaerobic digestion

3.1.2 Transport

Five Best practices were identified in transport (T1, T2…T5). In this section, a summary of all of them is made. The complete Best Practice Fact sheets are included in the annexes.

- T1 - Software designed optimized waste collection route: Route optimisation allows waste collection and street cleansing operators to identify and then remove inefficiencies. By building a digital model of their service, solid waste operators can compare different options with their current setup to identify more efficient and effective operating routes. In addition to cost savings, this can also mean balanced workloads and happier drivers, better customer service as crews is less likely to run short of capacity, and a safer operating environment since routes have been designed to account for safety issues properly.
- T2 - Compacting collection trucks: The compaction of the collected material allows increasing amounts of biowaste to be transported per trip. Less space required for the collection of waste. Thus, it is possible to increase the route length being so more effective.
- T3 - Using electric trucks to collect waste: Electric collection trucks will provide cleaner and healthier air in the cities where they operate. They will not create emissions, which will improve local air quality, and the electricity used to recharge batteries will come from a power generator with an individual emission point and pollution control equipment. Electric vehicles do not idle when stopped or parked, and they make far less noise than diesel engines while on the move. Electric trucks may create opportunities such as new renewable energy from waste generation.
- T4 - Truck traceability: Vehicle emissions depends on driving behaviour such as acceleration and speed. Monitoring the speed, excessive idling, unnecessary accelerations, and braking will give information that can be used to significantly reduce the fuel consumption.
- T5 - Eco-driving in waste collection trucks: Eco-driving is a systematic driving style that cuts fuel consumption and the emission of polluting gases. Onboard units now enable a wide array of vehicle data to be recorded, such as fuel consumption, revs per minute, acceleration, braking, maintenance, etc, while also flagging up technical alarms. All this information can then be combined with complementary data from other systems such as the fleet management system. Drivers are given instant feedback with visual and acoustic cues for correcting their driving style and cutting out inefficient behaviour such

as over-braking and excessive idling. Through the implementation of eco-driving, fuel reduction and better maintenance of the vehicle are obtained, extending its life.

3.1.3 Social awareness

Thirteen Best practices were identified in social awareness (SA1, SA2…SA13). In this section, a summary of all of them is made. The complete Best Practice Fact sheets are included in the annexes.

- SA1 - Clear instructions on the containers and bags: Confusion about selective collection leads to mistakes and scepticism which causes people to throw tons of waste into the wrong container daily. This confusion may be due, among other reasons, to the lack of clarity in the labels of recycling container. Consistent and regular information should be provided to citizens through different channels, up to the final separation point. The information is intended to clarify citizens' concerns, increase their understanding of recycling processes, and could include recycling targets as an additional motivation.
- SA2 - Pay as you throw principle for fee calculation: In the traditional schemes for household waste management in Europe, the services are financed via general taxes or due to a fixed recurring fee in bills of other supply services as electricity, regardless of the produced waste amount. This tax can act as an incentive to recycle and an excellent way to reward households doing it well. Introduce (mandatorily) specific bags for every source separated fraction and charge higher costs for fractions that need to be reduced. Pay for quantity of waste generated (not by m^2).
- SA3 - Educational areas in recycling yards: Educating our children about the importance of recycling provides the country with a path to a greener future. As children learn about recycling, they will be more likely to carry these habits into their adult years. They also will learn how their personal actions can affect the future.
- SA4 - Events, roadshows and workshops: environmental campaigns help consumers to change their habits. Some of the benefits of these actions are increasing citizen engagement and therefore increasing the quantity and quality of biowaste due to the

information received and direct feedback about problems to address them directly. Citizen's viewpoint can be very valuable in decision making processes to improve recycling rates

- SA5 - Competition rewarding the best performance in biowaste collection. Competitions can be an excellent way to generate awareness and interest in biowaste collection. They give extra motivation to the people and help to reinforce the messages from the recycling campaigns. Furthermore, the competitions can be held at different levels (Municipalities, neighborhoods, small business, schools).
- SA6 - Schools campaign: As any separation at source, the separation of biowaste in the households requires personal efforts in form of awareness and change of habits of the citizens. Therefore, it is important to convey to children the benefits of recycling for the environment. Fun activities are a great way to learn how about the environmental benefits of recycling and how to separate waste correctly. This is especially true for children who in addition have a powerful influence over the recycling habits of a household.
- SA7 - Publication of positive recycling news as TV advertisement. Advertisement on TV is a fast and direct way to give information to the population about how and why is important to recycle waste. Thus, motivate the people and increase recycling rates.
- SA8 - Include citizens actively in the information loop: Citizens are not involved in the decisions that municipalities take regarding waste management activities. This means that they are not involved in the activities proposed by municipalities and that the recycling rate is very low.
- SA9 - Waste ambassadors: The use of waste advisers is especially relevant to address specific issues by targeting a specific territory or audience with a poor separate collection rate or high contamination in separately collected fractions in order to deliver an adapted answer, as waste advisers can interact face to face. The action will be to design an awareness system based on ambassadors who inform citizens about the collection system established in the municipality.
- SA10 - Website on biowaste and recycling: Misinformation and false news about waste management lead to poor classification by citizens. In many occasions, the citizen has doubts about where to classify the most complicated materials and it is necessary a

tool that can solve the problems instantly. The website will serve to keep the city informed about the importance of recycling, bio-waste and its management, which will lead to an increase in the recycling rate and greater involvement by citizens. Thanks to this information, citizens will manage their waste correctly.

- SA11 - Association of citizens providing direct feedback to municipalities: it is important that citizens' organizations or associations communicate the problems of the cities and maintain a continuous flow of communication between the municipality and the citizens. Therefore, the creation of association of citizens who get together to discuss issues about waste collection will serve to solve the lack of flow communication between citizens and municipalities. Their feedback could be used by the municipality to improve the waste collection system.
- SA12 - Targeted communication campaigns: Public awareness campaigns are usually conducted for a general audience, which means that information does not reach certain people and is not recycled or done properly. For this reason, it is necessary to focus the information on specific groups of people, such as tourists in holiday flats, new residents or children motivating their parents to recycle.
- SA13 - Dissemination of the environmental and economic benefits of biowaste recycling: Campaigns to reduce bio-waste promoted by cities will help to reduce the environmental impact of waste by reducing the number of tons of waste going to landfill, while at the same time providing economic benefits from the transformation of this waste into high value-added products such as biogas and compost.

3.1.4 Characterization

Two Best practices were identified in characterization (CH1 and CH2). In this section, a summary of all of them is made. The complete Best Practice Fact sheets are included in the annexes.

- CH1 - Data collection and monitoring quality parameters: During waste collection, the main parameters are measured, such as: material composition, impurities, ashes, moisture and sticky contaminants. Thanks to these results, it is possible to know how

citizens are acting and if they are doing it correctly in addition to recycling. This will influence the quality of the final product. If this is not the case, it will be possible to know where to improve.

- CH2 - Monitoring and control of the composition of residual waste in other recycling streams: Based on the results of the monitoring, specific measures can be taken to obtain more recyclable and/or recoverable material and to prevent waste from ending up in the other recycling streams. This will result in an improvement of the recovered waste fraction and an increase in quality.

3.1.5 Sorting and pre-treatment

Two Best practices were identified in characterization (CH1 and CH2). In this section, a summary of all of them is made. The complete Best Practice Fact sheets are included in the annexes.

- SP1 - Live characterization with IRIS system: The characterization of the composition of the OFMSW is fundamental to evaluate its potential and the most adequate pre-treatments for their valorization. Current methods are time consuming and less precise, so a live-characterization can result in an in-situ, faster and more precise methodology. Therefore, live characterization by differnet camera technologies will result in time saving, high degree of results certainty and increase of potential valorization

- SP2 - Improvements on pre-treatments to raise the OFMSW quality: The presence of improper waste (non-biodegradable materials) in the OFMSW hinders its potential of valorization and the products obtained. However, the potential can be improved by implementing specific pre-treatment steps in each case. For instance, the improvements like the reduction of the size particle and the reduction on its degradation will help in the adequation of the biowaste for its use in the further saccharification. The selection of higher purity biowaste streams increases it significantly.

3.2 Selection of BBPPs for each city

For the project, a selection of best practices was made in order to improve the pilot cities in these fields. Every previous best practice was studied and after that, a mix of them was made for the current project.

The selected best practices for each city are detailed in Table 3. The extended explanation will take place in the details of each pilot city, where the improvements due to the best practices are detailed.

Table 3. Summary of best practices selected

Albano	Madrid	Kozani
Collection: **C4.** Containers with chip to register filling levels. **C8.** Efficient collection during summer. As the sensors detect the filling level and in summer more waste is produced, the collection during this season is more frequent not allowing neither exceeded containers nor bad odors. **C9.** Selective collection of biowaste from the HORECA waste. In Albano only the HORECA waste is going to be collected with Scalibur techniques because the rest is		**Collection:** **C4.** Containers with chip to register filling levels (in addition to gas emissions). **C6.** Start biowaste collection at schools. **C8.** Efficient collection during summer. As the sensors detect the filling level and the gas emissions, and in summer more waste is produced, the collection during this season is more frequent not allowing neither exceeded containers nor bad odors.

being collected with a "pay as you throw" system, and it's arealdy developed and implemented. **C13.** Build an anerobic digestion plant		
Transport: **T1.** Software designed optimized waste collection route **T4.** Truck traceability. It's done though the platform.		**Transport:** **T1.** Software designed optimized waste collection route **T4.** Truck traceability. It's done though the platform.
Social awareness: **SA2.** Pay as you throw principle for fee calculation. Explained above in C9 point. **SA4.** Events, roadshows and workshops. **SA10.** Website on biowaste and recycling (the Scalibur website)	**Social awareness:** **SA4.** Events, roadshows abd workshops. **SA10.** Website on biowaste and recycling (the Scalibur website) **SA13.** Dissemination of the environmental and economic benefits of biowaste recycling	**Social awareness:** **SA3.** Educational areas in recycling yards. **SA4.** Events, roadshows, and workshops. **SA6.** School campaign. **SA10.** Website on biowaste and recycling (the Scalibur website)
Characterization: **CH1.** Data collection and monitoring quality parameters	**Characterization:** **CH1.** Data collection and monitoring quality parameters	**Characterization:** **CH1.** Data collection and monitoring quality parameters
	Sorting and pre-treatment: **SP1.** Live characterization of OFMSW with the IRIS system	

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	SP2. Improvements on pre-treatments to raise the OFMSW quality

4. IMPLEMENTATION OF PILOTS

It has been developed three pilots in the following cities: Madrid (Spain), Albano (Italy) and Kozani (Greece).

In each city several actions have been carried out, for instance, best practices have been selected for each city to solve their problems (they are detailed in each pilot city section). A first approach to understand this point is summarized below:

- Madrid (Spain) ➔ On one side, it has been developed social awareness measures, where the goal was to increase the engagement and knowledge of the people about the importance of their individual actions in the circular economy. Secondly, different BBPP on pre-treatment, sorting and characterization were selected and implemented.
- Albano (Italy) ➔ In this city sensors have been installed in the containers in order to measure its filling level. Furthermore, with the information of these containers, collection trucks routes have been optimized with a platform to save costs (kilometers, fuel, CO_2 emissions and so on). In this city the sensors and the platform are commercial ones, of an external company.

  Moreover, different BBPP on transport, collection and characterization were selected and implemented.
- Kozani (Greece) ➔ in this city designed and manufactured sensors by ITENE not only measure filling level, but also gas emissions, thus, the waste is recollected when the filling level is proper, and when the waste it's in its optimal point to be revalorized into add-value items (measuring gas emissions). Moreover, the platform developed by ITENE optimizes the collection route in order to save costs like collection times, kilometers done by trucks, consumed fuel, CO_2 emissions of the trucks and so on.

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Moreover, different BBPP on transport, collection and characterization were selected and implemented.

4.2 Preliminary trials at ITENE

Not public information.

More information in "D3.6. Confidential annex".

4.3 Madrid Pilot

4.3.1 Status Before the Pilot

The status of the selective collection within the city of Madrid was studied, including the base line analysis, limitations, and current drawbacks of the system, but also new strategies to face the problems. The Biowaste Club of Madrid was created to contemplate and discuss the **main problems and solutions** within the city;

First BCM in Madrid (November 21st and 22nd, 2019): this BCM was focused on engaging participants to the SCALIBUR project and to provide an overview of the current situation in Madrid, specifically in regard to biowaste collection, treatment and citizen engagement (e.g. campaigns on biowaste sorting and collection). Challenges and solutions were discussed, highlighting best cases and possible pilot activities that can be implemented in Madrid through the Scalibur project. The types of organizations that attended this BCM were research organisations, universities, companies and the city council.

1st BCM Madrid (2019)

Most relevant comments:

-Low motivation to recycle

-There is a lack of knowledge on how to separate waste

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Second BCM in Madrid (Valdemingómez Technological Park, November 3rd, 2021): in this BCM, the presenters of the workshop provided a comprehensive overview of several topics related to biowaste in Madrid, including: strategies and policies in Spain & the EU, main challenges in cities, the role of citizens in biowaste management, experiences on biowaste management, selective biowaste pick up and logistics in urban areas, innovative technologies for sludge valorisation, advance processes to biowaste valorization through insects, among others. This BCM included networking spaces for all participants and a filed visit to "Las Dehesas" plant installations. Specifically, the organizations that attended this BCM were waste management companies, technology & research organisations and city council representatives. Further, some invited presenters in this BCM were Ministerio para la Transición Ecológica y el Reto Demográfico, Anthesis Lavola, Consorcio de Residuos de Gipuzkoa (GHK), Ayuntamiento de Valladolid, Asociación Española de Normalización, among others.

2nd BCM Madrid (2021)

Furthermore, some comments of the participants during the event, were the following: "

- Citizens must be seen as the basis of the bio-waste recycling chain.
- We need to be sustainable and for that we need to have data from the selective collection

In this sense, **is a main asset to raise the knowledge** of citizens on how to recycle and the **social awareness** to improve the recycling behavior of the citizens and ultimately the potential of the biowaste. For this aim, some activities like rising of awareness campaigns and engagement activities, uniform education with clear messages and disseminated in several idioms to avoid the barrier of the language must be interesting.

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In addition, there is the need of undertake further innovations to improve the potential of valorization of urban biowaste:

1. **Innovation in the OFMSW sorting** like a biowaste monitoring system-IRIS based on optic and spectroscopic cameras for the detection of contaminants within the organic fraction, allowing to separate and reach the required conditions of the biowaste for the WP4-6.

2. **Innovation in the OFMSW pre-treatment** steps for the OFMSW fraction is necessary to avoid biodegradability of biowaste which reduces its potential for valorization into high added value products. In this regard, the presence of lactic acid in the biowaste was seen.
3. **Improvement in characterization** since in the OFMSW from the **selective collection** is found high presence of improper waste, low purity of the biowaste is a main drawback for its valorisation as its value lows. In this sense, on one side, streamlined characterizations at collection points and on the other, to study of the segregation behaviour of citizens at households would be of main interest to increase the OFMSW purity and potential of valorization.

In this sense, after careful review of the current issues, the following improvements and BBPP were undertaken.

4.3.2 Results

With the overview of the main difficulties and disadvantages of the city identified, both citizens barriers from the two Biowaste Clubs (BC) and the drawbacks of the processing steps of the biowaste. Thus, selecting different strategies and innovations were executed to meet the needs.

Social Awareness

One that most impact could generate was the implementation of social awareness and engagement best practices (BBPP), as following:

- **SA4: Events, roadshows and workshops**

- **SA13: Dissemination of the environmental and economic benefits of biowaste recycling**

In this sense, CSCP developed a virtual webinar with the aim of educating companies and citizens, generating more knowledge and social engagement. For example, the CSCP organized the webinar "Sustainable Trends and Opportunities of the Retail Sector in Spain" targeted to representatives of the retail sector in Spain. In cooperation with "Asociación Española de Distribuidores, Autoservicios y Supermercados (ASEDAS)", the event took virtually on My 12th, 2022 and counted with the participation of important supermarkets in Spain (e.g., Mercadona, Uvesco, Juan Fornes) and ASEDAS. The objectives of the webinar were to:

- To analyze why the EU Green Deal and the circular economy are relevant issues for the retail industry.
- Analyze the opportunities and challenges in the recycling of bio-waste in the Spanish food sector
- To provide best practices and inspiration from European supermarkets and other actors in the food sector
- Support the development of sustainable strategies and concrete actions

During the webinar, the supermarket representatives highlighted main challenges and their current efforts on adapting their business practices towards the new legislation, the Law 7/2022 on "waste and contaminated soils for a circular economy", which is a law that highlights key measures that are necessary to modernize waste management systems in Spain and support the transitioning towards a Circular Economy in the country. The participants were interested in learning more about sorting and valorization technologies of biowaste, which could support them to address this new legislation and improve the efficiency of their business operations. It is planned for SCALIBUR partners to participate in the upcoming ASEDAS "Sustainability Committee" on September, to promote biowaste technologies that can be applicable to supermarkets in Spain (TBD). Some comments in this webinar were:

"Waste management is a major challenge, especially for retail distribution chains"

"We can no longer produce food only to throw it in the landfill"

"More multi-stakeholder interaction is needed to solve waste management problems"

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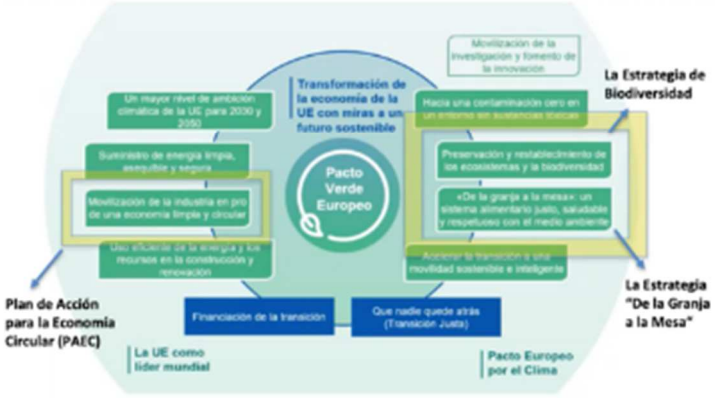
El Pacto Verde Europeo

El "Pacto Verde" proporciona un plan maestro para una transición justa hacia un futuro sostenible y climáticamente neutral.



Se necesitan habilidades y modelos de negocio en las cadenas de valor

Temas transversales:

- Cambio climático
- Biodiversidad
- Diseño de sistemas
- Rol de áreas urbanas

Sistemas de producción	Modelos de negocios
Logística y distribución	Retail
Patrones de consumo	Estilos de vida de los ciudadanos

SCALTBUR

10

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Furthermore, the CSCP is currently working with "Local Champions in Madrid", who are local organizations in Madrid that have the power to influence a positive change in the community and consumers in general, through the diffusion of practices related to circular economy and resource efficiency. To accomplish this, the CSCP is currently developing interviews with a series of organizations, which will then be selected and invited to become part of the project through communication activities and a virtual engagement event. The main objectives of engaging with the "local champions Madrid" are:

- To support the visibility of initiatives and organizations at the local and regional level.
- To encourage citizens in Madrid to improve solid waste reuse, recycling and the adoption of circular practices.
- To promote best practices and inspire initiatives in Madrid.

Additionally, the city of Madrid has been demonstrating its commitment with the recycling change out of the project SCALIBUR through rising social awareness campaigns and engagement activities. Some examples are the Biowaste collection citizenship engagement campaign "acierta con la orgánica","cuando reciclo yo acierto" and "con erre de" which has been developed since 2017 and it is expected to continue over the next years.

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Sorting

Regarding the innovation in **sorting**, the BBPP implemented was: **SP1 – Live characterization of OFMSW with the IRIS system**

1. IRIS provided a monitoring system for the detection of unwanted fractions.

Not public information.

More information in "D3.6. Confidential annex".

Pre-treatment

About the pre-treatments, the BBPP developed was: **SP2- Improvements on pre-treatments to raise the OFMSW quality.**

In the Madrid Demo site Las Dehesas biomethanization plant, the implementation of **innovations in the pre-treatment** of OFMSW were undertaken prior to entering the new processing technologies in WP4-6, focusing on the improvement of the process and the monitoring after the selective collection for optimizing the desired conditions to be feed in WP4.

Improvements in the pre-treatment step were necessary. For instance, OFMSW requires minimal degradation to preserve its potential for valorization, which was measured through the lactic acid content in the samples. Another aspect to work on was the absence of inert material within the biowaste since its presence reduce its content in organic matter and thus the quality and the yield of the valorization. Additionally, the size of the particle is also of great interest, the smaller it is the best can be used in the upcoming process. So, with the aim of improving these aspects, the following improvements were undertaken:

1. One action was to evaluate/use the Mercamadrid biowaste instead of the household due to its greater purity and perform a manual removal of undesirable materials before the pretreatment. (Mercamadrid is a wholesale market for fruit and vegetables in the city, so the waste from this entity contains less amount of improper than the OFMSW from the household)

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2. Work was also done in the reduction of the particle size by implementing an addiction grinding equipment
3. In order to improve the quality of the biowaste, reducing the percentage of improper, the mesh of the pretreatment trommel has been replaced by another with a smaller pore size.
4. Finally, to avoid possible degradation it was eliminated the heat treatment and the logistic were improved to reduce times.

Characterization

Regarding BBPP on characterization, an interesting one to solve some of the main concerns, was the implementation of the following one: **CH1: Data collection and monitoring quality parameters.**

Another factor of main interest is the streamlined characterizations of OFMSW from the **selective collection** at collection points to have data of the quality and purity of the biowaste (discussed also in the BCM). In addition, to perform a comparative study of biowaste in the different districts allowing to assess the segregation behaviour of citizens at households and the main barriers to recycle.

1. Streamline characterizations of OFMSW from different districts of Madrid: Amount of OFMSW sampled (Figure 10), characterization of OFMSW quality of Madrid (Figure 11) and by districts (Figure 12).

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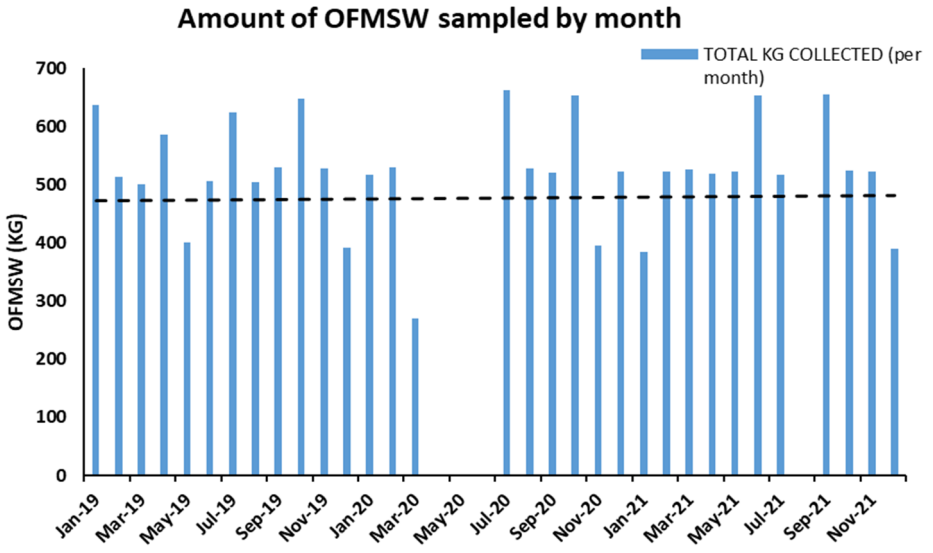

Figure 10. Amount of OFMSW collected in Madrid by months from 2019 until 2021

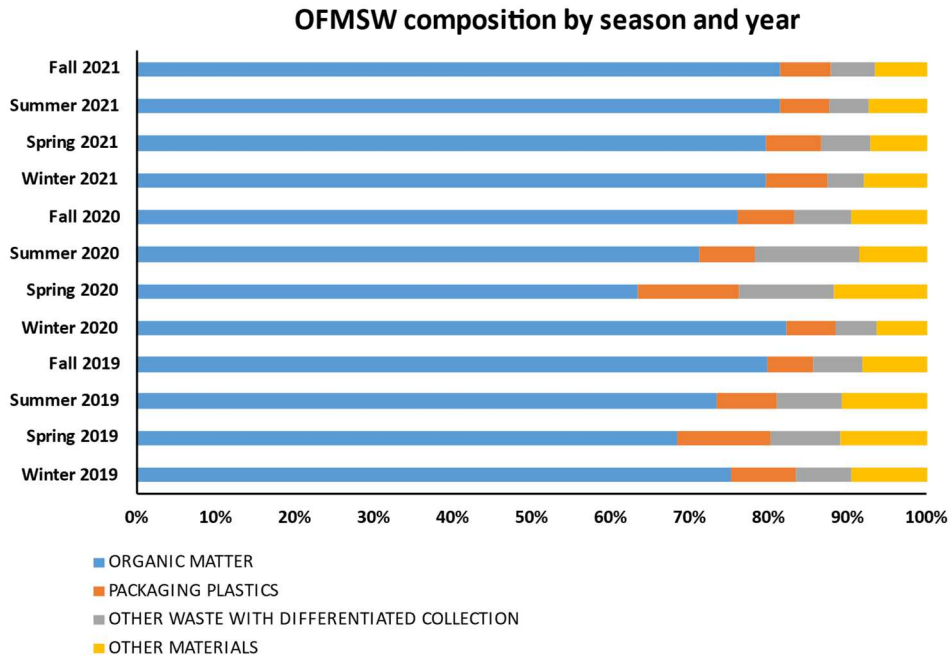

Figure 11. Composition and distribution the four fractions found in the samples by season: organic matter (blue), packaging plastics (orange), other waste with differentiated collection (grey) and other materials (yellow)

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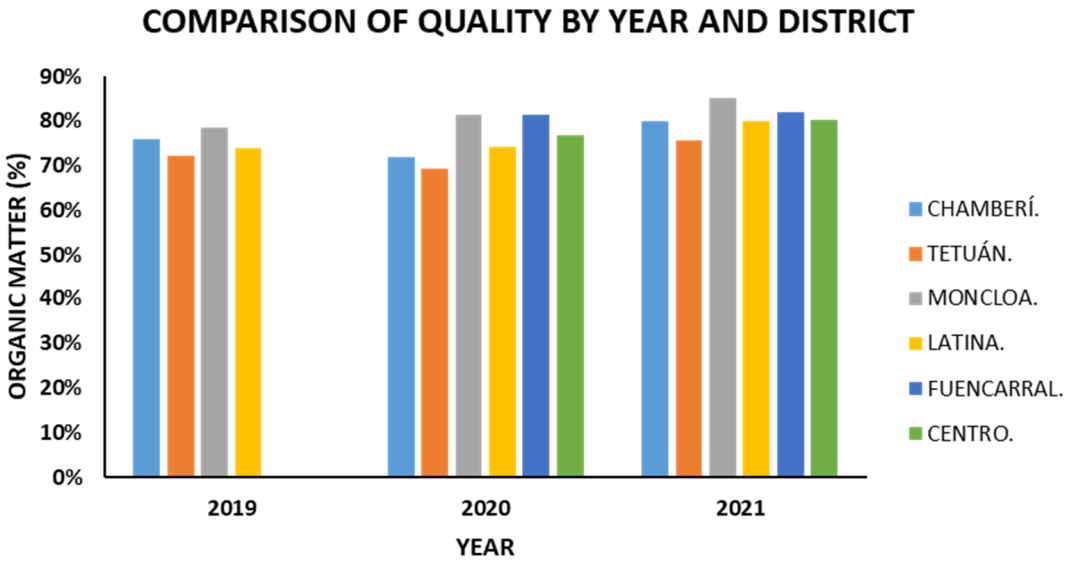

Figure 12. Comparison of the OFMSW quality from different districts by year

2. Secondly, it was performed a **study of impacting parameters on the biowaste segregation behavior** at household to face the barriers of the citizens and improve the biowaste quality generated.

To this aim, FCC provided data: Not public information.
More information in "D3.6. Confidential annex".

Overall, all the previous strategies were followed in the pilot to improve the quality level of the OFMSW and cover weakness within the segregation behavior of the population. Indeed, because of the pilot and together with the efforts of the municipality of Madrid in the search of a green and circular city, like the awareness and education campaigns, it led unavoidably to remarkable results such as the increase of the organic matter content from 2019 to 2022, from almost 75 % to near 83 %, what brings huge benefits for its potential of valorization.

Figure 14. Increase of the quality of the OFMSW collected in Madrid by year between 2019 and 2022

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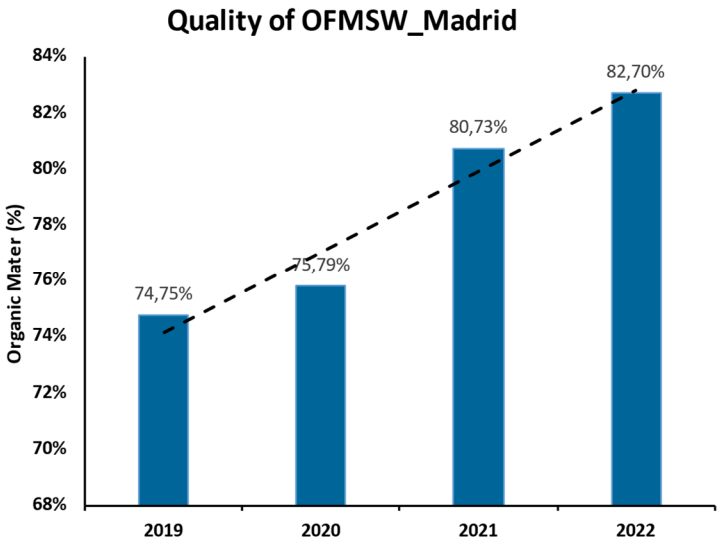

4.4 Albano Pilot

4.4.1 Status before the pilot

Before the implementation of the pilot project, the 19 containers were collected in Albano without any optimization. They are 19 containers because the pilot has been focused on the A3 route, that's because it's the more representative route of the city in Horeca, as Volska told us. In order to optimize this route, the first step was to find out how the containers were usually collected three times a week.

In the Table 7 the identification number and the address of each container are indicated.

Table 7. Location information of the 19 containers in Albano.

RESUMEN DE SERVICIOS

	CODIGO 1	CATEGORIA	TRANSPONDER	MOTIVO SELECC...
101257068126 - Via Vascarelle 112D - Albano Laziale (Albano Laziale) (1)				
1	811725	ORG240		
101257068163 - Via Vascarelle 13 - Albano Laziale (Albano Laziale) (1)				
2	811977	ORG240		
101257068165 - Via Vascarelle 1 - Albano Laziale (Albano Laziale) (1)				
3	811980	ORG240		
101257068161 - Viale Alessandro Fleming 5 - Albano Laziale (Albano Laziale) (1)				
4	811976	ORG240		
101257068160 - Viale Alessandro Fleming 5 - Albano Laziale (Albano Laziale) (1)				
5	811975	ORG240		
101257068163 - Via Vascarelle 13 - Albano Laziale (Albano Laziale) (1)				
6	811978	ORG240		
101257068170 - Via dei Cappuccini 12 - Albano Laziale (Albano Laziale) (1)				
7	811983	ORG240		
101257068171 - Via dei Cappuccini 12 - Albano Laziale (Albano Laziale) (1)				
8	811984	ORG240		
101257068167 - Via Trilussa 172 - Albano Laziale (Albano Laziale) (1)				
9	811981	ORG240		
101257068130 - Via Rossini 32 - Albano Laziale (Albano Laziale) (1)				
10	811729	ORG240		
101257068164 - Via Giuseppe Verdi 26 - Albano Laziale (Albano Laziale) (1)				
11	811979	ORG240		
101257068169 - Piazza Aldo Moro 23 - Albano Laziale (Albano Laziale) (1)				
12	811982	ORG240		
101257067135 - Via della Pallade 129 - Velletri (Velletri) (1)				

****

13	811696	ORG120	
101257068168 - Via Rossini 18 - Albano Laziale (Albano Laziale) (1)			
14	812631	ORG240	
101257068129 - Via Rossini 36 - Albano Laziale (Albano Laziale) (1)			
15	811728	ORG240	
101257068124 - Via Antonio Vivaldi 11 - Albano Laziale (Albano Laziale) (1)			
16	811722	ORG240	
101257068125 - Via Quarto Grotte 9 - Albano Laziale (Albano Laziale) (1)			
17	811723	ORG240	
101257068128 - Via Gaetano Donizetti 23 - Albano Laziale (Albano Laziale) (2)			
18	812630	ORG240	
19	811727	ORG240	

In the Figure 15 the position of the containers in Albano area can be seen.

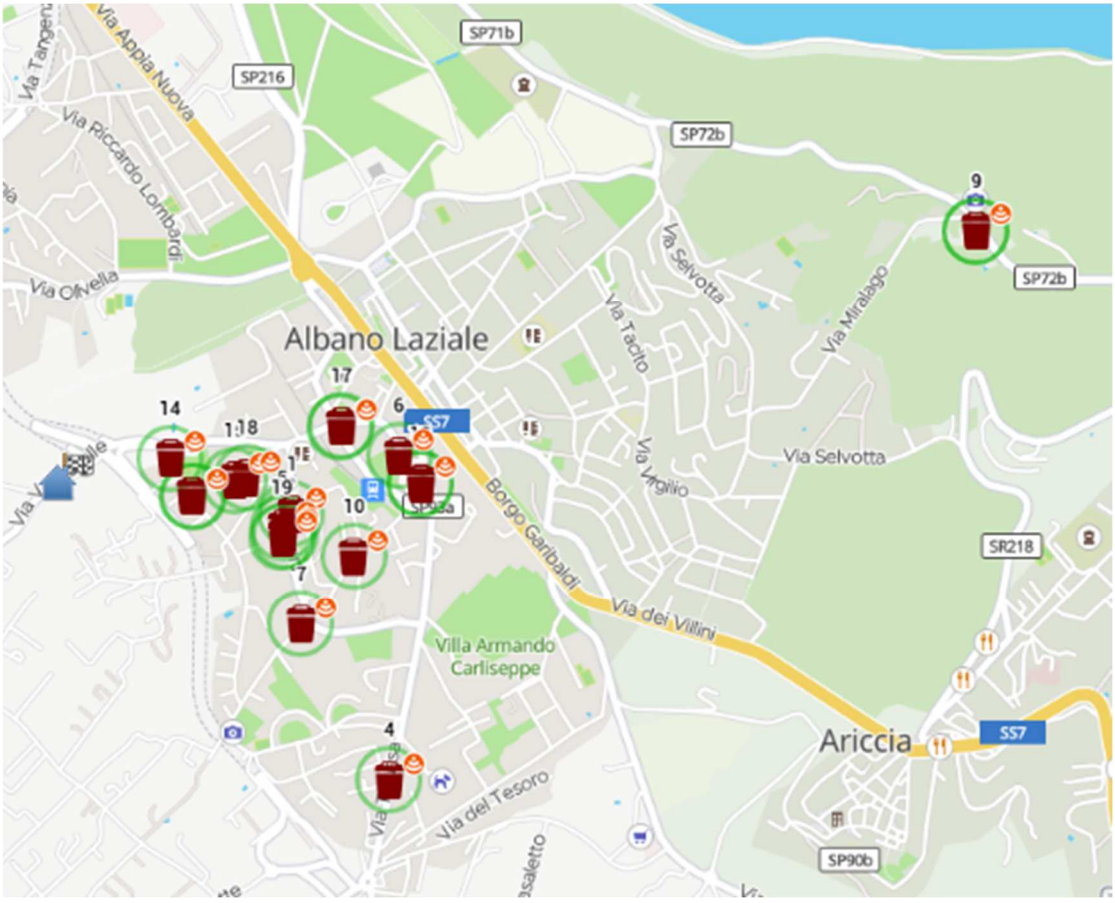

Figure 15. Position of the 19 containers in Albano.

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4.4.2 Results

Best practices and results in each theme are explained below:

Collection

Currently, HORECA's OFMSW collection service is carried out at a frequency of 3 times/week (Monday/Wednesday/Friday), and all containers are collected, irrespective of their filling level. However, some parameters such as population density, the greater or lesser concentration of establishments in the service areas, and even the holding of specific events in different areas (neighbourhood festivals, etc.) cause the level of waste concentration to be uneven along the service route. This can lead to health problems (odours, rats, etc.) in areas where it is higher, and to unnecessary use of resources (collection of practically empty containers) in areas where it is lower.

Therefore, and with the aim of improving the collection service, adapting it to the level of waste concentration, the installation and deployment of a system of IoT technology sensors capable of measuring the volumetric filling of the containers is proposed.

Specifically, in this case, a type of commercial sensor from the company MOBA has been used. The FLS2 filling sensor is an autonomous wireless device equipped with an ultrasonic sensor specifically designed to monitor the degree of filling of any type of waste container and litter bin (organic waste, plastic, paper-cardboard, glass, textile, etc.). This device measures the distance between the sensor and the waste by means of an ultrasonic emitter, and the frequency of measurement and data transmission can be fully programmed autonomously, depending on the needs of the final application.

The FLS2 sensor communicates via GPRS, NB-IoT, Sigfox or LoRa network, with an integrated SIM card (SoC) with international coverage and compatible with different communication providers.

Figure 16. MOBA FLS2 sensor.

The sensor complements with the MOBA's MAWIS integral platform for an efficient and effective management of the waste collection fleet in cities.

In order to optimise the collection operation, specific thresholds are established, after which alerts are generated for collection, so that only those containers that exceed these thresholds will be collected. This information allows waste resource managers to plan optimised routes for waste collection.

Table 8 shows the warning and critical values for the containers fill level.

Table 8. Values of the parameters analysed in the containers.

Parameters	Warning value	Critical value
Fill level (%)	60	85

The following pictures show the installation process during the pilot deployment.

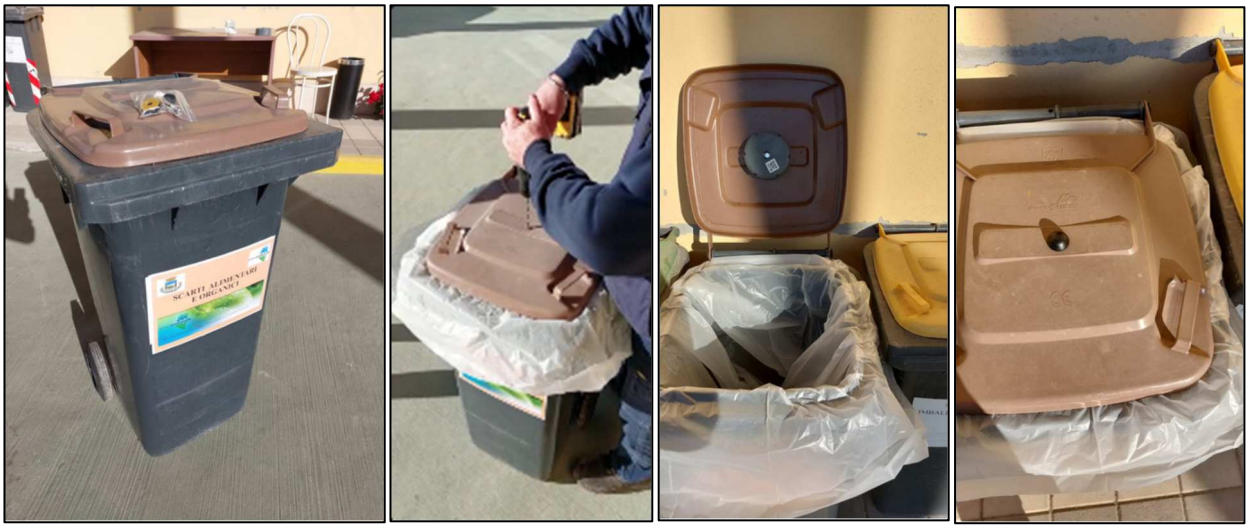

Figure 17. Sensor's installation process.

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Transport

The route optimization is developed in three phases. In the first phase the traceability of the non-optimized route is recorded. These recorded routes will be the baseline for comparison of the following stages. In the second phase, the route is optimized using the technology of an external company (not the device and the platform developed by ITENE like in the city of Kozani). The third phase includes the optimized route collecting only the containers with a filling level higher than the 60%. The value of 60% was chosen to avoid possible overfilling since the OFMSW containers are emptied only 3 times per week.

Phase 1: Measurement and analysis of the real route collecting all the containers.

The distance to be covered for the collection of the 19 containers indicated, without any optimisation, is **11 km**, which takes **95 minutes**. These data were provided by VOLSCA Ambiente, which is the concessionaire of the municipal waste collection service in the city of Albano Laziale.

These values have been used as a baseline for the following phases to reduce them through route optimization.

According to the used collection trucks in Albano (https://www.isuzutruckscn.com/3ton-5ton-isuzu-compressed-waste-garbage-compactor-truck-for-sale_p305.html), the consumed fuel in this route of 11 km has been **3.85 liters** and the equivalent CO_2 emissions of the truck **8.09 kg.**

Phase 2: Optimization of the current route collecting all the containers in order minimize time and distance.

Before implementing the route optimization in the real pilot, several theoretical calculations were done in order to evaluate the route optimization system. As an example, the theoretical distance and timing for the optimized route that independently minimizes time and distance for the collection of the 19 containers were calculated.

Subphase 2.1: Optimization of the current route collecting all the containers in order to minimize time.

The collection route with time optimization for the collection of the 19 containers in Albano is shown in Figure 18.

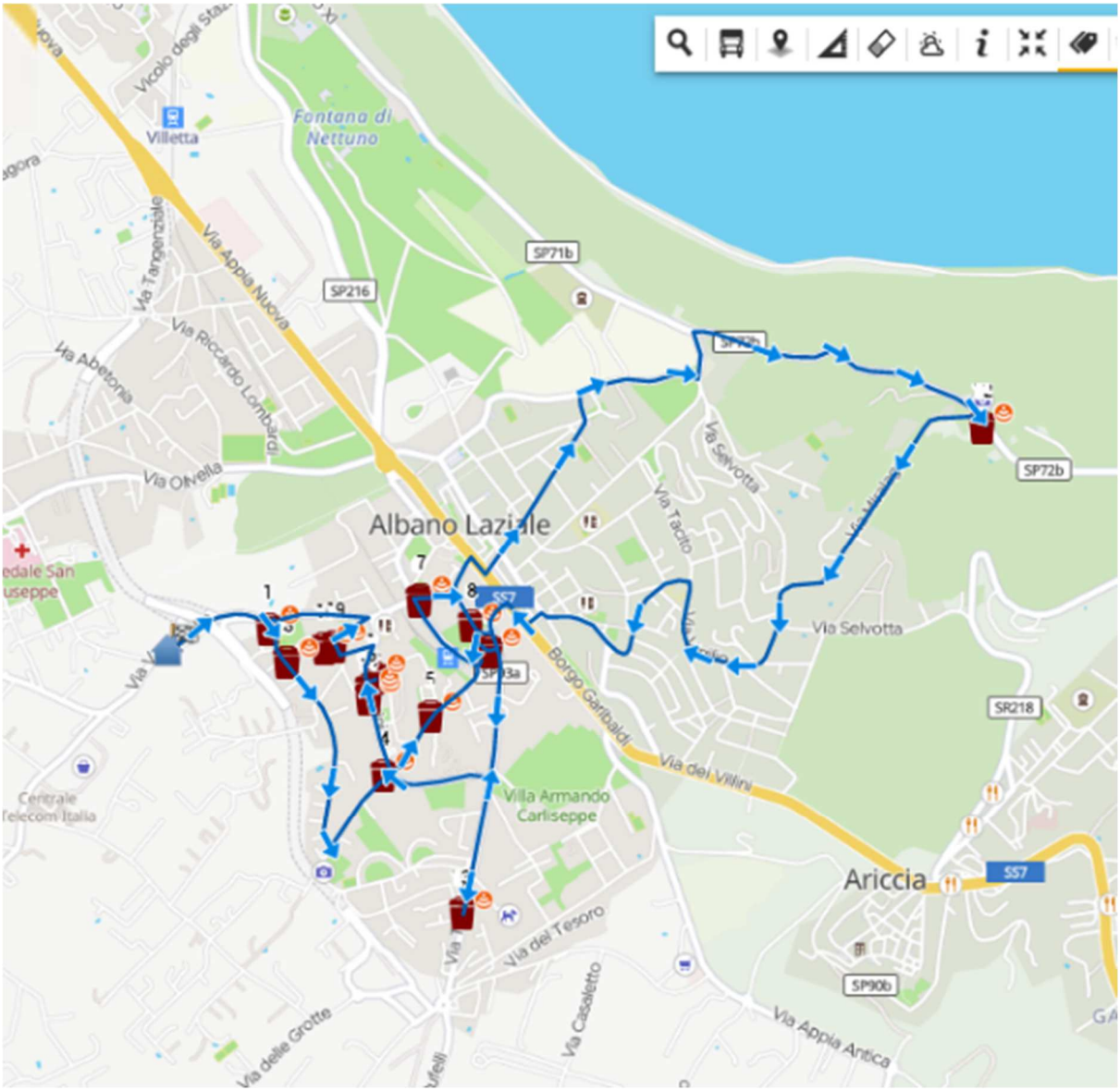

Figure 18. Collection route of 19 containers with time optimization.

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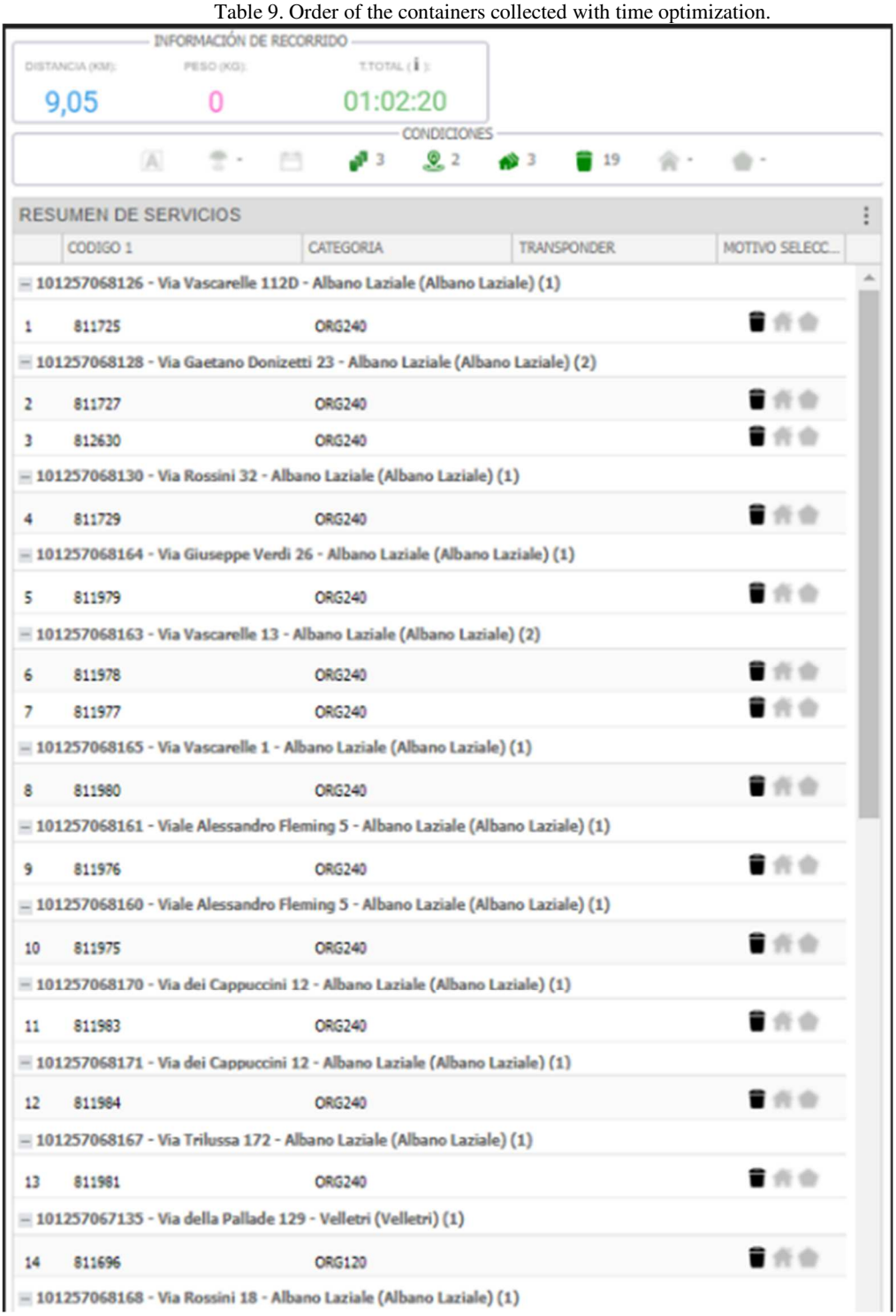
The collection order with real distance and time between containers for the theoretical route after route optimization is shown in Table 9.

Table 9. Order of the containers collected with time optimization.



INFORMACIÓN DE RECORRIDO

DISTANCIA (KM):	PESO (KG):	T.TOTAL (i):
9,05	0	01:02:20

CONDICIONES

3 2 3 19

RESUMEN DE SERVICIOS

	CODIGO 1	CATEGORIA	TRANSPONDER	MOTIVO SELECC...
101257068126 - Via Vascarelle 112D - Albano Laziale (Albano Laziale) (1)				
1	811725	ORG240		
101257068128 - Via Gaetano Donizetti 23 - Albano Laziale (Albano Laziale) (2)				
2	811727	ORG240		
3	812630	ORG240		
101257068130 - Via Rossini 32 - Albano Laziale (Albano Laziale) (1)				
4	811729	ORG240		
101257068164 - Via Giuseppe Verdi 26 - Albano Laziale (Albano Laziale) (1)				
5	811979	ORG240		
101257068163 - Via Vascarelle 13 - Albano Laziale (Albano Laziale) (2)				
6	811978	ORG240		
7	811977	ORG240		
101257068165 - Via Vascarelle 1 - Albano Laziale (Albano Laziale) (1)				
8	811980	ORG240		
101257068161 - Viale Alessandro Fleming 5 - Albano Laziale (Albano Laziale) (1)				
9	811976	ORG240		
101257068160 - Viale Alessandro Fleming 5 - Albano Laziale (Albano Laziale) (1)				
10	811975	ORG240		
101257068170 - Via dei Cappuccini 12 - Albano Laziale (Albano Laziale) (1)				
11	811983	ORG240		
101257068171 - Via dei Cappuccini 12 - Albano Laziale (Albano Laziale) (1)				
12	811984	ORG240		
101257068167 - Via Trilussa 172 - Albano Laziale (Albano Laziale) (1)				
13	811981	ORG240		
101257067135 - Via della Pallade 129 - Velletri (Velletri) (1)				
14	811696	ORG120		
101257068168 - Via Rossini 18 - Albano Laziale (Albano Laziale) (1)				

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The distance registered in the platform for the time-optimized route was **9.05 km** and the duration was **62.20 minutes**.

According to the used collection trucks in Albano (https://www.isuzutruckscn.com/3ton-5ton-isuzu-compressed-waste-garbage-compactor-truck-for-sale_p305.html), the consumed fuel in this route of 9.05 km has been **3.17 liters** and the equivalent CO2 emissions of the truck **6.65 kg.**

Subphase 2.2: Optimization of the current route collecting all the containers in order to minimize distance.

The collection route with distance optimization for the collection of 19 containers in Albano is shown in Figure 19.

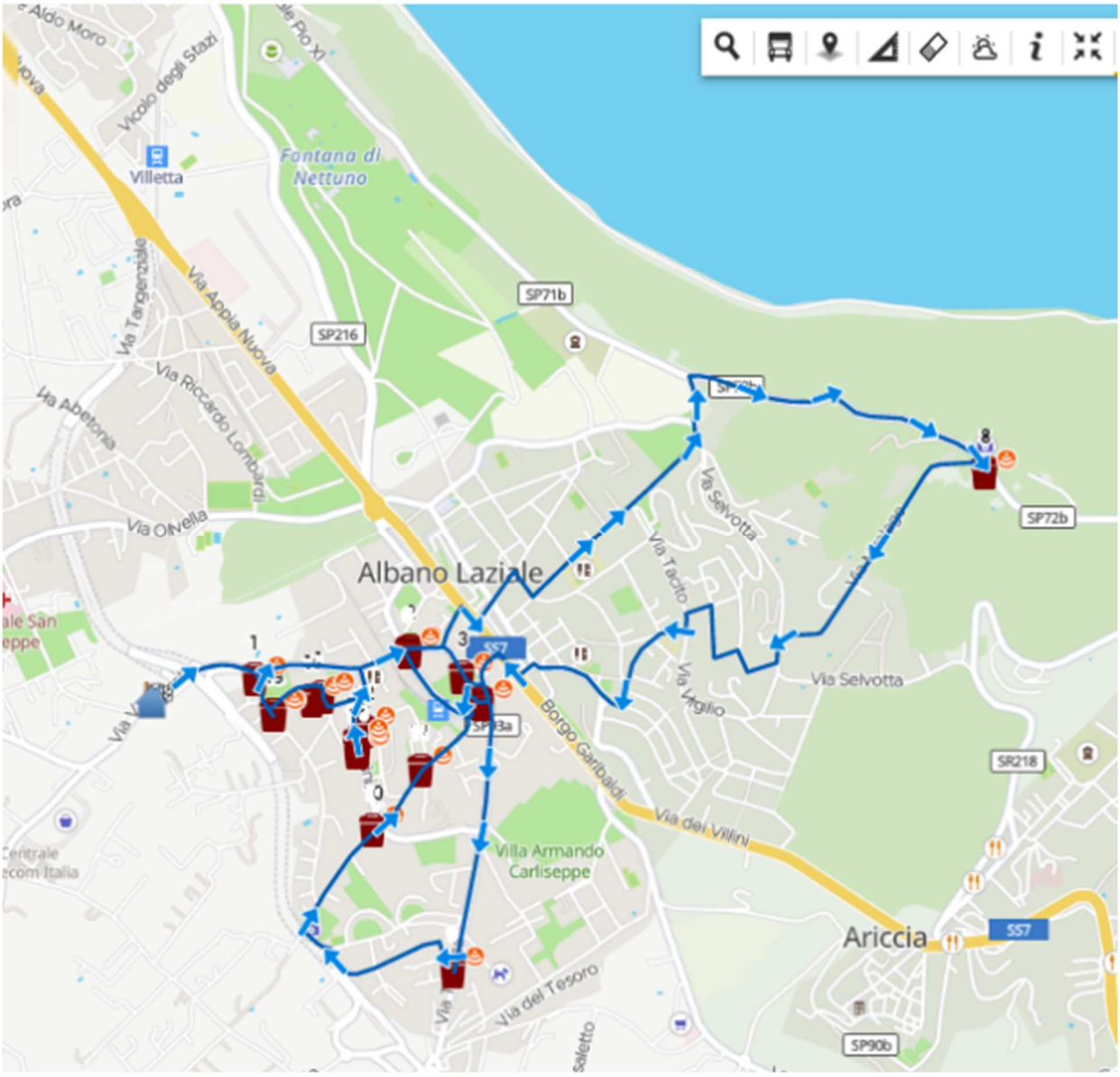
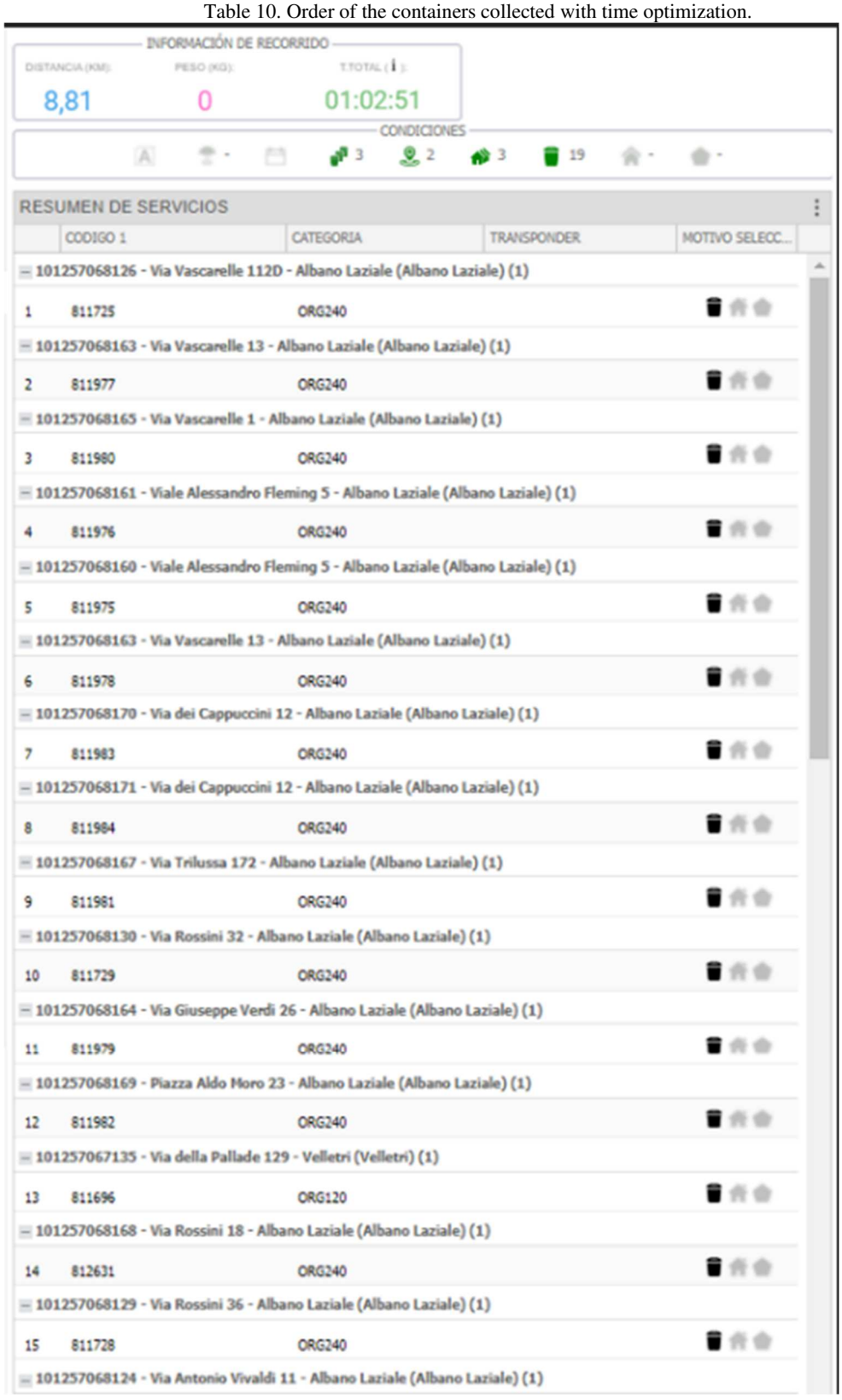


Figure 19. Collection route of 19 containers with distance optimization.

The collection order with the detail of the containers for the theoretical route after route optimization is shown in Table 10.

Table 10. Order of the containers collected with time optimization.



INFORMACIÓN DE RECORRIDO

DISTANCIA (KM):	PESO (KG):	T.TOTAL ( ):
8,81	0	01:02:51

CONDICIONES

3 2 3 19

RESUMEN DE SERVICIOS

	CODIGO 1	CATEGORIA	TRANSPONDER	MOTIVO SELECC...
101257068126 - Via Vascarelle 112D - Albano Laziale (Albano Laziale) (1)				
1	811725	ORG240		
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7	811983	ORG240		
101257068171 - Via dei Cappuccini 12 - Albano Laziale (Albano Laziale) (1)				
8	811984	ORG240		
101257068167 - Via Trilussa 172 - Albano Laziale (Albano Laziale) (1)				
9	811981	ORG240		
101257068130 - Via Rossini 32 - Albano Laziale (Albano Laziale) (1)				
10	811729	ORG240		
101257068164 - Via Giuseppe Verdi 26 - Albano Laziale (Albano Laziale) (1)				
11	811979	ORG240		
101257068169 - Piazza Aldo Moro 23 - Albano Laziale (Albano Laziale) (1)				
12	811982	ORG240		
101257067135 - Via della Pallade 129 - Velletri (Velletri) (1)				
13	811696	ORG120		
101257068168 - Via Rossini 18 - Albano Laziale (Albano Laziale) (1)				
14	812631	ORG240		
101257068129 - Via Rossini 36 - Albano Laziale (Albano Laziale) (1)				
15	811728	ORG240		
101257068124 - Via Antonio Vivaldi 11 - Albano Laziale (Albano Laziale) (1)				

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In the case of the distance-optimized route the distance registered was **8.81 km** and the duration was **62.51 minutes**.

According to the used collection trucks in Albano (https://www.isuzutruckscn.com/3ton-5ton-isuzu-compressed-waste-garbage-compactor-truck-for-sale_p305.html), the consumed fuel in this route of 8,81 km has been **3.08 liters** and the equivalent CO2 emissions of the truck **6.47 kg.**

Phase 3: Optimization of the route based on the filling level of the containers, skipping those containers which are not completely full at the day of collection.

Many routes have been registered in this phase during the pilot, and they will continue being registered until end of September 2022. In this phase, the collection is performed only for the containers which the filling level is more than the 60%. In addition, the route to collect them is optimized by the route optimization system (optimizing in the platform by distance).

The collection for a real optimized route where only 17 containers in the pilot area is shown in Figure 20.

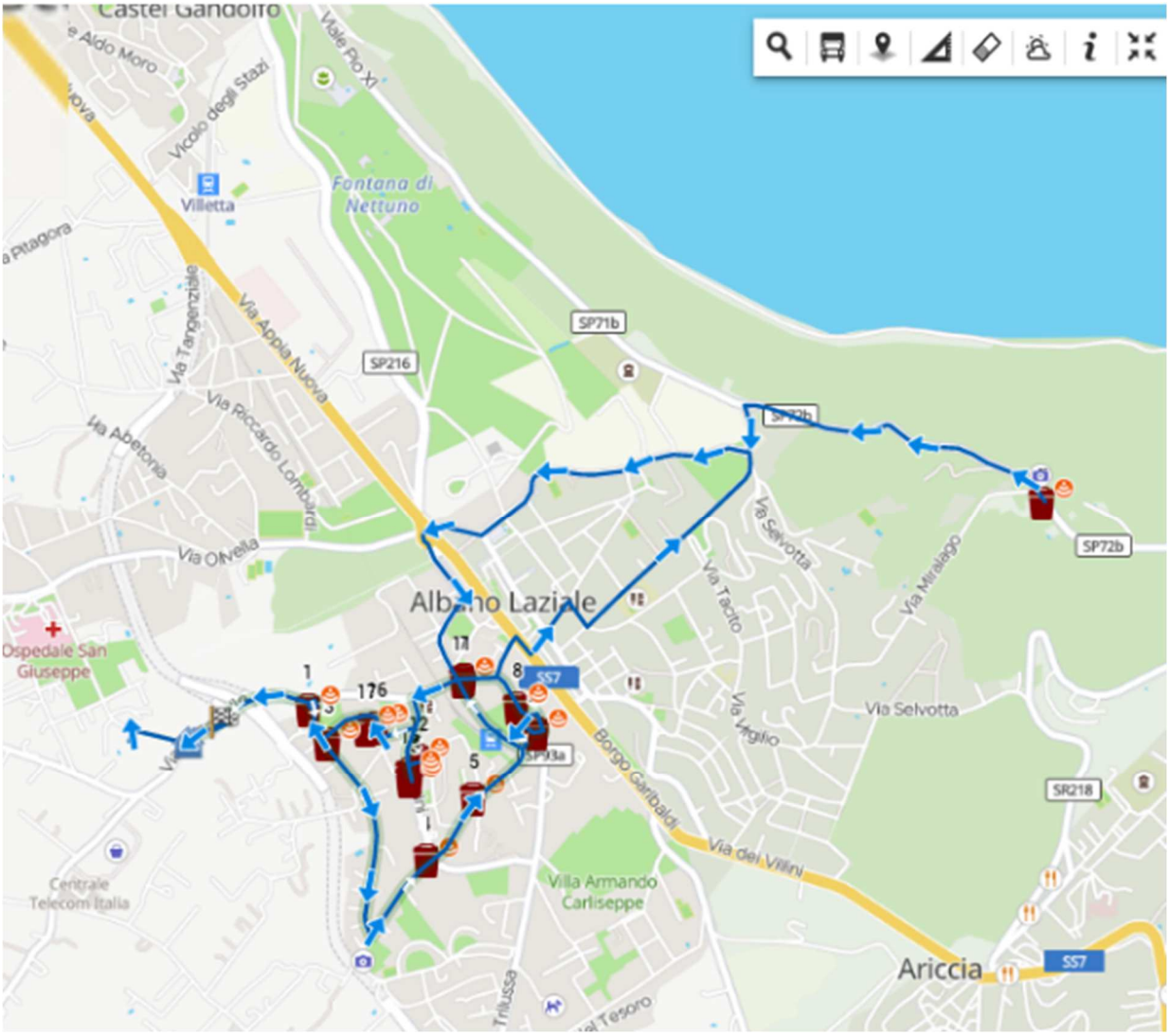
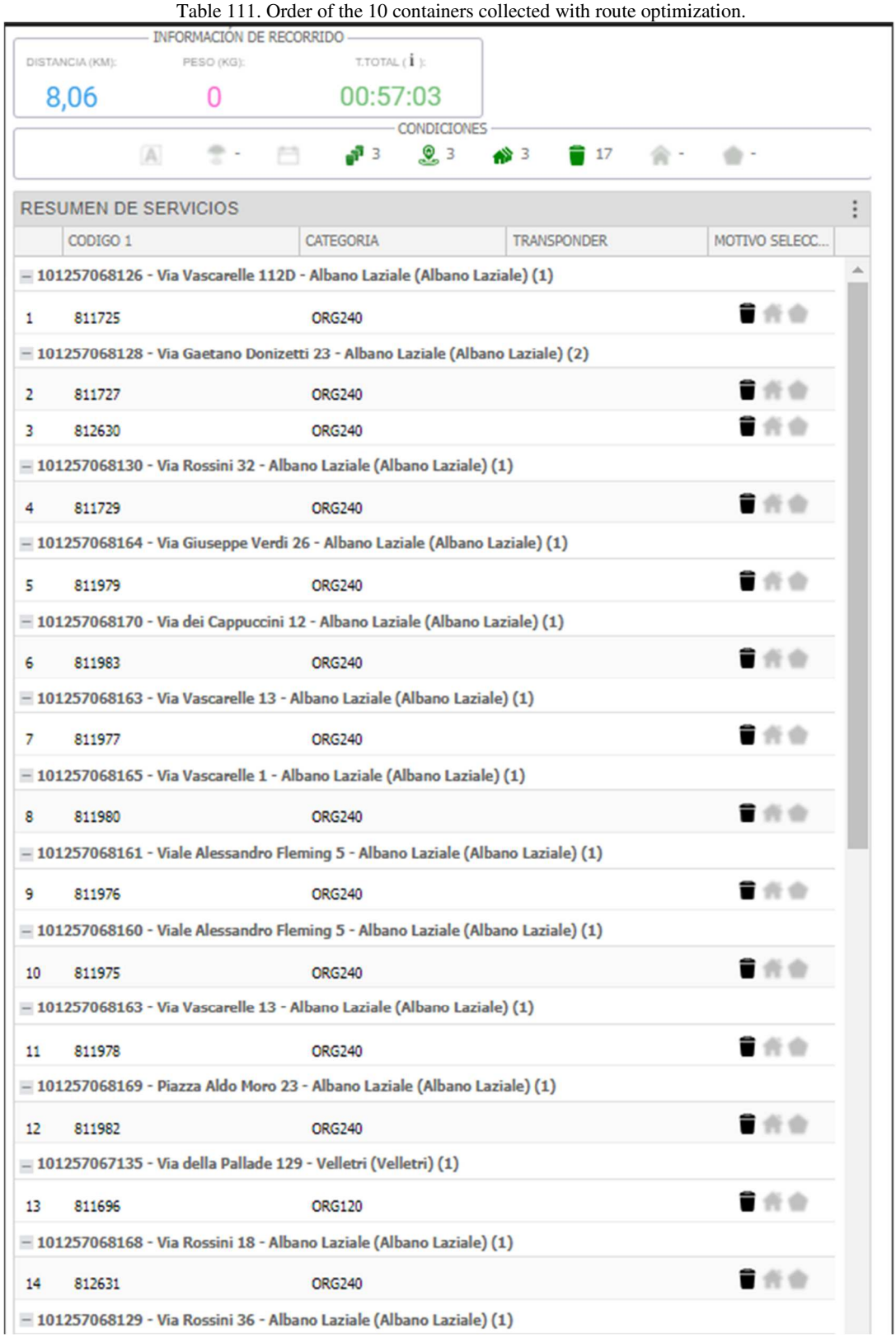


Figure 20. Collection route of the 17 containers with route optimization.

Table 11 shows the order of collection with real distance and time between containers for a real optimized route where only 17 containers in the pilot area where collected.

Table 111. Order of the 10 containers collected with route optimization.



INFORMACIÓN DE RECORRIDO

DISTANCIA (KM):	PESO (KG):	T.TOTAL (i):
8,06	0	00:57:03

CONDICIONES

A - 3 3 3 17 - -

RESUMEN DE SERVICIOS

	CODIGO 1	CATEGORIA	TRANSPONDER	MOTIVO SELECC...
101257068126 - Via Vascarelle 112D - Albano Laziale (Albano Laziale) (1)				
1	811725	ORG240		
101257068128 - Via Gaetano Donizetti 23 - Albano Laziale (Albano Laziale) (2)				
2	811727	ORG240		
3	812630	ORG240		
101257068130 - Via Rossini 32 - Albano Laziale (Albano Laziale) (1)				
4	811729	ORG240		
101257068164 - Via Giuseppe Verdi 26 - Albano Laziale (Albano Laziale) (1)				
5	811979	ORG240		
101257068170 - Via dei Cappuccini 12 - Albano Laziale (Albano Laziale) (1)				
6	811983	ORG240		
101257068163 - Via Vascarelle 13 - Albano Laziale (Albano Laziale) (1)				
7	811977	ORG240		
101257068165 - Via Vascarelle 1 - Albano Laziale (Albano Laziale) (1)				
8	811980	ORG240		
101257068161 - Viale Alessandro Fleming 5 - Albano Laziale (Albano Laziale) (1)				
9	811976	ORG240		
101257068160 - Viale Alessandro Fleming 5 - Albano Laziale (Albano Laziale) (1)				
10	811975	ORG240		
101257068163 - Via Vascarelle 13 - Albano Laziale (Albano Laziale) (1)				
11	811978	ORG240		
101257068169 - Piazza Aldo Moro 23 - Albano Laziale (Albano Laziale) (1)				
12	811982	ORG240		
101257067135 - Via della Pallade 129 - Velletri (Velletri) (1)				
13	811696	ORG120		
101257068168 - Via Rossini 18 - Albano Laziale (Albano Laziale) (1)				
14	812631	ORG240		
101257068129 - Via Rossini 36 - Albano Laziale (Albano Laziale) (1)				

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The distance registered in the platform for the real optimized route for the collection of 17 containers was **8.06 km** and the duration was **57.03 minutes**.

According to the used collection trucks in Albano (https://www.isuzutruckscn.com/3ton-5ton-isuzu-compressed-waste-garbage-compactor-truck-for-sale_p305.html), the consumed fuel in this route of 8,06 km has been **2.82 liters** and the equivalent CO2 emissions of the truck **5.92 kg.**

Additionally, the collection for a real optimized route (of another day) where only 10 containers in the pilot area is shown in Figure 21.

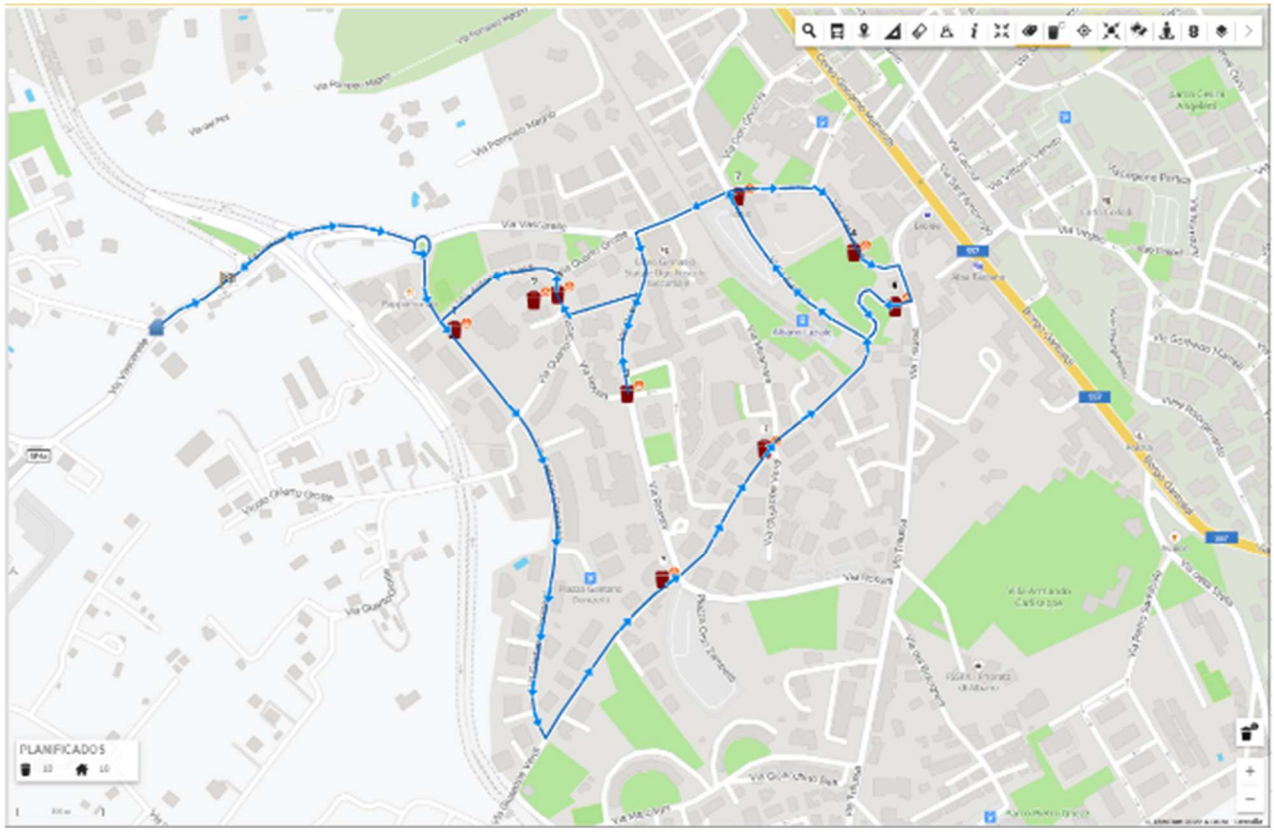
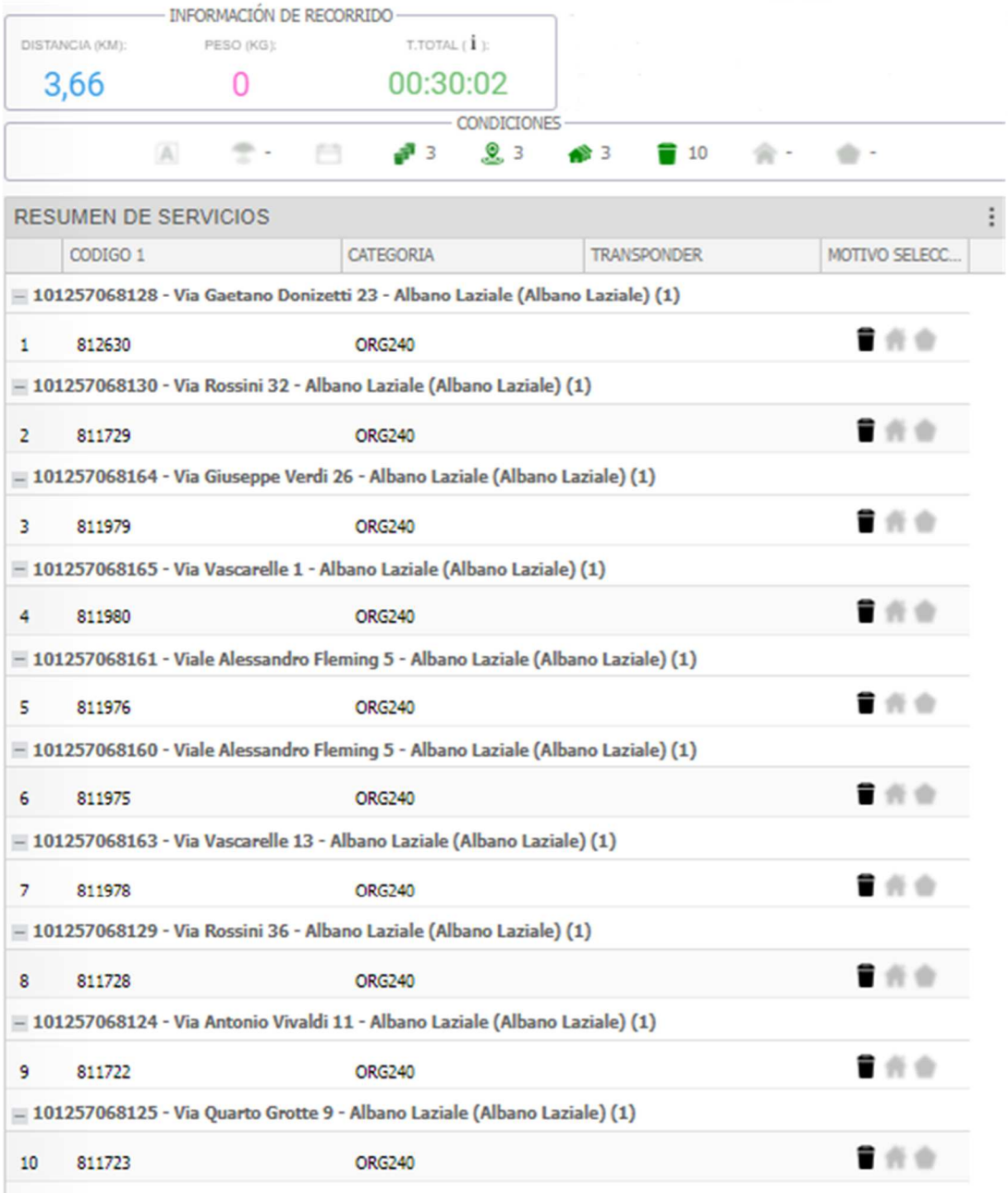


Figure 21. Collection route of the 10 containers with route optimization.

Table 12 shows the order of collection with real distance and time between containers for a real optimized route where only 10 containers in the pilot area where collected.

Table 122. Order of the 10 containers collected with route optimization.



INFORMACIÓN DE RECORRIDO

DISTANCIA (KM):	PESO (KG):	T.TOTAL (i):
3,66	0	00:30:02

CONDICIONES

A - 3 3 3 10 - -

RESUMEN DE SERVICIOS

	CODIGO 1	CATEGORIA	TRANSPONDER	MOTIVO SELECC...
101257068128 - Via Gaetano Donizetti 23 - Albano Laziale (Albano Laziale) (1)				
1	812630	ORG240		
101257068130 - Via Rossini 32 - Albano Laziale (Albano Laziale) (1)				
2	811729	ORG240		
101257068164 - Via Giuseppe Verdi 26 - Albano Laziale (Albano Laziale) (1)				
3	811979	ORG240		
101257068165 - Via Vascarelle 1 - Albano Laziale (Albano Laziale) (1)				
4	811980	ORG240		
101257068161 - Viale Alessandro Fleming 5 - Albano Laziale (Albano Laziale) (1)				
5	811976	ORG240		
101257068160 - Viale Alessandro Fleming 5 - Albano Laziale (Albano Laziale) (1)				
6	811975	ORG240		
101257068163 - Via Vascarelle 13 - Albano Laziale (Albano Laziale) (1)				
7	811978	ORG240		
101257068129 - Via Rossini 36 - Albano Laziale (Albano Laziale) (1)				
8	811728	ORG240		
101257068124 - Via Antonio Vivaldi 11 - Albano Laziale (Albano Laziale) (1)				
9	811722	ORG240		
101257068125 - Via Quarto Grotte 9 - Albano Laziale (Albano Laziale) (1)				
10	811723	ORG240		

In the case of the collection of 10 containers the distance registered in the platform for the real optimized route was **3.66 km** and the duration was **30.02 minutes**.

According to the used collection trucks in Albano (https://www.isuzutruckscn.com/3ton-5ton-isuzu-compressed-waste-garbage-compactor-truck-for-sale_p305.html), the

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consumed fuel in this route of 3,66 km has been **1.28 liters** and the equivalent CO2 emissions of the truck **2.69 kg.**

Table 13 summarizes the results obtained during the route optimization in Albano.

Table 133. Results obtained in the route optimization of Albano.

PHASE	DISTANCE (m)	TIME (min)	FUEL (liters)	CO_2 eq (kg)
1	11,000	95.0	3.85	8.09
2.1 - time	9,050	62.2	3.17	6.65
2.2 - distance	8,810	62.51	3.08	6.47
3 (17 cont.)	8,060	57.03	2.82	5.92
3 (10 cont.)	3,660	30.02	1.28	2.69

These results have been used to calculate the efficiency improvements in terms of savings in distance, time, fuel consumption and CO_2 emissions compared to the results obtained without route optimization. Table 14414 summarizes the results of efficiency obtained in the different phases during the route optimization in Albano.

Table 144. Efficiency obtained in the route optimization of Albano.

PHASE	EFFICIENCY DISTANCE (%)	EFFICIENCY TIME (%)	EFFICIENCY FUEL (%)	EFFICIENCY CO_2 eq (%)
2.1 - time	17.7	34.5	17.7	17.8
2.2 - distance	19.9	34.2	20.0	20.0
3 (17 cont.)	26.7	40.0	26.8	26.8
3 (10 cont.)	66.7	68.4	66.8	66.7

When the 19 containers are optimized by time (*phase 2.1*), the route improves around **17-18%** in **distance (km), fuel consumption (l) and equivalent CO2 (kg)**, regarding to the situation before the pilot without optimization (*phase 1)*. And **34.5% in the efficiency time (min)**.

When the same comparison is done but with the 19 containers optimized by distance (*phase 2.1*), the improvement route is around **20% in distance (km), fuel consumption (l) and equivalent CO2 (kg)**, regarding to the situation before the pilot without optimization (*phase 1).* And **34.2% in the efficiency time (min).**

And finally, the two last lines of the table (*phase 3*), indicate the improvement of these KPIs when less containers are collected (due to the sensors and platform information), and also compare these situations to the initial condition (*phase 1*), when the optimization wasn't done.

Characterisation

ANCI Lazio with the pilot city of Albano Laziale and the support of the municipal company VOLSCA AMBIENTE E SERVIZI SpA, has worked to improve the characterization of the separate collection of the organic fraction. Following the chemical analyzes carried out every six months on collected organic samples, it was found that the "organic" material went from a percentage of 86.27% to 90.22% with an improvement in percentages equal to 4,6%. Specifically, the "compostable" material (which includes other compostable fractions) went from 98.38% to 98.52% with minimal variation.

Another important element that was considered throughout the design was the presence of undifferentiated in the organic material, i. e., thanks to the work with stakeholders, the value went from 1.62% in 2019 to 1.48% in 2022 with a percentage reduction of 8%.

As a further evaluation element, the incidence of mater-b bags absent in the calculation of 2019 must be indicated, while in 2022 they represent a percentage of 1.43%.

A greater presence of impurities was also observed in the organic fraction collected in the HORECA sector compared to that of domestic users. Therefore, the interest in working to raise awareness among stakeholders on the issue was confirmed, with the aim of increasing the quality standards of the staff collected as much as possible.

In this context, a total of eight BIOWASTE MEETINGS were held. One of them took place on 24 June 2021, under the title *"Dialogo, opportunità e prospettive per il settore HORECA"* (Dialogue, opportunities, and prospects for the HORECA sector), and focused on the potential for recovery and valorization of OFMSW, and on raising awareness of the deployment of an optimized

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collection and transport system for such waste. To this end, emphasis was placed on the need to raise awareness among companies in the sector, starting with proper separation/characterization of waste at source. This meeting was attended by 11 representatives of HORECA companies.

Figure 22. Call for the meeting on 24 June 2021.

Later, another meeting held on 8 July 2021 was dedicated exclusively to pilot action using volumetric sensors. The meeting was attended by 11 managers of the HORECA sector while a total of 51 representatives of this sector operating both in the historic center and in the outskirts of Albano Laziale were contacted.

Furthermore, an important improvement is represented by the acquisition by the Municipality of an electromechanical composting plant for biodegradable urban waste from kitchens and canteens of 10 tons/day. The public tender was launched in 2020 and the contract with the contracting company was signed in 2021. To date, the construction of the plant has been completed and is in *Via della Cancelliera, Km2,2* and the procedure for the authorization of the plant must be proceeded.

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Notably, a project flow rate of 5 ton/g for 3 g/week was estimated, thus obtaining a total of 5 ton x 156 days of reception, to obtain 780 tons/year of organic and reducing the costs of the plants themselves. This change is important in the current organizational management model of Lazio, where the treatment and valorization of organic waste is expensive due to the lack of nearby treatment plants. This problem forces local administrations to send these flows to plants outside their territorial area, with a consequent increase in treatment and transport costs.

Specifically, 10 tons/day of biodegradable urban waste represent 15% of the MSW and total biodegradable urban waste collected in Albano Laziale. Through the work carried out within the BIOWASTE CLUBs it will be possible to sign an agreement with a Farmers' Association for the use of the compost produced as fertilizer.

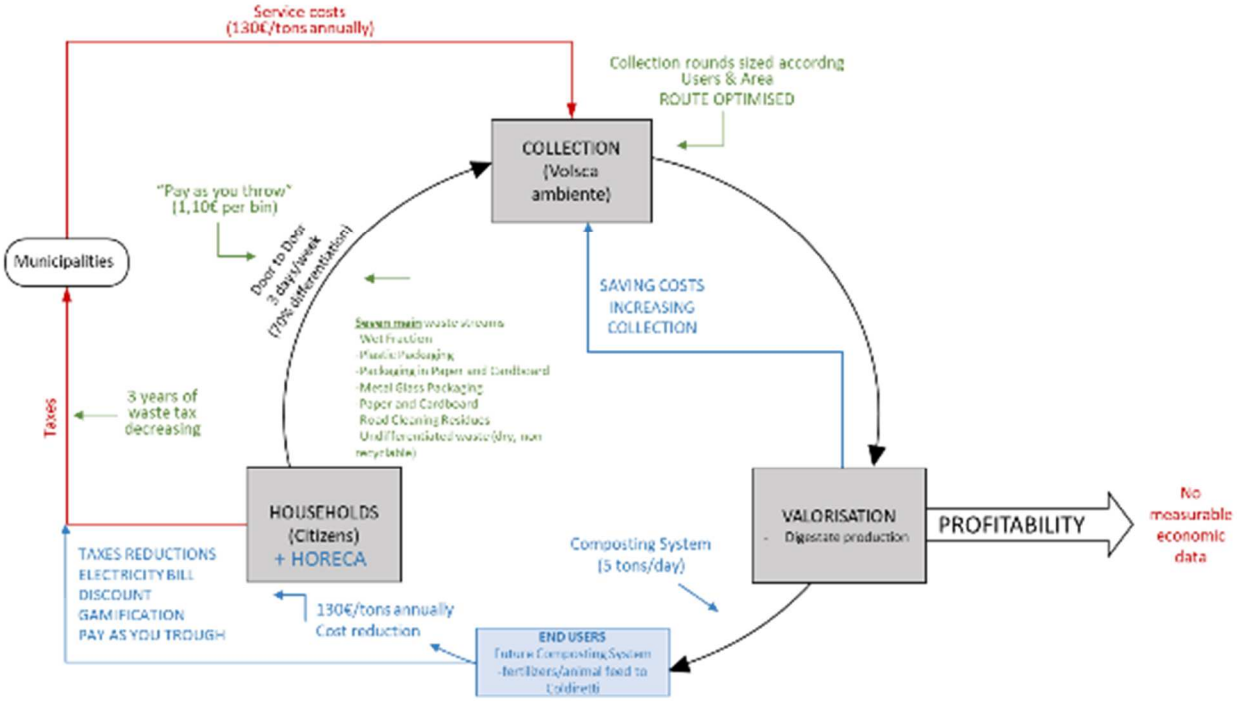

Figure 23. Flow chart of the system to be implemented for the recovery of OFMSW from households and HORECA in Albano Laziale.

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4.5 Kozani Pilot

4.5.1 Status before the pilot

Before the implementation of the pilot project, the 26 containers were collected in Kozani without any optimization. In order to optimize this route, the first step was to find out how the containers were usually collected twice a week.

In the Table 15 the identification number, the address and the coordinates (latitude and longitude) of each container are indicated.

Table 15. Location information of the 26 containers in Kozani.

#ID SENSOR	ADRESS	LATITUDE	LONGITUDE
49	GR. LAMPRAKI	40.292222	21.783056
50	N. ZORMPA	40.290278	21.7825
51	G. PAPANDREOU	40.2925	21.783889
52	AIANIS	40.291667	21.784444
53	3RD SEPTEMBRIOU	40.292778	21.786111
54	ER. AGIOY ATHANASIOY	40.291389	21.786389
55	ER. AGIOY ATHANASIOU (ADIEKSODO)	40.289722	21.786667
56	SX. KALOSTYPI	40.291944	21.787778
57	KARAISKAKI – THOUKIDIOU	40.290278	21.787778
58	PLATONOS	40.293611	21.786944
59	MAKRYGIANNI	40.293889	21.787222
60	EPIKOYROY	40.290833	21.790833
61	PAPAFI	40.292222	21.792222
62	KAKRIDI	40.291111	21.794167

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63	KOLOKOTRWNI	40.289444	21.795556
64	TH. MILISIOU	40.289444	21.791111
65	SLIMAN	40.290833	21.796111
66	SLIMAN	40.291944	21.795278
67	KSUGKOPOYLOY	40.291944	21.796111
68	KAROYZOY	40.293056	21.797778
69	KAKRIDI (KRHTIKOS)	40.290278	21.794444
70	G. MYLONA	40.293333	21.796667
71	ANTIGONOY	40.291111	21.796111
72	PAPAXATZI	40.290556	21.7975
73	KAKRIDI	40.293333	21.795
74	IONIAS	40.290833	21.798333

In the Figure 24 the position of the containers in Kozani area can be seen. The number indicates the identification number of each container.

Figure 24. Position of the 26 containers in Kozani.

4.5.2 Results

Not public information.

More information in "D3.6. Confidential annex".

5. CONCLUSIONS

The Best Practices to solve problems in each city have been focused on:

- **Albano Laziale (Italy)** ➔ Collection, transport and characterization.
- **Kozani (Greece)** ➔ Collection, transport and characterization.
- **Madrid (Spain)** ➔ social awareness, sorting, pre-treatment and characterization.
-

The SCALIBUR pilots in the three cities have been a considerable improvement for them, with successful **results.** In terms of savings, the optimization has been done in: distance done by the collection trucks (km), time required by the trucks to do the collection route (min), fuel used by the trucks during the collection routes (l) and equivalent CO2 emissions occurred during the routes (kg).

In Kozani and Albano the pilot has been studied in three phases:

- Phase 1 ➔ The routes which made the trucks before the pilot, without any optimization.
- Phase 2 ➔ The routes of the cities with every container (regardless the information of the sensors) but optimized with the platform, in time (phase 2.1) and in distance (phase 2.2).
- Phase 3 ➔ Different routes of different days during the months of the pilots with different number of containers to collect.

In Kozani, the improvement percentages in each stage have been in savings in terms of distance done by the collection trucks, time required to do the route, fuel consumed by the trucks and CO_2 emissions.

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Each stage have been compared to the results obtained without route optimization (phase 1). The following table Table 24 summarizes the results of efficiency obtained in the different phases during the route optimization in Kozani.

Table 245. Efficiency obtained in the route optimization of Kozani.

PHASE	EFFICIENCY DISTANCE (%)	EFFICIENCY TIME (%)	EFFICIENCY FUEL (%)	EFFICIENCY CO_2 eq (%)
2.1 - time	13.6	23.5	13.5	13.3
2.2 - distance	16.2	19.9	16.1	15.9
3 (10 cont.)	42.6	43.4	42.4	42.4
3 (9 cont.)	47.5	45.1	47.4	47.3

As can be seen during phase 2 in which the current collection route has been optimized using the technological platform, **theoretical improvements of around 13-24% have been achieved with respect to the usual route in Kozani** by collecting all the containers installed in the municipality.

With respect to the real optimization (phase 3), by collecting only the containers above the previously established level, the improvement obtained is notably greater, **reaching improvement values of around 42-48% with respect to the non-optimized route**.

On the other hand, in the same way, the results of the improvements in Albano are the following ones:

Table 256. Efficiency obtained in the route optimization of Albano.

PHASE	EFFICIENCY DISTANCE (%)	EFFICIENCY TIME (%)	EFFICIENCY FUEL (%)	EFFICIENCY CO_2 eq (%)
2.1 - time	17.7	34.5	17.7	17.8

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2.2 - distance	19.9	34.2	20.0	20.0
3 (10 cont.)	26.7	40.0	26.8	26.8
3 (9 cont.)	66.7	68.4	66.8	66.7

When the 19 containers are optimized, the route improves around **17-20%** in **distance (km), fuel consumption (l) and equivalent CO2 (kg)**, regarding to the situation before the pilot without optimization (*phase 1)*. And **34% in the efficiency time (min)**.

And finally, the two last lines of the table (*phase 3*), indicate the improvement of these KPIs when less containers are collected (due to the sensors and platform information), and also compare these situations to the initial condition (*phase 1*), when the optimization wasn't done.

Eventually, the BBPP selected for the pilot of the city of Madrid can be summarized as follow: social awareness, sorting, pre-treatments and characterization. Indeed, these implementations were in line with the main strategies and focus of the municipality of Madrid in their search of a green city. Therefore, as a result of this work, remarkable results in the increase of the organic matter content from 2019 to 2022, from 75 % to 83 %, were achieved, resulting in enormous benefits and promising valuable source.

6. ANNEX 1: BEST PRACTICES

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SCALIBUR Factsheets
SCALIBUR
Collection
1. Homogeneous bring banks around the country
2. Implementation of an underground container system
3. App for on-demand collection from HORECA
4. Containers with chip to register filling levels
5. Use of biodegradable and biocompostable bags for collection
6. Start collecting of biowaste at schools
7. Specific collection system adapted to each situation
8. Efficient collection during summer
9. Selective collection of biowaste from the Horeca waste
10. Collection of Open market biowastes
11. User-friendly collection containers
12. Volunteer collection of biowaste
13. Anaerobic digestion plant
14. Containers with an ergonomic design
Transport
15. Software designed optimised waste collection route
16. Compacting collection trucks
17. Using electric trucks to collect waste
18. Truck traceability
19. Eco-driving
Social awareness
20. Clear instructions on the containers and bags
21. Pay-as-you-throw principle for fee calculation
22. Educational areas in Recycling Yards
23. Events, roadshows and workshops
24. Competition rewarding the best performance in biowaste collection
25. Schools campaign
26. Publication of positive recycling news as TV advertisement
27. Include citizens actively in the information loop
28. Waste ambassadors
29. Website on biowaste and recycling
30. Associations of citizens providing direct feedback to municipalities
31. Targeted communication campaigns
32. Dissemination of the environmental and economic benefits of biowaste recycling
Characterisation
33. Data collection and monitoring quality parameters
34. Monitoring and control of the composition of residual waste in other recycling streams
www.scalibur.eu
SCALIBUR project


SCALIBUR
Best Practices:
Collection
SCALIBUR
LEADING A REVOLUTION
IN BIOWASTE RECYCLING
www.scalibur.eu
SCALIBUR project

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Homogeneous bring banks around the country

Collection | Transport | Characterisation | Social awareness

Best practice factsheet #1

SCALIBUR

Challenge

Size and shape of the containers is really important as no uniformity can later condition the transport, making it more difficult. Also, when bring banks look the same around the whole city, people tend to recognise them easily and can recycle more. According to the EEA, the collected fraction of bio-waste varies greatly from one EU country to another. In this context, less than 10% of municipal bio-waste is collected in certain countries such as Bosnia-Herzegovina, Cyprus, North Macedonia, Portugal, Spain or Turkey, so there is a great room for improvement regarding this aspect.

Action

Use the same colour in the containers for the selective collection of organic waste in all the region or country.

Implementation

1. Analyse morphology and socio-demography of the municipality.
2. Constant communication activities during the implementation of the system towards every main stakeholder.
3. The containers should be located within a short distance from the entry door of the apartment blocks so that it is not too inconvenient for users, and it reduces noise issues for the surrounding apartments.
4. Monitoring [illegible]

Results

Bring point collection is applied for the collection of recyclable materials and mixed waste. The advantage of this system is mainly that the collection points across the city are reduced substantially compared to door-to-door systems. Consequently, the homogenisation of colours, size, and shape of the containers facilitates recycling while improves the quality of the collected organic fraction. Bring systems can also be complementary to door-to-door collection and they may target specific materials that are not covered by door-to-door collection.

Example

Veneto, Italy

Within the region of Veneto, the public company Contarina is responsible for the management of waste in Treviso, amongst others. ... 554 000 inhabitants in 50 municipalities ... reached levels of source separation of up to 85% and generates only 53kg of residual waste per inhabitant and year. In contrast, the EU average level is a 42% source separation and a 208 kg per inhabitant ... major waste-streams: non-recyclable dry, organics (food scraps), garden waste, paper and cardboard, glass, plastic and tin. They are placed in special colour coded bins that are readily available ...

Benefits

Benefits	€	🚶	🍃
Better identification of the correct bring bank to recycle the different types of waste	○	○	○
Higher quality of the organic fraction	○		○
Increased community commitment to the environment		○	○
Increase in the recycling rate	○	○	○

Curbside collection

Further reading

1. https://ec.europa.eu/environment/pdf/WasteManagement...
2. https://greeneuropeanjournal.eu/...CONTARINA...pdf

www.scalibur.eu | SCALIBUR project

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N° 817788.

Implementation of an underground container system

Collection | Transport | Characterisation | Social awareness

Best practice factsheet #2

SCALIBUR

Challenge

Solid waste collection systems are one of the most important activities in urban management. In 2016, Europe generated 2740 million tonnes of municipal solid waste, which is almost 477 per capita. Cities in Europe spend up to 120 €/tonne dealing with their waste management system. Unfortunately, and despite their high running costs, systems currently used in modern cities have some weaknesses, for instance in the case of containers, and ... they do not provide a service of sufficient ... quality. In this sense, it is common that in some cases containers are too small and consequently, they become overcrowded, littering the city and causing odours, visual impact, and reducing the quality of the urban environment.

Action

Implementation of an underground collection system to collect biowaste in order to ... improve the collection efficiency.

Implementation

1. Conduct a first morphology and socio-demography research on where the containers should be placed. The municipality should bear in mind the walking distance to the container (less than ...), the safety, the accessibility for the garbage truck, or any obstacles such as trees, cables, pipes...
2. After the investigation, the municipality should submit the proposal on the location of the underground containers. Citizens who live in the neighbourhood should be able to appeal or to propose new locations.
3. The municipality, after reviewing all the responses from citizens, will make a final implementation plan.
4. Search for companies specialised in implementing underground container systems and contact them for a quotation. Analyse the catalogue of underground containers available and select the best fitting one.
5. Place the containers in the desired locations.
6. After the implementation, constant monitoring on the collection system is recommended to improve possible flaws.

Results

Replacing common waste bins by underground containers with a high capacity for waste implies several direct benefits for the urban environment as mentioned below: 1) the system avoids the visual impact of containers on the street, 2) it dignifies the urban area, which can be used for other purposes, 3) it makes waste disposal more accessible for citizens, 4) and a greater cleanliness is achieved. They are also an interesting solution to overcome difficulties linked with the implementation of separated collection in dense areas and vertical housing.

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This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N° 817788.

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Implementation of an underground container system

Collection | Transport | Characterisation | Social awareness

Best practice factsheet #2

SCALIBUR

Benefits

Benefits	€	Social	Environment
A higher collection capacity as the container is underground	○		○
Collection frequency is reduced, lowering costs and reducing environmental impacts from traffic	○		○
As temperature below ground level is lower and more stable, waste decomposition and odours are reduced		○	○
Waste is stored up to a height of 2.5m, resulting in better compaction by its own weight	○		
Public areas are unburdened and the cities aesthetic is better		○	
Vandalism and the possibility of re-collection is reduced		○	
Containers take less space therefore more parking space is available	○	○	○

Example[4]

In the Portimão area, in Portugal introduced underground collection points to the town's collection system in 2010. Amongst the main problems that led this change were hygiene impacts specially during summer months (flies, odours, rodents...), aesthetic and improvement of both recycling rates and the flexibility in collection frequency. According to the EMARP (Empresa Municipal de Águas e Resíduos de Portimão) the savings offered by the adoption of the system reach up to 35% compared to the old collection scheme. Also, the truck collection crews have been reduced from 3 to 2 persons while an increase of productivity of 10 hours per week per truck crew is attained.

Source: https://www.dlsplast.nl/underground-containers

Further reading

1. https://ec.europa.eu/eurostat/statistics-explained/index.php/Waste_statistics#Waste_treatment
2. "Costs for Municipal Waste Management in the EU final Report to Directorate General Environment, European Commission" (2002)
3. https://www.dlsplast.nl/...underground-containers
4. https://www.iswa.org/index.php?eID=tx_iswaknowledgebase_download&documentUid=3157

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N° 817788

App for on-demand collection from HORECA

Collection | Transport | Characterisation | Social awareness

Best practice factsheet #3

SCALIBUR

Challenge

In the EU over 100 million tonnes of biowaste are thrown away each year – around 250 kg per person. Currently 75% of this goes to landfill or is incinerated, causing major environmental problems: biowaste produces greenhouse gases when it decomposes and contaminates soil and groundwater. landfilling of biowaste goes against the principle of a circular economy and is a waste of nutrients, energy and resources for bioproducts. It is usual in the HORECA sector that the waste bins are filled before the collection date, avoiding more waste to be collected. When the opposite happens, bins are not completely full the collection is not optimised.

Action

Implementation of an app that allows the HORECA sector to have on-demand collection when needed.

Implementation

1. Find a company to help create an app for waste collection.
2. Inform the HORECA sector on how they can use and install the app.
3. Train personal on its use.
4. Perform periodic checks to verify proper functioning and periodic maintenance.

Results

When implementing an app for on-demand collection for the HORECA sector it can have a big impact on the amount of waste collected. It gives restaurants and hotels more flexibility and control and optimised resources for the waste management system, because biowaste is collected quickly. It significantly reduces the amount of waste sent to landfill. IT can also help with keeping streets free from unsightly discarded materials.

Benefits

Benefits	€	Social	Environment
Efficiency of the separate collection service, avoiding "empty" trips because the containers have not yet been filled for various reasons.	○		○
Increased satisfaction of the municipal service and users		○	
Increase in the quality of composting	○		○

Example

Yo-waste[1]

Yo-Waste is a tech waste management company that provides waste, recycling and smart city solutions to businesses and governments. As start-up based in Uganda, they connect local waste haulers and recycling businesses to customers who need their services through mobile app and website. This app allows anyone who owns a truck to sign up as a garbage collector and get access to the variety of customers that need their services.

Recycle Track Systems[2]

Recycle Track Systems (RTS), a waste and recycling technology company headquartered in New York City, launched their On-Demand Waste & Recycling Pick-Up App in 2015. RTS uses a software platform and a proprietary tracking system to provide hauling services for businesses. The app is an easy and quick way to accurately price and schedule pick-ups for traditional, recyclable materials or bulk waste. Users can select from a drop-down of items or simply take and upload a photo of the items they wish to be removed.

Further reading

1. https://yowasteapp.com/
2. https://www.rts.com/services/waste-management-app/

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N° 817788


Containers with chip to register filling levels

Best practice factsheet #4

Collection
Transport
Characterisation
Social awareness

SCALIBUR

Challenge

Action

Implementation

Results

Benefits

Waste collection emits less CO_2

Reduce collection costs by optimizing routes and fuel

Real time filling levels of the containers

Improve government to citizens communication

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Containers with chip to register filling levels

Best practice factsheet #4

Collection
Transport
Characterisation
Social awareness

SCALIBUR

Example

SmartBin Technology in Dublin (Ireland)[1]

Increasing Waste Management Efficiency in Rotterdam (Netherlands)[2]

Further reading

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Use of biodegradable and biocompostable bags for collection

Collection · Transport · Characterisation · Social awareness

Best practice factsheet #5

SCALIBUR

Challenge

The Austrian compost and biogas association KBVÖ (Kompost- und Biogasverband Österreich) reported that 80-90% of impurities in the organic waste collected from households are conventional non-biodegradable bags. To tackle this problem and reduce impurities, biodegradable and biocompostable bags can be used to collect biowaste.

Action

Implement the use of biodegradable and biocompostable bags for biowaste collection.

Implementation

1. Design compostable bags with instructions on how to use them.
2. Make sure this information is also in the containers so citizens know they should use them with biowaste.
3. Give away bags during events or to households that want to recycle.

Results

The use of biodegradable bags can reduce the amount of impurities in biowaste collection as conventional, non-biodegradable bags will be reduced. A study in a Spanish municipality showed that approximately 84% of the population were willing to participate in selective collection of biowaste. This percentage would increase until 88% if the Town Council provided specific waste bins and bags, since the main barrier to participate in the new selective collection system is the need to use specific waste bins and bags for the separation of biowaste[1].

Benefits

Benefits	€	Social	Environment
Contamination in biowaste collection could decrease	○		○
Biowaste is easily collected in bags	○		
Citizens find it easier to handle biowaste if it is in bags		○	
Biowaste produces less odours		○	○

Example

The Austrian compost and biogas association (KBVÖ) plans to launch an initiative aiming to only market single-use carrier bags in Austria that are compostable according to the European standard for industrial composting EN 13432. Combined with a consumer information campaign, the compostable bags are intended to be re-use to collect and dispose organic kitchen waste. This way, more bio waste will be separately collected and diverted from other recycling streams, while, at the same time, the contamination of the collected organic waste with conventional, non-biodegradable plastics will be reduced.

Further reading

1. Bernad D, Sara A, Flores MD. Attitude towards the incorporation of the selective collection of biowaste in a municipal solid waste management system. A case study. Waste Manag. 2014; 34 (12): 2414-2444 doi:10.1016/j.wasman.2014.08.023
2. https://www.biosackerl.at/

Start biowaste collection at schools

Collection · Transport · Characterisation · Social awareness

Best practice factsheet #6

SCALIBUR

Challenge

Schools often produce tremendous amounts of waste with instructional materials, used electronics, and food. One estimate is that 24% of school waste is recyclable paper and 50% is food waste and non-recyclable paper that can be composted. But teachers and students can work collaboratively to reduce the amount of waste produced[1]. Getting students and teachers involved in recycling at school is good for the environment, educational and can be a lot of fun. Educating our children about the importance of recycling provides the country with a path to a greener future. As children learn about recycling, they will be more likely to carry these habits into their adult years. They also will learn how their personal actions can affect the future.

Action

An educational project promoting the collection of biowaste in schools, where they will be a starting point to collect organic waste.

Implementation

1. Contact schools and inform them of the project and its benefits.
2. Set up biowaste recycling bins for each classroom so children and teachers can use them.
3. Make sure they are clearly labelled and placed in obvious places.
4. Brief the teachers about the recycling scheme and hold assemblies to inform the pupils. Make sure that the teachers and staff understand the importance of recycling, and this should filter down to the students.
5. Teachers and children can be involved in making the compost by adding items such as tea bags, coffee granules, fruit and vegetable cuttings from the cafeteria. If your school has a garden, then you can add leaves, plant cuttings and grass trimmings to the compost heap.
6. Organise games and fun activities that help them remember and understand the message without difficulties using simple language.

Results

As any separation at source, the separation of biowaste in the households requires personal efforts in form of awareness and change of habits of the citizens. Therefore, it is important to convey to them the benefits of biowaste collection. Starting collection at schools is a good way to educate students in that way, who tend to bring their experience home and act as multipliers of the information.

Benefits

Benefits	€	Social	Environment
Increase social awareness on the importance of recycling	○	○	○
Increase recycling rates in the city	○		○
Increase quantity and quality of biowaste	○		○
Improvement of the citizens' perception about their municipal entities		○	○

Example

Kindergartens and schools in Liberec to recycle biowaste[2]

A total of 40 composters have been sent free of charge to kindergartens and primary schools in Liberec as the result of cooperation between the town and our subsidiary FCC Liberec. The aim of the joint project is to teach schoolchildren and pre-schoolers to recycle all biowaste.

Uganda schools recycle biowaste[3]

During Martyrs Day, a weeklong celebration that attracts thousands of visitors from all around Uganda, tons of waste is discarded. But students of St. Kizito have come up with ways to collect it and transform it into useful products. The students turn the biowaste collected into organic fertilizer for the school's garden, where they learn how to grow vegetables and they use dried briquettes made from biowaste as fuel to cook school meals.

Further reading

1. https://www.recyclebank.com/articles/guide-to-recycling-at-school/
2. https://www.fcc-group.cz/en/czech-republic/news/kindergartens-and-schools-in-liberec-to-recycle-biowaste.html
3. http://www.ipsnews.net/2017/08/ugandan-students-turn-waste-wealth/

Specific collection system adapted to each situation

Best practice factsheet #7

Collection | Transport | Characterisation | Social awareness

SCALIBUR

Challenge

In low-density areas great distances have to be covered per amount collected which increases the costs and reduces the overall environmental benefit. In rural areas home composting can often be easily implemented and the recovered nutrients can be used locally. A Spanish study[1] of home composting demonstrated a capture rate of 77% of household organic waste with 120 kg/person composted each year. In highly populated areas, door to door collection is more optimal and cost effective. However living space especially in high rise buildings may not allow for storage of several waste streams, hindering source separation. That is why a specific collection system needs to be implemented bearing in mind each particular situation.

Action

Selection of the best collection system (door to door, mobile collection points, bring banks, [illegible]) for each zone of the municipality by considering its specific characteristics and needs (type of building, density of population, climate, infrastructure...).

Results

Adapting the collection scheme to the territory, in particular regarding the frequency, the type of collection (door to door, bring scheme) and the collection vehicle, and testing the scheme at a pilot level before implementing it full scale, by enlarging progressively the territory and promoting biowaste prevention in areas where there is low quantity/potential.

Implementation

1. Development of an understanding of municipal solid waste management. It is important to understand the features of the municipal solid waste management system, the [illegible] factors, the main phases and the actors and organisations involved. Local waste authorities and waste management companies should have an overview of all the [illegible] that their municipal solid waste management system comprises as well as stakeholders involved, including the roles they play.
2. Prepare the appropriate action plan to define the actions to be implemented. Also provide guidelines on how to go from the planning phase to the implementation phase.
3. Monitoring & review is also important to ensure both that the plan remains relevant to its goals and objectives over time. The simplest and most common monitoring tools are visual observations, general feed-back from the work-force and customer complaints.

Source: https://ajuntament.barcelona.cat/

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Specific collection system adapted to each situation

Best practice factsheet #7

Collection | Transport | Characterisation | Social awareness

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Benefits

Benefits	€	Social	Environmental
Lower cost of overall waste management	○	○	
Conservation of raw materials			○
Better coordination between urban services	○	○	○
Better cost management and higher recovery cost	○	○	
Less environmental pollution	○	○	○

Further reading

1. JRC (2011), Del et al. (2018)
2. EU project Mini-waste that inventories good practices regarding bio-waste minimization in Europe (Mini-waste 2012)
3. Vázquez and Soto (2017)
4. AJUNTAMENT DE BARCELONA (2018): Ecology, Urban Planning and Mobility
5. CITY OF COPENHAGEN: Resource and Waste Management Plan 2018

Example

Household waste collection in Barcelona[4]

Barcelona has an extensive municipal service to collect daily household waste according to the characteristics of each urban district. This service is carried out through street containers, door to door bag collection services, pneumatic collection and bins for collections [illegible].

- Brown containers for organic waste: This waste is delivered to ecoparks, where it becomes compost and biogas. All citizens have recycling collection containers located less than 100 metres from their home.
- Manual bag collection service: Door-to-door waste collection of different types of waste and recyclables service in specific areas including the old part of the city, where is especially difficult to place containers or access with vehicles.
- Recycling centre: Used to get rid of municipal waste fractions which can't be thrown into street containers.

Waste management plan 2018 in Copenhagen[5]

The city of Copenhagen established an efficient waste management plan in 2018. The efforts fall under four topics, each with a specific target and several measures and concrete initiatives. Each topic furthermore contains a flagship project.
Under the Topic 2: "Better separation among citizens and business" all citizens in the City of Copenhagen must have access to separation of the most ordinary types of waste near their home, and all institutions of the City will source separate their waste.

Source: https://www.[illegible]

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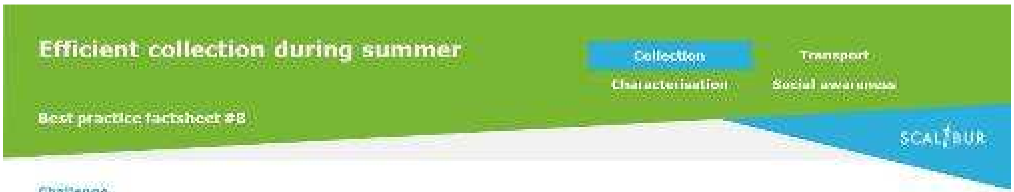

Efficient collection during summer

Collection | Transport | Characterisation | Social awareness

Best practice factsheet #8

SCALIBUR

Challenge

Depending on local conditions such as food and drink habits, type of dwellings, seasons and climate, living standard and degree of economic development, bio-waste accounts for 30% to 40% by weight and volume of municipal solid waste. This proportion is much larger (up to 60%) in Mediterranean countries, due to a larger consumption of vegetables and fruits in the daily diet as well as to the effects of tourism. Especially during the summer months odour nuisance is a problem. In order to overcome this problem, the collection intervals are shortened, and the collection bins get washed regularly.

Action

During summer months the organization of the collection must be very effective in order to avoid problems related to odours, flies, etc.

Implementation

1. Development of an understanding of municipal solid waste management: it is important to understand the features of the municipal solid waste management system, the influencing factors, the main phases and the actors and organisations involved. Local waste authorities and waste management companies should have an overview of all steps/operations that their municipal solid waste management system comprises as well as stakeholders involved, including the roles they play.
2. Prepare the appropriate action plan to define the actions to be implemented. Also provide guidelines on how to go from the planning phase to the implementation phase. The decision to follow a proactive or reactive strategy for vermin, pests and smells, and whether to initiate local government wide actions or address issues on a house-by-house basis, will depend on factors including community support for the service, as well as the available budget and resources. These decisions should be considered in the early planning stages of a new organics service.
3. Continuous monitoring: to monitor change over time, to conclude on the efficiency of activities and/or measures implemented, it is crucial for the monitoring/collection of data becomes a continuous process. That way, seasonal changes can be identified.

Results

As any separation at source, the separation of biowaste in the households requires personal efforts in form of awareness and change of habits of the citizens. Therefore, it is important to convey to them the benefits of biowaste collection. Starting collection at schools is a good way to educate students in that way, who tend to bring their experience home and act as multipliers of the information.

[illegible]

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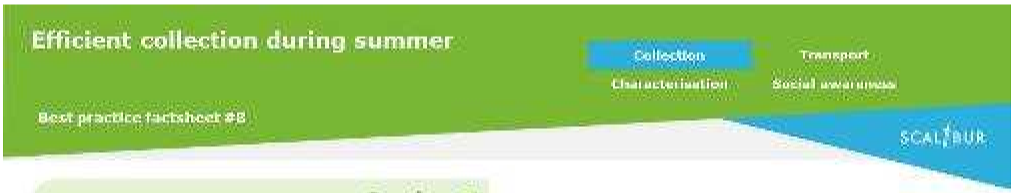

Efficient collection during summer

Collection | Transport | Characterisation | Social awareness

Best practice factsheet #8

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Benefits:

- Biowaste can be turned into high quality product
- Biowaste bin cuts residual waste by up to 40%, which saves households money
- Prevents odours and other nuisance factors

Example

Heidelberg, Germany[3]

Some councils in Europe have opted for a weekly organics collection in summer and a fortnightly collection in winter. For example, in Heidelberg, Germany, during the winter months has the option of emptying the bins either once a week or on a two week basis. In the summer months, all biowaste bins are emptied weekly. For a population density of 1,000/km² and each resident generates 100 kilograms of biowaste and green waste every year. The waste goes to the city's composting centre where it is transformed into valuable compost.

Further reading

1. https://ec.europa.eu/environment/life/project/Projects/index.cfm?fuseaction=home.showFile&rep=file&fil=LIFE08_ENV_E_000135_[illegible]
2. 2012. FOOD AND GARDEN ORGANICS Best Practice Collection Manual. [PDF] Available at: <https://www.environment.gov.au/system/files/resources/[illegible]/files/collection-manual.pdf> [Accessed 21 October 2020]
3. https://www.heidelberg.de/english/Home/[illegible]/biowaste.html

Source: [illegible]

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Selective collection of biowaste from the Horeca waste
Collection
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SCALIBUR
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Results
Action
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HO
Hotel
RE
Restaurant
CA
Café
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Selective collection of biowaste from the Horeca waste
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Collection of Open market biowaste

Collection | Transport | Characterisation | Social awareness

Best practice factsheet #10

SCALIBUR

Challenge

The environmental impact of biowaste is significant. Because of the energy and resources used to produce, transform and transport food from producer and supplier to the home and subsequently to landfill, there is a major carbon impact. Moreover, different studies about energy use indicate that food is the second most energy demanding product group after housing. The amount of food thrown away is a waste of resources as energy, water and packaging used for food production, transportation and storage. All this goes to waste when we throw away edible food.

Action

Selective collection of biowaste (i.e. food waste plus green waste) Open markets

Implementation

1. Establish a selective collection service either provided by the municipality or by a private authorised waste collector, to collect the organic fraction in Open markets.
2. Agreement with the stakeholders to increase the quality of biowaste collection.
3. Provide Open markets with a map that registers all the biowaste bring banks and all the areas served by the door to door collection schedule in order to help the accessing the system.
4. Encourage biowaste generators to separate organic waste and comply with the requirements of the collection service such as schedules, correct separation...
5. Open markets should appoint a responsible person to coordinate the implementation and assessment of the measure. Training and awareness activities of the staff should also be implemented.

Results

With the collection of biowaste from hotels and restaurants, compost can be produced. After a quality control, it can be sold to farmers, for example. The selling market price in Europe for agricultural purposes is [illegible] on average[1]. While the composition of household and assimilated kitchen waste is generally comparable, some differences between the two can be noted. Selectively collected biowaste from commerce is generally more uniform in its composition and of higher purity[2]. It occurs in larger quantities and therefore has the potential to be separated at source more easily and effectively, as it can more easily be traced, and corrective actions taken if needed.

Benefits

Benefits	€	Social	Environment
Less waste of resources by operators in open markets			○
Increase in the quality of the material to be used for composting	○		○
Saving of landfill space	○		○
Avoidance of greenhouse gas emissions			○
Less waste of resources by operators in open markets			○

Example

[illegible]

Two central markets were included: 'Coco-Coco' and 'Mercado Municipal'. These markets posed different challenges compared with local businesses owing to their chaotic nature and high density of vendors, both inside and outside. The strategy implemented with municipal markets was to use 'tutors' as focal points. Tutors are sellers who were trained and motivated for separate biowaste collection. Green 120 l wheelie bins were placed at strategic sites near tutors. A shredding machine was installed in both markets in July 2014 to shred biowaste (banana peels mainly) and reduce the volume. Information about biowaste collection was spread by the tutors as 'word-of-mouth' and through written notices in wall posters.

Further reading

1. [illegible]
2. [illegible]
3. [illegible]

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User-friendly collection containers

Collection | Transport | Characterisation | Social awareness

Best practice factsheet #11

SCALIBUR

Challenge

Recycling should be easy and encouraging for all the population. Thus, the design of the collection infrastructure should be appealing and adapted to all the users. Furthermore, proper maintenance and clean surroundings are also important to boost biowaste recycling as well as the adaptability of the frequency of collection and opening hours of recycling yards to all citizens. Citizens that are disabled or of younger or older age, find it difficult to recycle due to the non user friendly containers. This causes a reduced collection rate and a worse quality waste.

Action

Use of containers with ergonomic design adapted to different kind of users such as children, elderly people and disabled citizens.

Implementation

1. Make an analysis of the containers to know if they are ergonomic by asking the users. If it is not the case, keep it in mind for future container purchases.
2. Check containers regularly (maintenance).
3. Make a cleaning plan for the containers and the surroundings.

Results

Design is important and it should include the maximum part of the population. Making containers user friendly will allow more citizens to use it increasing therefore the amount of waste collected. They will also find it more comfortable and convenient to recycle making the city cleaner. Furthermore, containers and surrounding spaces should be kept clean, accessible, well-lighted and in good condition in general.

Further reading

1. https://www.[illegible].eu/sites/default/files/[illegible]%20Ljubljana%20capital%20factsheet.pdf

Example

[illegible]

In 2013, Ljubljana introduced a simpler and more user-friendly method of collecting packaging, which increased the quantities collected. 62% of the total households collected biowaste with bins with a total of [illegible] collected in total. Using their own bins/containers outside their buildings, residents collect residual waste, biowaste, packaging and paper. They also collect packaging at collection points or eco-islands situated in public areas.

Benefits

Benefits	€	Social	Environment
Citizens will find it easier to use containers	○	○	○
More comfort and convenience for the citizens		○	
Cleaner city		○	○
Prevention of non-biowaste materials in the container		○	○
Increased biowaste collection rates	○	○	○

Source: [illegible]

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Volunteer collection of biowaste

Collection | Transport | Characterisation | Social awareness

Best practice factsheet #12

Challenge

Volunteer collection is an initiative that public or private organisations (e.g. schools, sports clubs, charity organisations, etc.) at local level (neighbourhoods, sports clubs, etc.) can implement in a municipality by collecting paper and board separately.

Volunteer collection can provide benefits for the entire community, not only by raising money but also by increasing environmental awareness in people.

Action

Form a network of volunteers to promote environmentally friendly actions and biowaste collections.

Implementation

1. Allow NGOs, schools or clubs to collect waste on their own behalf and by their own means.
2. Give recommendations and information on methods to collect biowaste and how to communicate results to the municipality.
3. Establish an efficient communication channel to allow organisations to communicate with the municipality.
4. Evaluate and monitor the quantity of biowaste collected by the organisation.

Results

Specific campaigns for collection of biowaste by public and municipal centres like schools and sports clubs, which may provide an extra revenue and used for helping to fund their activities and needs. A specific measure adopted for awareness-raising is the establishment of a network of waste advisors. These are employees or volunteers trained in waste prevention and management who support residents in reducing and correctly separating at source the waste generated in households at the very local level down to even individual buildings or households.

Benefits

Benefits	€	Social	Environmental
Increase of biowaste collection		✓	✓
Better quality of the collected material, reducing therefore sorting costs	✓		
Collect funds for a social cause	✓	✓	
Commitment of citizens on biowaste collection at least by financing a social and environmental cause		✓	✓

Example

Compost Advisor Scheme[1]

A network of Compost Advisors, in partnership with The Conservation Volunteers and funded by the Kent council, was established in 2001. The Compost Advisor Project aims to appoint volunteers, who will advise people on composting issues and help promote the need for waste reduction. Since the project began in 2001, the BTCV has recruited over 200 advisors across Kent, each one receiving free training, a compost bin to get them started, access to the documentation of the BTCV offices and introduction in the Compost Advisors network. As volunteers they can decide how much time they spend being a Compost Advisor and where their particular interest lies. For example, some may prefer to offer telephone support to composters or be able to promote the scheme at local events.

Further reading

1. https://ec.europa.eu/environment/life/project/Projects/index.cfm?fuseaction=home.showFile&rep=file&fil=LIFE08%20ENV%20ES%[illegible]_biowaste_good_practices_inventory1.pdf

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Anaerobic digestion plant

Collection | Transport | Characterisation | Social awareness

Best practice factsheet #13

Challenge

The EU Waste Framework Directive of December 2008 underscores the need to make better use of bio-waste. The Directive prescribes in Article 22 that Member States shall take appropriate measures to encourage the separate collection of bio-waste with a view to their composting and anaerobic digestion. Only high-quality biogenic waste is suitable for composting, so impurities must be separated, which necessitates technical efforts or increased personnel input. Biowaste material is a good candidate for the production of energy in urban territories. The presence of unfavourable or contaminants mixed with the biowaste collected by municipalities makes it difficult to recycle organic matter of sufficient quality for agricultural uses. Methane production is particularly attractive for energy recovery notably because this energy vector can be distributed using the grid already in place for natural gas in many cities.

Action

Build an anaerobic digestion plant to treat biowaste.

Implementation

1. Determine the Municipality goals and needs and perform a feasibility study to implement an anaerobic digestion plant.
2. Interview designers and consultants and select the digester designer. There are several factors to consider when choosing a design company to work with through the process of building an AD system: the type of design, knowing if the company has previously built and how they perform and guarantees.
3. Obtain proper permits like building permits, land application permits, etc.
4. Start the construction.

Results

Per metric ton of bio-waste between 80 and 140 cubic metres (m^3) of biogas with a methane content of 50-65 percent is produced which equates to 50-80 m^3 of natural gas. In most cases the biogas is converted directly into electricity and heat via a cogeneration plant. As an example, an input of 20,000 metric tons of bio-waste per year suffices to operate a cogeneration plant with a rated electrical capacity of 600 kW, producing enough electricity for 1,000 to 1,500 homes.

The anaerobic digestion of biological waste also consumes energy, requiring between 30 kWh and 60 kWh of electricity per metric ton of input as well as heat for the digestion process. However, by using the emerging biogas to produce electricity and heat, specific energy credits in the order of 200 kWh for both electricity and heat offset this consumption, with the result that the whole process has a clear energy surplus. The most important end products of anaerobic digestion are biogas and a nutrient-rich digestate that can be used in agriculture.

Source: https://www.[illegible]

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Anaerobic digestion plant

Collection | Transport | Characterisation | Social awareness

Best practice factsheet #13

SCALIBUR

Benefits

Benefits	€	Social	Environmental
Anaerobic digestion achieves a positive energy and climate balance due to the emerging biogas and the resulting substitution of fossil fuels		○	○
Less greenhouse gas emission	○		
Less biowaste that ends up in landfill	○	○	
High-value product from biowaste		○	○

Source: https://teltoncsson.com/company/biogas/

Example

Deisslingen anaerobic digestion plant[1]

The anaerobic digestion plant in Deisslingen recycles the separately collected bio-waste from the Schwarzwald-Baar-Heuberg region, which is made up of the districts of Rottweil, Schwarzwald-Baar-Kreis and Tuttlingen. The project is an example of successful cooperation between local authorities. The preferred anaerobic digestion technology was only economically viable based on the wastes from all three districts. The plant was constructed next to the Upper Neckar Joint Wastewater Board sewage treatment works. It is situated conveniently for vehicle access in the middle of the waste management area close to the A 81 motorway to Lake Constance. Anaerobic digestion started in 2005. Each year around 25,000 metric tons of bio-waste are processed. The biogas produced is converted into electricity in a cogeneration plant and fed into the public electricity grid. The surplus heat from the cogeneration plant is used on site to dry municipal sewage sludge. In this way almost the entire energy is used. Wastewater can be discharged the short distance into the neighbouring treatment works. All the materials to be used for anaerobic digestion are pasteurised by heat treatment. The solid digestates are sold as high-grade, quality-controlled fertilisers to farmers in the region.

Further reading

1. https://pubmed.ncbi.nlm.nih.gov/15660157/

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N° 817788.

Containers with an ergonomic design

Collection | Transport | Characterisation | Social awareness

Best practice factsheet #14

SCALIBUR

Challenge

Recycling should be easy and encouraging for all the population. Thus, the design of the collection infrastructure should be appealing and adapted to all the users. Furthermore, citizens that are disabled or of younger or older age find it difficult to recycle due to the non-user-friendly containers. This causes a reduced collection rate and a worse quality waste.

Action

Implement containers with an ergonomic design adapted to different kind of users like elderly and disabled people and children.

Implementation

1. Make an analysis of the containers to know if they are ergonomic by asking the users. If it is not the case, keep it in mind for future container purchases.
2. Check containers regularly (maintenance) so they are clean.
3. It is important for employees to receive continuing education in ergonomics and body biomechanics basics. Workers should understand the importance of maintaining the back in an ergonomically neutral position and be able to recognize the early onset of ergonomic injuries so back injuries can be minimized.
4. Make a cleaning plan for the containers and the surroundings.

Results

Controlling ergonomic hazards in trash collection can present some difficulties. The main problem involves how customers put out their trash for pickup. Repeatedly giving customers information, such as flyers, about employee safety and health may encourage some customers to correctly use and place containers for pickup. Customers will likely improve such behaviour, however, only if the necessary equipment is easily attainable and convenient to use. Improving collection the safety can bolster overall employee health because injuries are cumulative by nature.

Example

Innovative ergonomic litter bin in Alcoy, Spain[1]

Alcoy City Council has placed about 100 units of this litter bin model in different places of the city. The peculiarity of this litter bin lies in the fact that it has been designed to be fitted to the existing streetlights. Its main feature is a quick and ergonomic emptying system to make easier its handling by waste collection workers.

Benefits

Benefits	€	Social	Environmental
Citizens will find it easier to use containers	○	○	○
More comfort and convenience for the citizens and workers		○	
The city looks cleaner		○	○
Prevention of non-biowaste materials in the container		○	○
Increased biowaste collection rates	○	○	○

Source: https://www.urbanenvironment.com/en/

Further reading

1. https://www.revistainfoenviroment.com/en/news/alcoy-city-has-placed-an-innovative-ergonomic-litter-bin-developed-by-urban-environment

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N° 817788.

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Best Practices: Transport

SCALIBUR
LEADING A REVOLUTION IN BIOWASTE RECYCLING

Software designed optimised waste collection route

Collection | Transport | Characterisation | Social awareness

Best practice factsheet #15

SCALIBUR

Challenge

Collection rounds have to be planned according to anticipated quantities and composition of collected organics (which may fluctuate by season and area). As the segregation of garden and food organics alters quantity and composition of residual waste, existing garbage collection services may also have to be adjusted. Even without significant changes to the service, typical savings for resources and costs for route optimisation projects in the household waste sector are between 5 and 15 per cent. For these projects, the primary service remains the same—such as the collections offered to households, the vehicles used to make collections, the location of facilities - but how the work is done is optimised. Where more radical changes are incorporated into projects, such as changing shift patterns or the frequency of collections, then savings of up to 45 per cent have been achieved[1]

Action

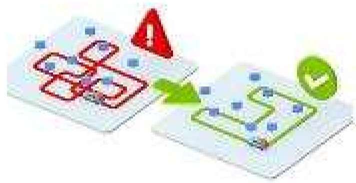
Implementation of an optimisation software which will plan the routes of the collection trucks.

Implementation[2]

1. Find a company able to design and install the system.
2. Involve drivers and supervisors: Route optimisation software lets people who understand waste collection design better rounds faster, but it doesn't seek to replace the knowledge of the people who operate the service. Their knowledge is vital in understanding the parameters in which the design must operate, and the operational issues associated with different types of collection.
3. Choose Sector-Specific Software as the optimisation of waste collection and street cleansing rounds is different and more complex than routing problems in other industries, such as deliveries or field service.
4. Create a Plan to Maintain Your Routes Going Forward: Where data has been kept up to date, it is much easier to re-plan routes as they become inefficient. In this way, solid waste operators can consistently maintain a more efficient set of routes.

Results

Route optimisation allows waste collection and street cleansing operators to identify and then remove inefficiencies. By building a digital model of their service, solid waste operators can compare different options with their current setup to identify more efficient and effective operating routes. In addition to cost savings, this can also mean balanced workloads and happier drivers, better customer service as crews are less likely to run short of capacity and a safer operating environment since routes have been designed to account for safety issues properly.



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Software designed optimised waste collection route

Collection | **Transport** | Characterisation | Social awareness

Best practice factsheet #15

Example

Ireland[1]

AES is a leading provider of waste management and recycling services in Ireland. The collection routes used to be planned by the drivers, resulting in inefficient routes, missed bins and dissatisfied customers. AES decided to contact a route optimisation company that resulted in spectacular cost savings and highly improved customer service. The company handles recyclable, organic, and general waste, keeping the species. 165 vehicles busy with 400-800 collections per route on average and serving over 70,000 residential homes and 5,000 commercial customers. They reduced approximately 10% in costs per lift and 100% elimination of ad hoc routes for collecting missed bins (most expensive routes). They also improved their customer service, as the number of missed bins were reduced. The existing vehicles have, therefore the ability to take on a more significant number of new customers.

Further reading

1. https://www.environment.gov.au/system/files/resources/...-collection-manual.pdf
2. https://www.webospec.com/resources/blog/route-optimization-secrets-of-success/
3. https://www.amcsgroup.com/success-stories/aes/

Benefits	€	👤	🍃
Improve efficiency and productivity	✓		
Minimise the number of vehicles and routes driven	✓		✓
Maximising stops and lifts per hour	✓		
Reduction in total work hours, labour, and overtime costs	✓	✓	
Decrease fleet maintenance, fuel consumption costs, and emissions	✓		✓
Provide better overall service to customers – less missed bins		✓	

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N° 817788.

Compacting collection trucks

Collection | **Transport** | Characterisation | Social awareness

Best practice factsheet #16

Challenge

Access to appropriate collection vehicles and container systems is a fundamental consideration for organics collection services. The configuration of collection vehicles and services may have a significant impact on the overall efficiency and cost effectiveness of organics collection services[1]. Organics have a different bulk density and are more compactable than residual household waste. It is important to ensure the capacity of the collection vehicle is appropriate to the tonnage collected.

Action

Use of a truck equipped with a compactor in order to reduce the volume of waste.

Implementation

1. Define the amount of biowaste that is expected to be collected.
2. Select the best fitting compacting vehicle and determine the number of trucks according to the quantity estimations.
3. Include additional measures to optimise filling of the truck (e.g. redesign routes, collection calendars, etc.)
4. Monitoring the quantity of organics loaded into the truck is recommended so as to avoid overloading, particularly when the proportion of grass clippings is high, or in high density housing areas where the proportion of food organics is high.

Results

The compaction of the collected material allows increasing amounts of biowaste to be transported per trip. Less space required for the collection of waste. Thus it is possible to increase the route length being somewhat effective.

Further reading

1. https://www.environment.gov.au/system/files/resources/...-collection-manual.pdf

Example

Use of compacting truck for paper and board collection in Urola Erdia (Spain)

The technical specifications established in the tendering process for MSW collection in 'Urola Erdia' require the use of a 20 m³ compacting truck for the collection of organic, light packaging, P/B and mixed waste. It also specifies that compacting truck should be rear load and suitable for containers between 80 and 1300L. In addition, the rear load compactor collection box must be fully installed in the chassis cab. The main benefit of installing compactor in the truck is the volume reduction making transport more efficient.

Benefits	€	👤	🍃
The compaction of biowaste allows to increase the amount of waste collected	✓	✓	✓
Increase efficiency of collection operations	✓		✓
Less emissions of greenhouse gases			✓
Savings on operating and fuel costs	✓		✓
Improve local air quality	✓	✓	✓

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N° 817788.

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Using electric trucks to collect waste

Collection | **Transport**
Characterisation | Social awareness

Best practice factsheet #17

SCALIBUR

Challenge

Almost every waste collection round relies on refuse collection vehicles (RCVs) that are powered by diesel-fuelled internal combustion engines. As local authorities become increasingly alert to the dangers of climate change and air pollution, and the urgent need for action, the days of diesel vehicles seem likely to be numbered. While there are several alternative technologies that might replace diesel, one of the best developed is battery powered electric propulsion, recharged from the electricity grid.

When considering the seven-year lifespan of a waste collection vehicle, it has been discovered that an electric fleet would be more sustainable and cost effective in the long term compared to diesel. Moreover, the cost of repowering a vehicle would be recovered during its lifetime. In comparison to a standard diesel waste collection truck, early life cycle cost analysis suggested a saving of roughly [illegible] per month per eRCV.[1]

Action

Use electric vehicles to collect biowaste.

Implementation

1. Define the amount of biowaste that is expected to be collected.
2. Select the best-fitting electric vehicle and determine the number of trucks according to the quantity estimations.
3. Include additional measures to optimise filling of the truck (e.g., redesign routes, collecting calendars, etc.).
4. Monitoring the quantity of organics loaded into the truck is recommended so as to avoid overloading, particularly when the proportion of grass clippings is high or in high density housing areas where the proportion of food organics is high.

Result

Electric collection trucks will provide cleaner and healthier air in the cities where they operate. They will not create emissions, which will improve local air quality, and the electricity used to recharge batteries will come from a power generator with an controlled emission point and pollution control equipment. Electric vehicles do not idle when stopped or parked, and they make far less noise than diesel engines while on the move. Electric trucks may create opportunities such as new renewable energy from waste generation.

Benefits

Benefits	€	Social	Environmental
Electricity generation is less emissions intensive than diesel and the air quality emissions occur further away from residential areas, reducing their impact.			○
Savings on operating and fuel costs	○		○
Improve local air quality	○		○
Electric engines are also far quieter than diesel equivalents, reducing noise pollution and improving the working environment for collection crews.			○

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Using electric trucks to collect waste

Collection | **Transport**
Characterisation | Social awareness

Best practice factsheet #17

SCALIBUR

Example

Electric refuse collection vehicles in the UK[2]

A research done in the UK studied the benefits of electric collection trucks in comparison with diesel powered vehicles. This research estimates that local authority RCVs emit approximately 330 kilotonnes of carbon dioxide equivalent per annum (ktCO$_2$e/yr). Replacement eRCVs would produce only 40 ktCO$_2$e/yr, a carbon saving equivalent to every person in the UK recycling an extra 250 plastic bottles each year. A cost benefit analysis (CBA) comparing diesel RCVs with eRCVs found that under quite conservative assumptions, the lower capital costs of a diesel RCV are largely offset by the lower running costs of an eRCV. In the CBA's central scenario, the eRCV's total cost of ownership (TCO) is [illegible] ([illegible]%) greater than that of the diesel equivalent. If the monetised impact of emissions is included, the eRCV's TCO saving is [illegible] ([illegible]%).

If we were to look at the air quality damage costs of nitrogen oxides (NO$_x$), on average it costs [illegible] per tonne of emission. When you consider the fact that converting one waste collection vehicle to fully electric is the equivalent of taking 30 diesel-powered cars off the street, it makes a big difference in air quality.

Source: [illegible]

Further reading

1. https://[illegible]-council-first-electric-refuse-collection-trucks/
2. Tomes, T. and Williams, L. (2020) Ditching Diesel: A Cost-benefit Analysis of Electric Refuse Collection Vehicles. Eunomia. Available at: https://www.eunomia.co.uk/reports-tools/ditching-diesel-analysis-electric-refuse-collection-vehicles/

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N° 817788.

Truck traceability

Collection | Transport
Characterisation | Social awareness

Best practice factsheet #18

SCALIBUR

Challenge

Waste collection is a highly visible municipal service that involves large expenditures and difficult operational problems, plus it is expensive to operate in terms of investment costs (i.e. vehicles fleet), operational costs (i.e. fuel, maintenance) and environmental costs (i.e. emissions, noise and traffic congestion). Modern traceability devices permit to obtain data in real time, which is fundamental to implement an efficient and innovative waste collection routing model. The basic idea is that knowing the real time data of each vehicle and the real time replenishment level of each bin makes it possible to decide, in function of the waste generation pattern, what bin should be emptied and what should not, optimizing different aspects like the total covered distance, the necessary number of vehicles and the environmental impact[1].

Action

Installation of a system of sensors and GPS to the waste collection truck to track vehicles.

Implementation

1. Find a company to design and build chips to install in trucks.
2. Filling sensors need to be assembled in the container and wireless connection is needed.
3. Train personnel on how to use it properly.
4. Perform periodic checks to verify proper functioning and periodic maintenance.

Results

Vehicle emissions depend on driving behaviour such as acceleration and speed. Monitoring the speed, excessive idling, unnecessary accelerations, and braking will give information that can be used to significantly reduce the fuel consumption. The truck traceability system allows to monitor the speed, acceleration, RPM and engine load. The system allows to detect speeding, high acceleration and braking during a route. Monitoring the speed, RPM and engine load allows to identify interesting events as container emptying and excessive idling.

Reducing the time of use of the power take-off (PTO) in the process of emptying the containers and making the collectors to work at the optimum RPM (i.e., in the optimum power curve and consumption). This will significantly reduce the fuel consumption and cost.

Benefits

Benefit	€	Social	Environment
Reduction in investment costs for vehicles fleet, thanks to the ability to schedule pre-determined pick-ups according to the effective need, with a consequent reduction in the number of vehicles.	✓	✓	✓
Reduction in operational costs (fuel, maintenance, etc.), thanks to the reduction of vehicles covered distance and stationary load and unload times.	✓		
The elimination of unnecessary stops, which means a reduction of engine emissions, produced both by sanitation vehicles and traffic congestion.	✓		✓
The reduction of noise especially in urban areas.		✓	✓

Example

Dubai[2]

The municipality of Dubai, together with Dubai Technologies, implemented mobile RFID readers that feature GPS, GSM modules and cameras to create a system of traceable bins. A total of 5,000 garbage bins were tagged with durable RFID tags. Each garbage bin's information was recorded to the database with a unique ID and GPS location. Each garbage truck was outfitted with mobile RFID readers. At each pickup, garbage collectors scanned the bin from inside the truck, reviewing the data thanks to the RFID tags and readers' long-range performance. Any bin damage observed by collectors was photographed, and the system automatically reported the bin's condition. The main outcome of the project is the management of bin inventory based on reliable information and can therefore optimise the level of spare parts that municipality officials can keep. The monitoring of a live city map with data in real time provides a planning tool for the municipality managers to plan and provide waste collection routes in a more efficient way.

Further reading

1. Faccio, Maurizio & Persona, Alessandro & Zanin, Giorgia. (2011). Waste collection multi objective model with real time traceability data. Waste management (New York, N.Y.). 31. 2391-405. 10.1016/j.wasman.2011.07.005.
2. [illegible]/dubai-waste-collection-rfid/

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N° 817788.

Eco-driving in waste collection trucks

Collection | Transport
Characterisation | Social awareness

Best practice factsheet #19

SCALIBUR

Challenge

We are living today in a globalised world in which millions of vehicles are emitting harmful gases day after day. Any responsible company is therefore duty bound to look out for the environment. Moreover, eco-friendly companies have been shown to be more highly regarded by their customers. Especially driving with high engine revolutions (high RPM) raises the fuel consumption significantly. Also, avoidable sequences of acceleration and braking will lower fuel efficiency. Following the guideline "Safety First", Eco-driving enables a highly fuel-efficient, smart and relaxed driving style without any loss of time.

Action

Implementation of eco-driving in waste collection trucks.

Implementation

1. Anticipate traffic flow to make use of the vehicles momentum and to let the car roll in neutral.
2. Maintain a steady speed at low RPM using the highest possible gear.
3. Shift up early approximately at 2000 RPM.
4. Check tyre pressures frequently at least once a month and before driving at high speed.
5. Consider that extra energy required costs fuel and money such as air conditioning and electrical equipment.

Source: https://[illegible]

Further reading

1. [illegible]

Results

Eco driving is a systematic driving style that cuts fuel consumption and the emission of polluting gases. Onboard units now enable a wide array of vehicle data to be recorded, such as fuel consumption, revs per minute, acceleration, braking, maintenance, etc, while also flagging up technical alarms. All this information can then be combined with complementary data from other systems such as the fleet management system. Drivers are given instant feedback with visual and acoustic cues for correcting their driving style and picking out inefficient behaviour such as over-braking and excessive idling. This allows drivers to react immediately to correct the driving style and enables performance reports to be drawn up afterwards as the basis for continual driver training, better service planning, vehicle maintenance, etc. Through the implementation of eco-driving, fuel reduction and better maintenance of the vehicle are obtained, extending its life.

Benefits

Benefit	€	Social	Environment
Reduces fuel consumption	✓		✓
Reduces noise pollution as well as local air pollution		✓	✓
Reduces costs for maintenance and costs for repairing cars after accidents as a result of safer driving	✓	✓	
Enhance municipalities public image		✓	✓

Example

Rio de Janeiro[1]

In Rio de Janeiro, Brazil, the company in charge of the urban waste collection applied a range of eco driving techniques to the collection trucks' fleet. Eco driving training was offered to 22 drivers in a fleet of 11 trucks, which operate in two different scenarios: a stop and go cycle and a trans-shipment to a single delivery point. As results, eco-driving techniques provide economic returns according to the mileage driven. The practice not only has effects on fuel economy, up to US$15,507.55 per month for a fleet of 46 vehicles, but also mitigates 7.1% of CO_2 emissions and local air pollutants.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N° 817788.

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Best Practices: Social awareness

SCALIBUR

LEADING A REVOLUTION IN BIOWASTE RECYCLING

Clear instructions on the containers and bags

Collection · Transport · Characterisation · **Social awareness**

Best practice factsheet #20

Challenge

[illegible]

Action

Include an illustrative and brief information about biowaste collection with the recycling instructions.

Implementation

1. Use images and keep it simple and consistent.
2. [illegible]
3. [illegible]
4. [illegible]

Results

[illegible]

Further reading

1. Barcelona City Council. [illegible] 2016.
2. https://www.[illegible]

Benefits

- Increase of biowaste collection
- Increase citizen participation in recycling activities
- Increase social awareness on the importance of recycling

Example

[illegible] single-use carrier bags in Austria

The Austrian compost and biogas association (KBVÖ) plans to launch an initiative aiming to only market single-use carrier bags in Austria that are compostable according to the European standard for industrial composting EN 13432. Combined with a consumer information campaign, the compostable bags are intended to be reused to collect and dispose organic kitchen waste. [illegible]

Source: [illegible]


Pay-as-you-throw principle for fee calculation

Collection | Transport | Characterisation | Social awareness

Best practice factsheet #21

SCALIBUR

Challenge

Action

Implementation[1]

Benefits

Increase citizen participation in recycling activities.

Variable pricing promotes equity in user payments by basing cost on the actual volume of waste generation.

Higher transparency of service and thus promotion of a more reliable public image of waste services.

Example

Esporles, Majorca

Further reading

Results

www.scalibur.eu

SCALIBUR project


Educational areas in Recycling Yards

Collection | Transport | Characterisation | Social awareness

Best practice factsheet #22

SCALIBUR

Challenge

Action

Implementation

Benefits

Visiting recycling yard can be very impressive for children and the message to communicate could be more easily understood.

Practical demonstration can be easily remembered.

Example

La Rioja

Further reading

Results

www.scalibur.eu

SCALIBUR project

Events, roadshows and workshops

Collection | Transport | Characterisation | **Social awareness**

Best practice factsheet #23

SCALIBUR

Challenge

Action

Implementation

Results

Further reading

Benefits

Increased satisfaction as citizens feel part of the system.

Example

Competition rewarding the best performance in biowaste collection

Collection | Transport | Characterisation | **Social awareness**

Best practice factsheet #24

SCALIBUR

Challenge

Action

Implementation

1. Design your competition and make it appealing to the target public.

Results

Benefits

Example

Further reading

****

Schools campaign

Collection | Transport | Characterisation | **Social awareness**

Best practice factsheet #25

SCALIBUR

Challenge

As any separation at source, the separation of biowaste in the households requires personal efforts in form of awareness and change of habits of the citizens. Therefore, it is important to convey to children the benefits of recycling for the environment. Children are our future, it is therefore important to provide meaningful information on ecological and waste management aspects in good time. By visiting schools and organizing activities children's engagement increases.

Action

Start educational campaigns in different schools to engage children with the recycling in their town.

Implementation

1. Identify a specific campaign goal.
2. Determine the duration of the campaign.
3. Set up biowaste recycling activities that are fun for children that help them remember and understand the message without difficulties using simple language.
4. Encourage participation and gather support for the campaign school-wide.
5. Brief the teachers about the recycling scheme and hold assemblies to inform the pupils. Make sure that the teachers and staff understand the importance of recycling, and this should filter down to the students.
6. Publicise the campaign.

Results

Fun activities are a great way to learn how about the environmental benefits of recycling and how to separate waste correctly. This is especially true for children who in addition have a powerful influence over the recycling habits of a household. The population can learn how to separate waste and the plants/bioy and depots. This increases the amount and quality of waste.

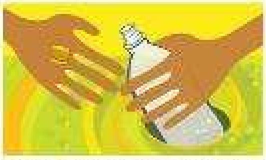
Benefits

- Increase social awareness on the importance of recycling
- Increase recycling rates in the city
- Increase quantity and quality of biowaste
- Improvement of the citizens perception about their municipal entities
- Practical demonstrations can be easily remembered

Example

King county Council

Schools across King county, Washington, have raised awareness of the schools use of plastic bottles and encouraging them to recycle them. The campaign encourages alternatives to disposable plastic bottles by promoting reusable drink bottles and recycling of the plastic ones.



Source: https://kingcounty.gov/~/media/depts/dnrp/solid-waste/secondary-school/documents/Plastic-Bottle-Campaign.ashx?la=en

Further reading

1. https://kingcounty.gov/~/media/depts/dnrp/solid-waste/secondary-school/documents/Plastic-Bottle-Campaign.ashx?la=en

www.scalibur.eu | SCALIBUR project

This project received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N° 817788

Publication of positive recycling news as TV advertisement

Collection | Transport | Characterisation | **Social awareness**

Best practice factsheet #26

SCALIBUR

Challenge

[illegible] advertising enables [illegible] to reach local and national [illegible] markets. Population should be aware of the actions and possibilities they could take as individuals to have a positive impact (localised actions, undertaken by citizens, should cumulate to have global effects). The publication of these actions [illegible] ideas and news as inspiration to engage other citizens. News that contain good information about recycling and positive results help people to become more committed with recycling.

Action

Advertising campaign [illegible] the [illegible] TV [illegible] environmental [illegible] benefits of recycling in the town/country.

Implementation

1. Collect and analyse information of interest on the waste collection system including contact information for citizens.
2. Design the advertisement in a user friendly way by organising and providing information clearly.
3. Promote it on local media.

Results

Advertisement on TV is a fast and direct way to give information to the population about how and why it is important to recycle waste. This motivates the people and increase recycling rates.

Example

UK[1]

Recycle Now, the campaign to promote recycling in England, [illegible] campaign to encourage people to recycle garden waste at compost. The ad, created by [illegible], [illegible] the [illegible]. The [illegible] Recycle Now's first [illegible] of advertising which focused on recycling [illegible], they demonstrate how common garden waste such as leaves, twigs and grass cuttings, can easily be composted. The campaign has been adapted to run in the national press and gardening magazines. Recycle Now is managed by the Waste and Resources Action Programme, a government-backed non-profit organisation.

Benefits

- Promotion of biowaste recycling
- Improve the brand image in the case of companies
- Serve as inspiration for new ideas for innovation and research
- Increase environmental awareness
- Change in the habits of life and consumption of society

Source: https://[illegible]

Further reading

1. https://www.marketingweek.com/recycle-now-runs-tv-campaign/

www.scalibur.eu | SCALIBUR project

This project received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N° 817788

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Include citizens actively in the information loop

Collection | Transport | Characterisation | **Social awareness**

Best practice factsheet #27

Challenge

[illegible]

Action

[illegible]

Implementation

1. **Identify stakeholders.** [illegible]
2. **Explain the current system.** [illegible]
3. **Identify current problems.** [illegible]
4. **Define possible solutions.** [illegible]
5. **Develop actions to implement them.**

Results

[illegible]

Benefits

- Improving organic waste management
- Increase the recycling rate
- Citizens involved with the correct functioning of the city
- Reduction of waste management costs
- Changing citizens' views on recycling issues
- Increase citizen participation in recycling activities
- Incorporating a cleaner collection system
- Increase the quality of the waste collected

Example

The Netherlands[1,2]

[illegible]

Further reading

1. [illegible]
2. Verhoeven, I. (2014). Do-ocracy and the reinvention of government. [illegible]

www.scalibur.eu — SCALIBUR project

Waste ambassadors

Collection | Transport | Characterisation | **Social awareness**

Best practice factsheet #28

Challenge

[illegible]

Action

[illegible]

Implementation

1. Identify current problems.
2. [illegible]
3. Form a team to manage the Recycling Ambassador Programme.
4. [illegible]
5. [illegible]
6. [illegible]
7. [illegible]
8. Develop a Zero Waste Plan.
9. [illegible]
10. [illegible]

ZERO WASTE

Source: [illegible]

Results

[illegible]

Benefits

- Citizens trained in environmental issues related to waste generation and management
- Improvement of urban waste management
- Increased recycling rate
- Increase citizen participation in recycling activities
- Better communication and feedback between citizens and authorities

Example

California Polytechnic State University[1]

[illegible]

Further reading

1. [illegible]
2. [illegible]

www.scalibur.eu — SCALIBUR project

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Website on biowaste and recycling

Collection | Transport | Characterisation | Social awareness

Best practice factsheet #29

SCALIBUR

Challenge

[illegible]

Action

Website explaining the municipal waste collection system in an easy way and showing the benefits of recycling.

Implementation

1. Collect and analyse information of interest on the waste collection system including contact information for citizens.
2. Design the website in a user-friendly way by organizing and providing information clearly.
3. Explain the importance of recycling to citizens through clear and graphic images
4. Promote the existence of the website by local media.

Results

[illegible]

Example

Spain[1]

In Spain, Ecoembes has developed a website to teach how to recycle well and explain the role of packaging in society. In addition, they have incorporated an intelligent Recycling Assistant (A.I.R-e) that solves the doubts of the population about where to recycle the different materials.

Benefits

	€		
Increase the knowledge of the citizens about the operation of the system and the benefits of recycling.		○	○
It is an easy way for people to access information and engage.		○	
Improve the image of the municipality.	○	○	
Provide useful information on biowaste collection system.		○	
Solve the citizens' doubts quickly.		○	○

Source: https://www.ecoembes.com/proyectos-[illegible]

Further reading

1. https://www.ecoembes.com/proyectos-[illegible]

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N° 817788.

Associations of citizens providing direct feedback to municipalities

Collection | Transport | Characterisation | Social awareness

Best practice factsheet #30

SCALIBUR

Challenge

[illegible]

Action

Creation of associations of citizens who get together to discuss issues about waste collection. Their feedback is afterwards used by the municipality to improve the waste collection system.

Implementation

1. Create an open space/discussion or organise online/telematic tools for consultation.
2. [illegible]
3. Evaluate the proposed solutions.
4. Improve collection system [illegible]

Results

[illegible]

Further reading

1. Residents' associations in York (UK)
2. CAG (2015): Citizens association of Georgetown

Benefits

	€		
Increase the quantity and quality of biowaste collected as well as the environmental awareness.	○	○	○
Improve the green image of the municipality.	○		
Improve the citizens' perception about their municipal services.		○	

Example

City of York[1]

[illegible]

Georgetown[2]

[illegible]

Source: [illegible]

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N° 817788.

Targeted communication campaigns

Collection | Transport | Characterisation | Social awareness

Best practice factsheet #21

SCALIBUR

Challenge

Action

Implementation

Benefits

Results

Example

Further reading

www.scalibur.eu | SCALIBUR project

Dissemination of the environmental and economic benefits of biowaste recycling

Collection | Transport | Characterisation | Social awareness

Best practice factsheet #22

SCALIBUR

Challenge

Action

Implementation

Benefits

Example

Results

Further reading

www.scalibur.eu | SCALIBUR project

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SCALIBUR
Best Practices:
Characterisation
SCALIBUR
LEADING A REVOLUTION
IN BIOWASTE RECYCLING
www.scalibur.eu
SCALIBUR project
Data collection and monitoring quality parameters
Collection
Transport
Characterisation
Social awareness
Best practice factsheet #33
SCALIBUR
Challenge
Action
Implementation
Benefits!
Example
Results
Further reading
www.scalibur.eu
SCALIBUR project

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Monitoring and control of the composition of residual waste in other recycling streams
Best practice factsheet #34
Collection
Transport
Characterisation
Social awareness
SCALIBUR
Challenge
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Example
Further reading
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SCALIBUR (Scalable technologies for bio-urban waste recovery) brings together a unique blend of organisations and expertise, led by **ITENE Packaging, Transport & Logistics Research Center**. The project began in November 2018 and will run for four years.

COORDINATOR
Cesar Aliaga
cesar.aliaga@itene.com

COMMUNICATIONS
James Ling
j.ling@greenovate-europe.eu