SECTOR-WIDE CIRCULARITY ASSESSMENT FOR THE BIOMASS SECTOR

SEVILLA

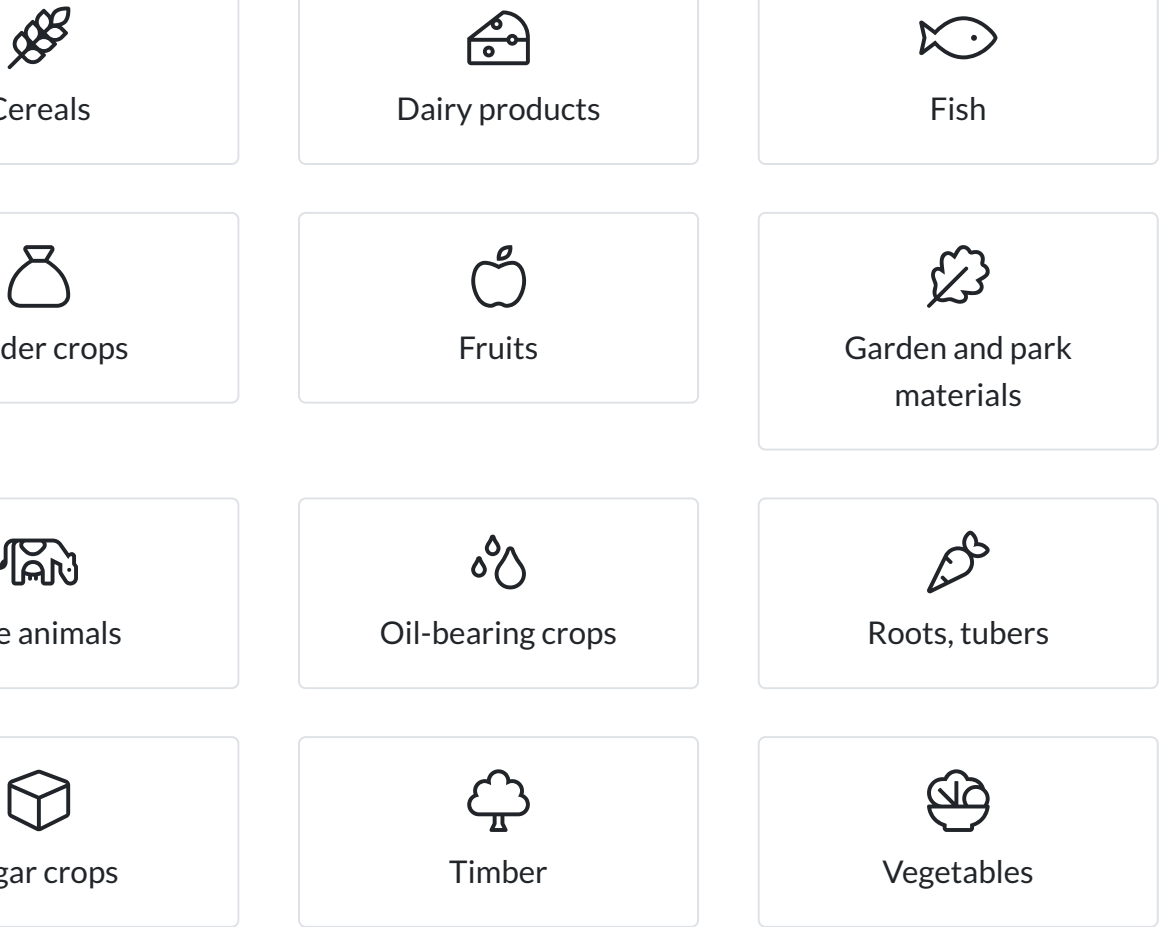
CITYLOOPS

METABOLISM OF CITIES

Introduction

The EU Horizon 2020 funded CityLoops project focuses on closing the material loops of two central sectors of any city in terms of material flows, societal needs and employment, namely the construction and biomass sectors. Due to their sizes, they represent a considerable opportunity for cities to transform their metabolism and economy towards a more circular state.

Within this project, seven European cities, amongst those also the City of Sevilla are planning to implement demonstration actions to kickstart their circularity journey. To better understand what the current circularity status quo is, as well as the impact of these actions, and the efforts needed to transform their sector, a Sector-Wide Circularity Assessment method was developed. This method combines a circular city and circular sector definition, a material flow and stock accounting method, as well as circularity indicators. The sector itself was defined in terms of a number of representative materials that make up a large share of the sector and associated economic activities. The biomass sector is made up of 12 materials, depicted as icons here, which were studied along the entirety of their supply chains. Altogether, these elements help to set a solid knowledge and analytical foundation to develop future circularity roadmaps and action plans.



The assessment was carried out by the cities themselves after receiving extensive training in the form of courses on data collection (construction and biomass) and data processing. Numerous additional insights can be found in the individual Data Hubs of each city.

This current Sector-Wide Circularity Assessment report provides contextual information on the city and the economic sector under study. It then illustrates how circular these sectors are through circularity indicators and a Sankey diagram. Finally, it analyses and interprets the results, presents the limitations from the data used and offers recommendations about how to make this sector more circular.

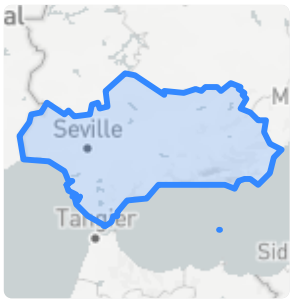
(The italic texts in this report were written by Metabolism of Cities' Aristide Athanassiadis and Carolin Bellstedt. They provide relevant general information and serve as connecting elements of the single report parts.)*

Urban context

To contextualise the results of the sector-wide circularity assessment, this section provides population and land use information data of the city. In addition, population and area of the city under study, as well as its corresponding NUTS3, NUTS2 and country were included. Data for these scales were added to better understand how relevant and important the approximations are when downscaling data from these scales to a city level.

Sevilla
688,592
142 km^2

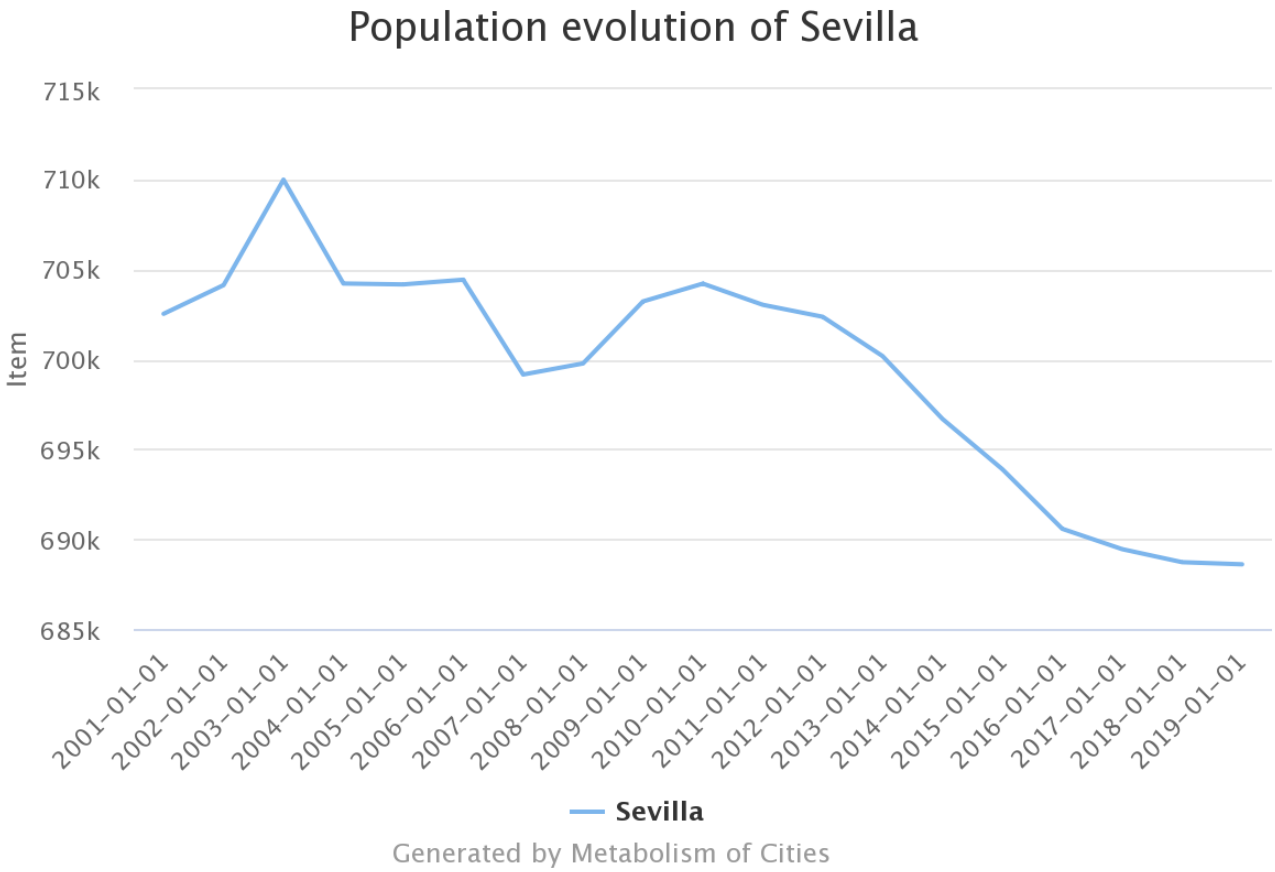
Sevilla
1,942,389
14,036 km^2



Andalucía
8,414,240
87,600 km^2

Spain
47,026,208
505,990 km^2

Population of Sevilla



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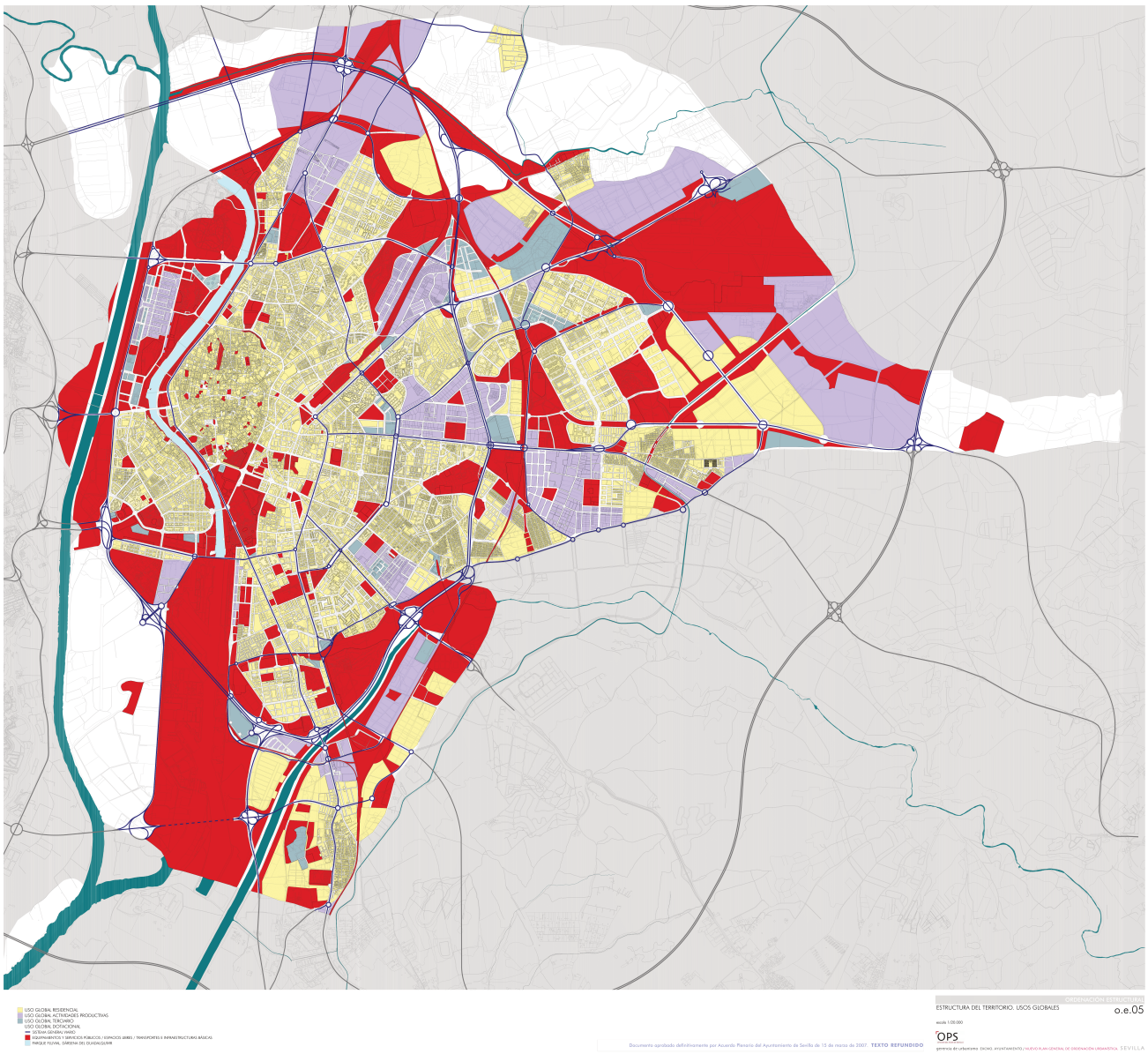
The municipality of Seville is made up of 11 districts, which are administratively subdivided into 108 neighbourhoods and these, in turn, into 542 census sections. As of January 1, 2019, the population amounted to 688,592 inhabitants, which represents a loss of 10,098 people compared to January 1, 2017, with the South district being the one that loses the most inhabitants. If the comparison is made with respect to January 1, 2013, the loss of people is even greater, reaching 11,577 inhabitants i.e., 1.65% of the total population. The highest concentration of population is found in the East district, where there are 105,964 inhabitants registered. This population represents 15.10% of the total population of the city.

Land use



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Seville's land use is urban and mostly classified as residential, but has public facilities, services, free spaces, transport and basic infrastructures. The historic area is composed of 3.9 km². The green spaces only occupy 1.8 km² of the territory.

Economic context of biomass sector

This section puts into perspective the economic context of the sector under study. It describes how many people are employed in this sector, as well as who the main actors involved (from all lifecycle stages for the sector's materials) are.

	GDP (monetary value, in €)	Employees
Sevilla	854,408,809	22,975
Sevilla	2,190,068,000	64,847
Andalucía	10,771,369,000	312,866
Spain	32,553,000,000	949,500

The biomass sector in Sevilla

The city of Seville is located on the plain of the Guadalquivir River, South-Western Spain, in the region of Andalusia. The region is also the national leader in the biomass sector. Seville has a municipal population of about 688,592 and a metropolitan population of about 1.9 million, making it the fourth-largest city in Spain and the 31st most populous municipality in the European Union.

Agricultural waste includes all plant waste that is generated directly in the field. Depending on the crop, they can be grouped as woody crop residues that include the pruning of fruit, citrus, vine, and olive trees; and herbaceous crop residues, which are formed by the remains of herbaceous species that remain after harvest. They are traditionally used in animal feed, as fuel or as an organic and structural amendment by incorporating them into the soil.

The organic waste generated in the manufacturing sector is mostly part of the by-products generated by these industries, which on many occasions have an alternative use in the market as raw materials that find applications in other industries or sectors. The industries and waste with the greatest use and potential in Seville are the olive grove industry, rice plants, juices and canned vegetables, cotton waste or breweries, and meat industries and slaughterhouses.

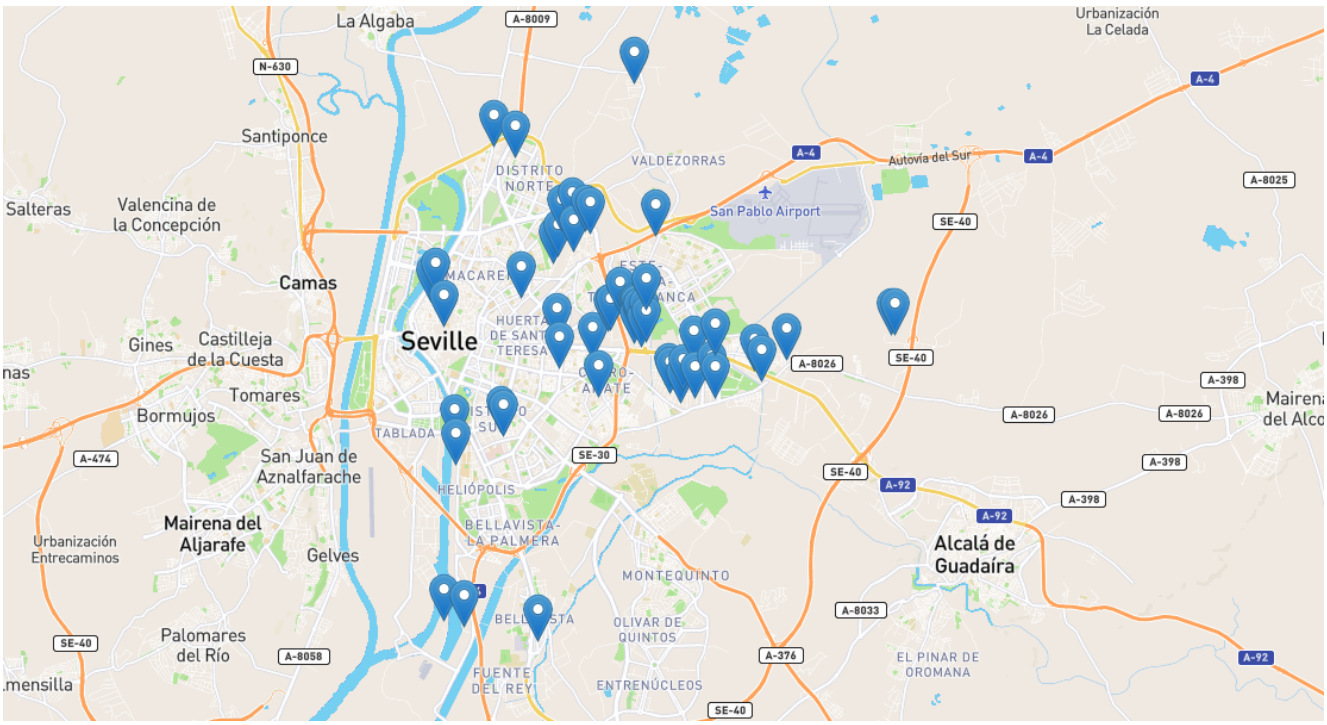
By urban waste, we understand that which is generated in an urban environment by the daily activities of human beings. The urban waste that can be considered biomass is the organic fraction of municipal waste, wastewater and sewage sludge, used vegetable oils and vegetable

waste from parks and gardens.

Urban waste is subjected to operations for its classification to separate those recoverable or recyclable materials and is subsequently disposed of by depositing it in landfills and subsequently sealing it, when it has reached its capacity limit. In these sealed landfills, after a period in which biogas has been produced, because of the degradation of organic matter, they are degassed and the biogas obtained can be recovered to be used as fuel, as is done in Aborgase.

In the same way, the management and purification of wastewater, Emasesa's wastewater treatment stations (WWTPs) have anaerobic digestion facilities for sludge that recover the biogas generated for thermal uses in the purification process itself or the generation electrical.

Extraction and harvesting infrastructure



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Waste collection infrastructure

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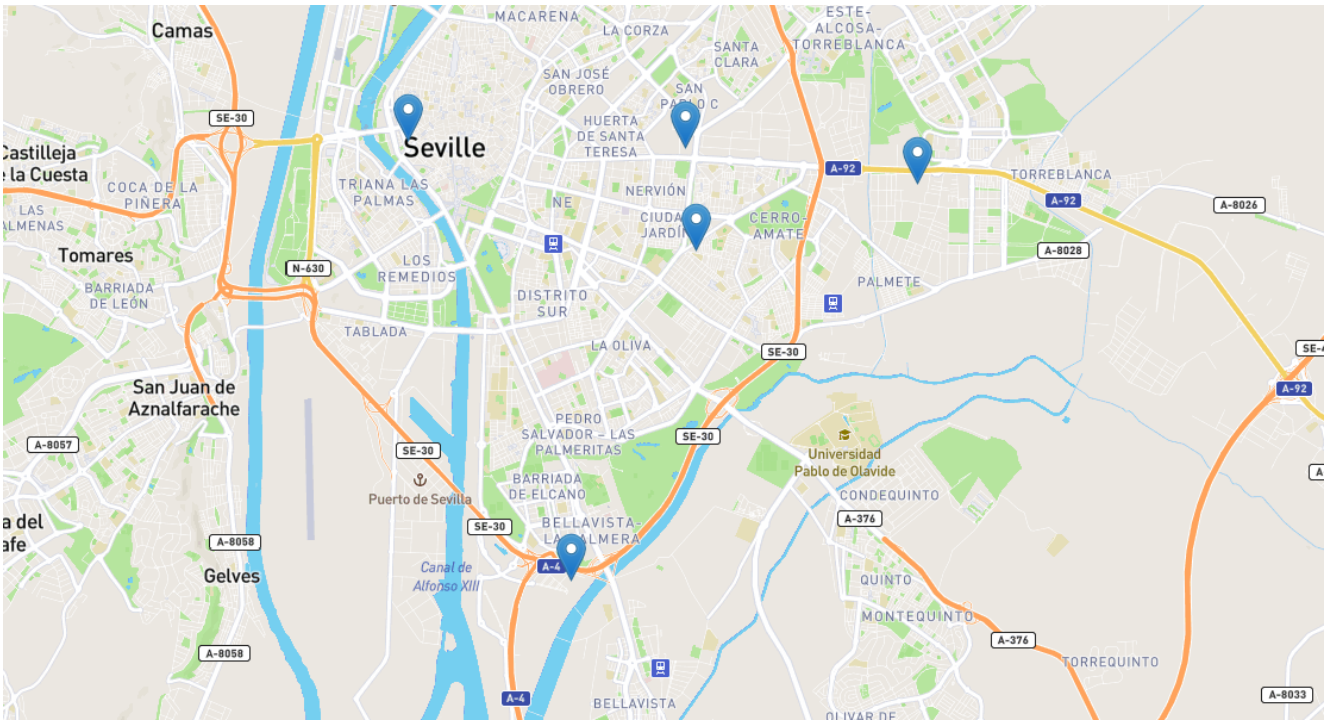
Cogeneration plants



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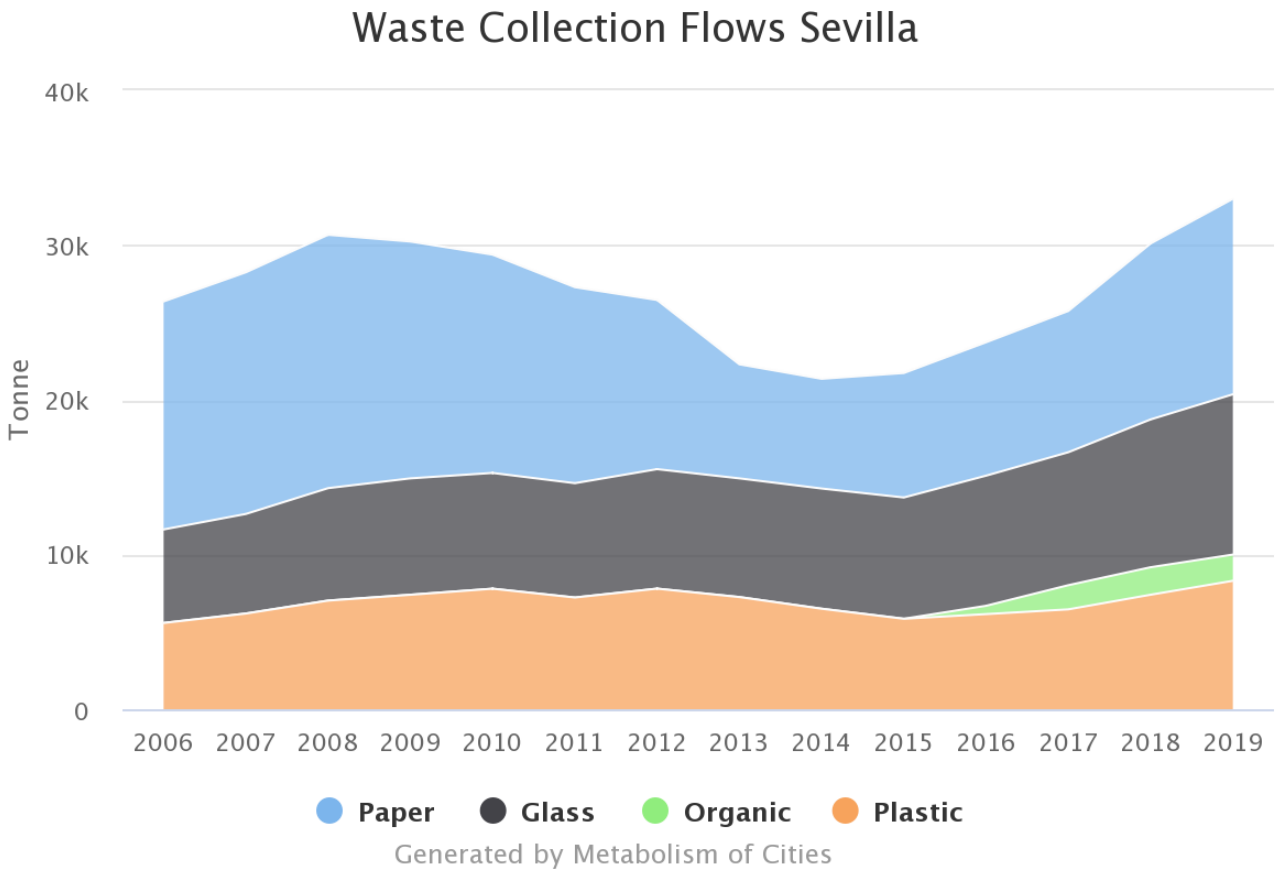

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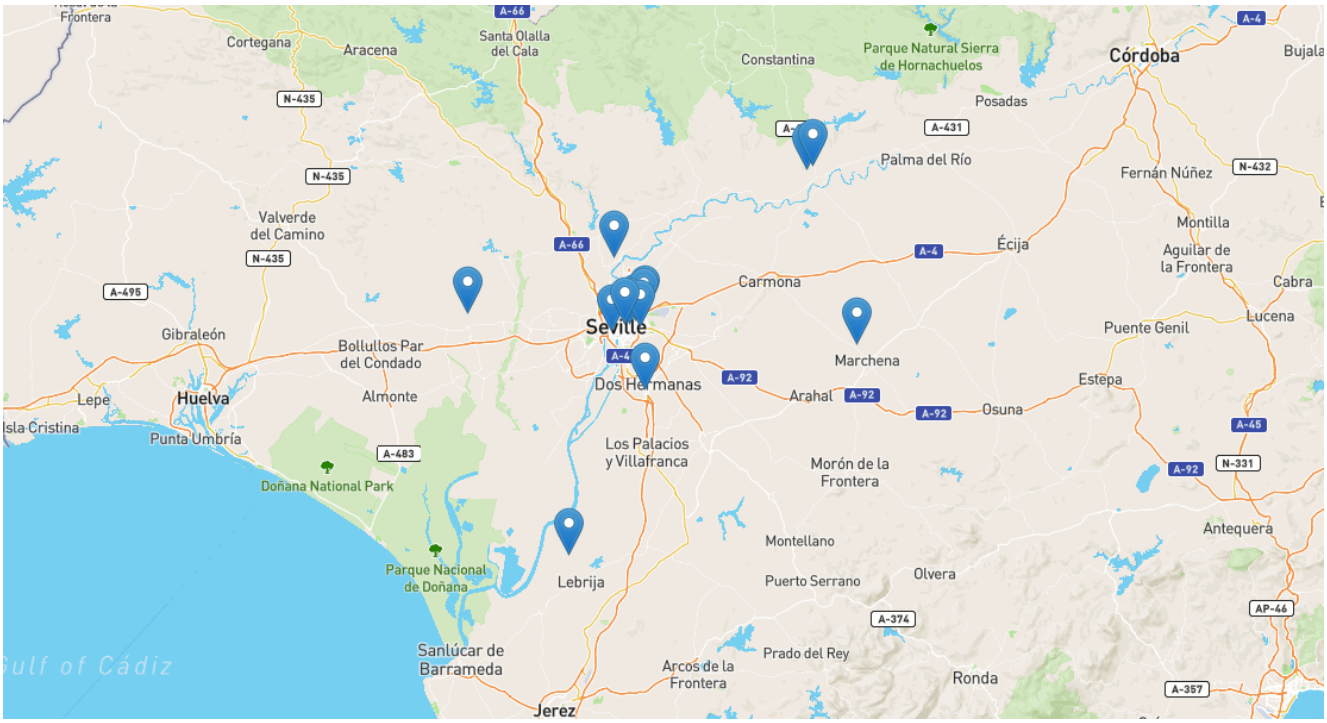
The actors of the biomass sector



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Sevilla shows the higher useful agricultural area in the Andalucia region with more than one-fifth of the total area. The main cultures are cotton, potatoes, oranges, olives, and rice but there are also significant exploitations focused on Wheat, Barley, Chickpeas, Dried beans, Dried peas, Sugar beet, Sunflower, Tomato, Sweet orange, Tangerine, Peach, Plum, Almond among other.

In Seville, there are both extractive industries and transforming industries, one of the most emblematic manufacturing examples is the Heineken manufacturing plant. In 1904, the first La Cruz del Campo beer factory was founded in Seville and, in that same year, the first Cruzcampo beer was launched on the market. In 1995, the Cruzcampo Foundation was born, based in Seville. In 2000, Heineken International bought the Cruzcampo Group creating the Heineken Spain group. Heineken Spain, the current German firm that owns the mythical Cruzcampo, moved production to the new factory on the Seville-Mairena del Alcor highway in 2008, becoming one of the most modern and advanced technology factories in Europe. On a 71-hectare site, it has a storage capacity of 3,000 m2, being able to produce 450 million litters per year. In the extractive sector, Andalucia is the region with the highest rice production in Spain, representing 42% of the national total and just over 10% of the European Union. The area dedicated to rice cultivation is 40,715 hectares, with 94% being concentrated in Seville.

The City of Seville also has plenty of retail infrastructures, from supermarkets to hypermarkets. The main wholesale establishment in the city is Mercasevilla, which is the provider of both retail infrastructures and big hostelry.

There are 18 local markets distributed around the 11 districts in Seville to support the local economy, reducing the value chain between producer and users. There are also weekly local markets, where can a wide variety of products, from clothing, plants and flowers and food products can be found. The municipal waste collection in Seville is managed by the municipal Public Cleaning company i.e., Lipasam, of the Seville City Council. Lipasam is responsible for the cleaning of the 1,077 km of roads, the collection of urban waste and its subsequent treatment to save resources and avoid contamination of the environment. For this task, LIPASAM has a staff of 1,987 men and women, 750 vehicles of different types, a Central Machinery Park, six Auxiliary Cleaning Parks, five Clean Points, a Transfer Station, four Pneumatic Waste Collection Centres (three fixed and another mobile), and some Central Offices and finally with an annual budget (2020) of more than 107 million euros.

The collection of bio-waste began in Seville in June 2017 with the implementation of the system in markets, hotels, and hospitals in the city, as well as in various points of the Old Town. Later it was introduced in neighbourhoods such as Sevilla Este, Bellavista, Bermejales, Jardines de Hércules, Heliópolis, Pineda, El Cano and Pedro Salvador. To date, more than 5 million kilograms of bio-waste have been collected. In 2020, Lipasam carried out the implementation in the San Jerónimo and La Bachillera neighbourhoods of the Northern district of the new bio-waste containers for the selective collection of biodegradable organic matter (for citizens) through a new model of containers that present as a particularity the opening by means of a contactless electronic card and the brown cover. Within the framework of the CityLoops project, Lipasam contemplates the expansion of bio-waste collection in the city. Once collected, the bio-waste is sent for treatment in infrastructures outside the limits of the municipality, to the Aborgase infrastructures, where it will be processed, valorised, and sent for the final destination.

Indicators

To monitor the progress of this economic sector towards circularity, a number of indicators were proposed and measured. Altogether, these indicators depict several facets of circularity of the sector. As such, they need to be considered in combination rather than in isolation when assessing circularity. In addition, these indicators can be compared to other cities or spatial scales (such as the country level). However, this has to be done with great care and use of the contextual elements in the previous sections of the report. Finally, the value measured from these indicators can be traced over time to track the sector's progress towards circularity.

Indicator number	Indicator	Value	Unit
34	Domestic material consumption (DMC)	19,047,323.39	Tonnes/year

Indicator number	Indicator	Value	Unit
41	Share of secondary materials in DMC	0.4	%
48	EU self-sufficiency for raw materials	135.85	%
53	Quantity of material for anaerobic digestion	75,000.00	Tonnes/year
56	Quantity of material for composting	600	Tonnes/year
57	Amount of sector specific waste that is produced	144,110.00	Tonnes/year
58	EOL processing rate	99.21	%
59	Incineration rate	0.07	%
61	Landfilling rate	24.52	%

Indicators #34, #41, #48

- Domestic material consumption (DMC) (#34): 19,047,323.39 ton
- Share of secondary materials in DMC: (#41) 0.4 %
- EU self-sufficiency for raw materials (#48): 135.85 %

In the first indicator (DMC, #34) it was estimated a value of 27.66 tons per capita, higher than the value for Spain (2.67 tons per capita). Considering the value of the share of secondary material in DMC, the value is very low (0.4%), but with the increasing values for separate collection of bio-waste and the subsequent valorisation in the Aborgase plant and in the Emasesa's Anaerobic Digesters, the value of this indicator will increase in the following years. For the increase of this value, it will also contribute to the increase of local composting, considering the home composting, community composting and urban farms composting.

Indicators #53, #56, #57

- Quantity of material for anaerobic digestion(#53): 75,000.00 ton
- Quantity of material for composting:(#56) 600.00 ton
- Amount of sector specific waste that is produced (#57): 144,110.00 ton

Analysing these three indicators, it is possible to observe that Seville shows a good scenario that results from the implementation of the separate collection system of biowaste for the huge producers by Lipasam as well as the cogeneration facilities operated in Emasesa's facilities. These indicators will be increasing due to recent investments done by Lipasam with the implementation of the separate collection of biowaste in some neighbourhoods recently and will have a significant increase during the following years, as a result of these investments, including the investment from CityLoops for the Demo Actions in Seville.

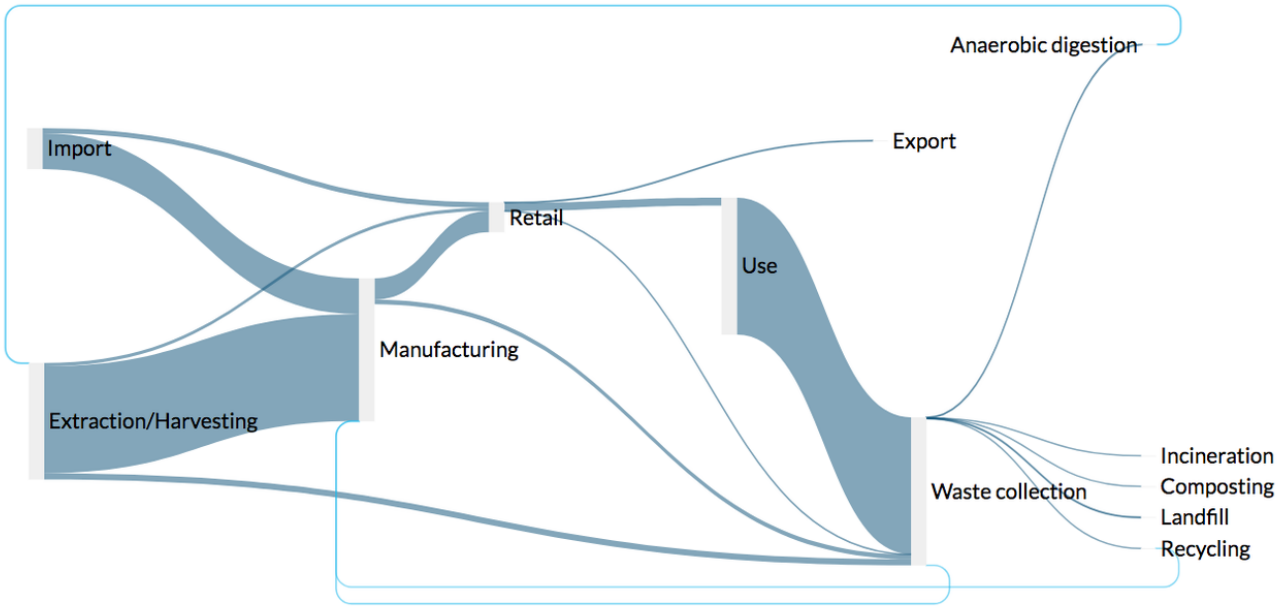
Indicators #58, #59, #61

- EOL processing rate (#58): 99.21 %
- Incineration rate (#59): 0.07 %
- Landfilling rate (#61): 24.52 %

These three indicators show a good status of municipal waste management in Seville. Lipasam is committed to valorising and reducing the landfilling and incineration of municipal solid waste. Lipasam is focused to increase the circularity of municipal solid waste management in the following years not only with the implementation of the separate biowaste collection in the city but also promoting the valorisation of the biowaste by cogeneration in collaboration with Emasesa. Additionally, several advertising campaigns will be delivered in order to improve the management for the rest of the kind of municipal solid waste as well as to improve the use of the local "clean points" that collect different kinds of waste such as CDW, Electronics, Metals, etc.

Visualisations

Measuring circularity is a data heavy exercise. Numerous datasets were collected and visualised throughout the sector-wide circularity assessment process. To synthesise these findings, a Sankey diagram illustrates how material flows from the studied economic sector are circulating from one lifecycle stage to another. The height of each line is proportional to the weight of the flow. This diagram therefore helps to quickly have an overview of all the materials flows that compose the sector and their respective shares. The flows that are coloured in light blue in the Sankey diagram, are return flows. This means that they flow in the opposite direction of the lifecycle stages and are subjected to reuse, redistribution, or remanufacturing. Their size relative to the others is a good indication for the materials' circularity.



Data source

The Sankey diagram describes the large Extraction/Harvesting of materials for the biomass sector in Seville compared to the import. This means that for the City of Seville almost all the materials required for the biomass sector came from the metropolitan area of Seville. Most part of the imported materials goes to the manufacturing sector, mostly from Fish, Live animals, Dairy products and Timber economic activities. The rest of the imported materials goes directly to the retail sector, including wholesale. Considering this, almost all the food consumed by the citizens or served in restaurants, hotels and canteens are produced locally. Finally, considering the export, there is the export mainly from the retail sector. These numbers were estimated, because it wasn't found data that allows the inclusion of precise and accurate data for the City of Seville.

Data quality assessment

Numerous datasets were collected and considered in the sector-wide circularity assessment. In some cases, datasets were not available for some materials or for some lifecycle stages for the studied sector. Therefore, estimations need to be done by looking at data at higher spatial scales (region or country). This section qualitatively assesses how reliable the data used is.

Data quality

Before describing data gaps and assumptions, the overall data quality is considered. It is expressed through four data quality dimensions that are depicted in the data quality matrix: reliability, completeness, temporal correlation, and spatial correlation. Each dimension has its own criteria for the ranking of high (green), medium (yellow) and low (red), which is based on this Pedigree report and shown in the table below. There can be additional explanations in some cells, as supporting information.

Rating	*Reliability*	*Completeness*	*Temporal correlation*	*Spatial correlation*
high	*Reviewed or measured data*	*Data exists for all of the single materials and their respective economic activites*	*Data less than 3 years difference to the time period of the data set*	*City-level data*
medium	*Estimated data*	*Data exists for most single materials and most economic activities*	*Data less than 6 years difference to the time period of the data set*	*Regional-level data (NUTS 3)*
low	*Provisional data*	*Data exists for the sector only for the Life Cycle Stages*	*Data less than 10 years difference to the time period of the data set*	*NUTS 2 and country-level data*

Data quality matrix

Lifecycle stage	Reliability	Completeness	Temporal correlation	Spatial correlation
Extraction/Harvesting				
Manufacturing				
Retail				
Use				
Stock				
Waste collection				
Landfill				
Incineration				
Recycling				

Lifecycle stage	Reliability	Completeness	Temporal correlation	Spatial correlation
Anaerobic digestion				
Composting				
Imports				
Exports				

EXTRACTION AND HARVESTING

The data source was the National Institute of Statistics (INE) and Andalusian Institute of Statistics and Cartography (ICA).

MANUFACTURING

The manufacturing data were obtained by downscaling 2019 statistical data from INE at the country level and ICA at the regional level to the city scale. The data was considered to cover the main actors and manufacturing infrastructures identified in Seville.

RETAIL

Retail data were obtained by downscaling statistical data from INE and ICA and Eurostat only from some materials.

USE

Statistical data on food consumption, of the different biomass materials, were collected from INE and ICA at the country and regional scale and, from income and number of inhabitants, it was possible to convert to the city of Seville.

STOCK

Data regarding existing animals in the municipality of Seville was obtained from ICA. Although it is known that there is tree stock in the city (green spaces and nurseries), it was not possible to obtain or to convert this information into tons.

WASTE COLLECTION

Waste collection data was provided by Lipasam at the local level and ICA at the regional level. The bio-waste selective collection and mixed waste collection data were provided by Lipasam.

Data gaps and assumptions

The only real data that has actually been obtained for Seville is in terms of extraction/harvesting, animal stock, and waste collection. All other data were obtained by downscaling to the city. The main sources used for data collection was INE, ICA, municipal statistics, Lipasam and the data obtained from Eurostat. For the downscaling, it resorted to income figures and the number of employees. Data regarding the number of employees and GDP of the biomass sector in Seville could be improved and could be more realistic if more detailed information were available (4-digit NACE codes), so these values were estimated from the other geographical scales (NUTS 2, Country and Regional).

Data analysis

This section analyses the Sankey diagram developed in the previous section. It discusses and interprets the results for the sector-wide circularity assessment. It also reflects on how the current demonstration actions fit within the bigger picture of the sector, as well as how they could be upscaled to accelerate the transition towards a more circular sector.

Insights on status quo of the biomass sector

The Sankey diagram of the City of Seville shows that almost all the materials of the biomass sector come from Extraction/Harvesting, but there is a significant contribution from import activity. This means that several measures should be implemented to promote more circular flows in the city, as well as to upscale the ongoing circular projects i.e., municipal organic waste collection and its valorisation. For instance, the ones related with separate collection of bio-waste (associated with the cogeneration valorisation) and explore other local initiatives such as urban farming, food waste reduction initiatives, food donation networks or sustainable food procurement.

The current circular initiatives in the biomass sector have currently a small impact on the circularity of the city, despite all the efforts already done by public and private entities. But it needs to be taken into account that some of these initiatives are very recent, like the new municipal separate collection of bio-waste.

The food donation projects, linking sectors such as the retail sector with institutions from the social sector, helping families with low-income or in a situation of social exclusion needs to be upscaled to assure a higher impact than it happens today.

Connection to and upscaling of demonstration actions

The CityLoops demonstration actions (DAs) in Seville target mainly organic waste management, which is a very important flow of bio-waste within the urban solid waste, with the goal of promoting more circular management of bio-waste.

DAs like the implementation of bio-waste selective collection in new neighbourhoods and local treatment solutions like cogeneration will promote more circular destinations for the food waste increasing the mass of bio-waste valorised. This DA upscaled to other parts of the City of Seville could have a relevant impact on the circularity of the management of the food waste management produced in Seville.

Another DA that could have a relevant impact regarding the upscaling of the separate organic waste collection is the IT software tool developed to optimise the waste collection routes that will be tested during the CityLoops demonstration phase. This IT software tool was designed to improve the separate waste collection cost to speed up the implementation of the entire city.

Another DA that can improve the circularity in the biomass sector is the launch of a campaign to disseminate the DAs under implementation in Seville and search for the commitment of citizens. The success of these campaigns could upscale the success of these DAs and have a relevant impact on the circularity of organic waste management, in the City of Seville.

Recommendations for making the biomass sector more circular

- Encourage the transformation of food production sector (at the city and metropolitan scale), requiring fewer negative impacts and reducing the production of food waste throughout the value chain;
- Promote the increase of small production units (local and metropolitan producers) in Seville Metropolitan Area as well the increase of urban farming in the City of Seville;
- Disseminate the inclusion of circular economy criteria (e.g., efficiency in the use of resources, proximity to the production site, separate collection, local composting) in the public procurement procedures such as public canteens (schools, high-schools, universities, etc.) or maintenance of green spaces;
- Support the creation and development of new business models that promote the closing of nutrient cycles and an urban bioeconomy in which nutrients are properly returned to the soil, with a reduction in waste;
- Upscale the separate collection of organic waste to all the City of Seville, promoting the closing of the loop.

References

- Spain
- Andalucía
- Sevilla
- Population of Sevilla line graph
- Land use
- Sevilla_Geo_localisation_of_main_actors_biomass sector Imagen