ICONIC CASE

EXPO PARK LISBON

THE FOREFRONT OF INNOVATIVE WASTE COLLECTION

"25 YEARS OF EXPO PARK: FROM WORLD EXPOSITION TO MODERN SUSTAINABLE DISTRICT"

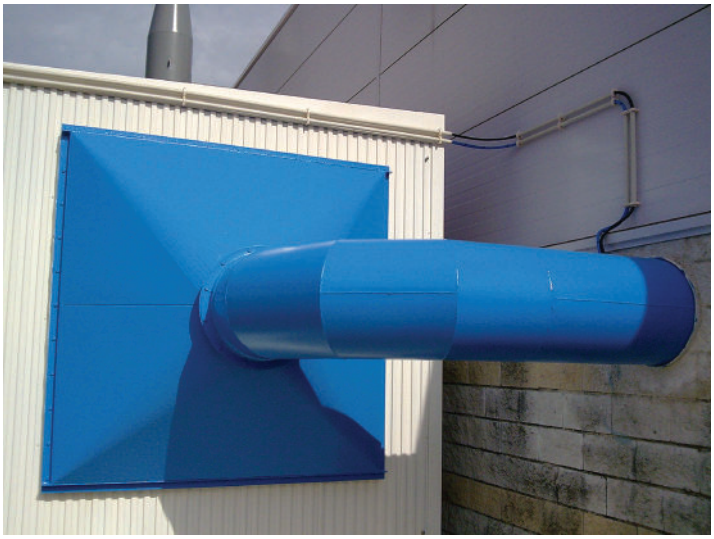
In 1998, the district of Expo Park (Parque das Nações) was established as the location for the 1998 Lisbon World Exposition. After the exposition, the area was renovated and transformed into a modern commercial and residential district. The exhibition theme was "The Oceans, a Heritage for the Future," chosen in part to honour 500 years of Portuguese discoveries. Over 10 million visitors attended the exposition, which was open for 132 days and featured 143 countries and numerous organisations.

The chosen location for the exposition was a 5-kilometre-wide area that covered 50 hectares in Lisbon's east end, along the Tagus River. In 1942, this area was used as a Hydroport, but as technology changed, hydroplanes became obsolete, and the area became an industrial park. However, the industrial park had become a source of pollution and degradation over the years, so the Expo '98 was built from the ground up. The new construction included a new bridge across the river, a new line for the Lisbon Metro, and a new main multi-modal terminal, Gare do Oriente, to support the plan of sustainable urbanisation. The Vasco da Gama Bridge was also built during this time; it was then the longest bridge in Europe.

Waste collection Reimagined

Inside of the Envac waste collection terminal

Envac's waste collection system at Expo Park in Lisbon is an underground automated waste collection system that uses a vast network of pipes to transport waste from various locations in the area to a central collection station. The system was implemented in 1998 as part of the infrastructure for Expo '98 and has since been expanded and modernised to accommodate the area's growing needs. The system uses vacuum technology to transport waste, eliminating the need for traditional garbage trucks to collect waste from individual bins. Users deposit their waste into one of the many waste inlets located throughout the area, and the waste is then transported through the pipes to the central collection station. The system has several benefits, including reduced noise pollution, cleaner streets, and improved hygiene. It also reduces the carbon footprint typically associated with waste collection, eliminating the need for heavy fossil fuel powered garbage trucks to travel through the area.



Filter room connected with the terminal to clean the air particles and eliminate the odours

"Envac system has been in operation for half a million hours and is available 24/7. The successful installation and operation of the resilient waste collection system at Expo Park in Lisbon for the past 25 years is a testament to the importance of preserving the environment and enhancing the quality of life in urban areas." - says Roberto Rello, Service Director, Envac Region EMEA

A STATIONARY PNEUMATIC WASTE COLLECTION SYSTEM ELIMINATES THE NEED FOR WASTE TO BE COLLECTED BY TRUCK. INSTEAD, IT IS TRANSPORTED THROUGH UNDERGROUND PIPES BY AIR AND THEN COMPACTED IN SEALED CONTAINERS. THIS SOLUTION MINIMISES THE NEED FOR ROAD TRANSPORT AND ELIMINATES THE PROBLEM OF UNPLEASANT ODOURS. UNLIKE TRADITIONAL WASTE MANAGEMENT, NOBODY NEEDS TO COME INTO CONTACT WITH WASTE BAGS OR CONTAINERS.

AMBITIOUS WASTE MANAGEMENT AND COMMITMENT TOWARDS SUSTAINABLE DEVELOPMENT

As the system celebrates its 25th anniversary this year, it is worth noting the positive environmental outcomes it has yielded. The Expo Park system is a successful example of improving the quality of urban life while preserving the environment.

- The system has supported urban planning and management by eliminating heavy-duty collection vehicles and bulky waste storage containers on the streets.
- From an environmental perspective, the system has prevented around 8 tonnes of carbon emission per year, which is equivalent to 1,175 Olympic-sized swimming pools, in the last 25 years.
- Additionally, it has eliminated greenhouse gases (GHG) such as; 15 tonnes of nitrogen oxide and 53 tonnes of carbon monoxide over time.
- The automatic waste collection system works through a 40 km underground pipe network that transports waste using an air stream to a consolidation plant making the solution safe, resilient and hygienic.

214
tonnes of carbon emissions

is prevented in 25 years. Approx. 8 tonnes a year making city life greener, smarter, and more sustainable

40,000
homes

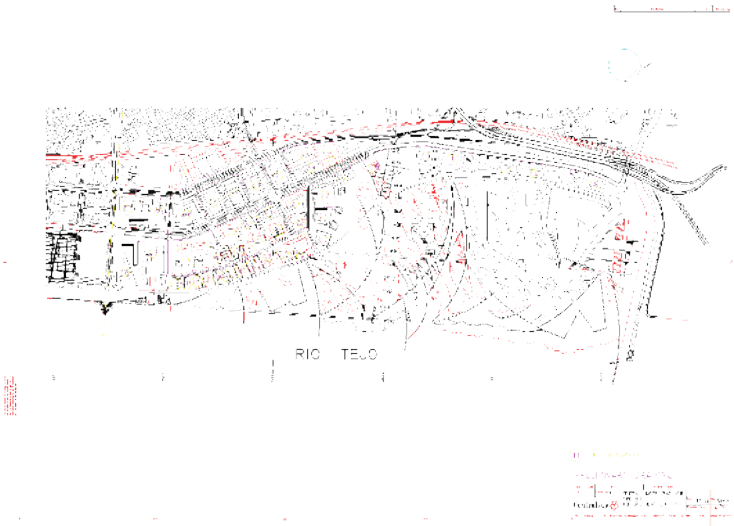
The system has served around 120,000 inhabitants while eliminating the need for heavy collection vehicles

240,775
tonnes of waste

2 different fractions, general/residual and packaging (paper + plastic) have been collected from over 1500 valves

24/7
availability

The system has been in operation for around half a million hours so far with round the clock availability thus proving its roubustness



The original drawings of connecting the Envac stationary vacuum waste collection system with the Expo Park, Lisbon area.

Expo Park design illustration during the planning process

> *EXPO'98 was more than just a chance for improving the environment and urban renewal. It was an opportunity to both modernise and internationalise Lisbon - a large-scale undertaking, with a unique opportunity to apply innovative concepts in building tomorrow's cities, with the accent on the environment.*
> *- Jonas Törnblom*
> *Director Marketing & Public Affairs, Envac (Sep 2001 - Aug 2017)*

- In the future, it is possible that Envac may utilise clean energy sources like solar energy from photovoltaic panels on-site. This would make the project a prime example of sustainable urban development.

The urban space we know now:

- The area provided an opportunity for urban recovery and environmental cleanup of a space previously occupied by stockyards, slaughterhouses, etc.
- Following Expo '98, the area was transformed into a modern commercial and residential district, known as the Parque das Nações (Park of the Nations).
- A commitment to sustainable development was made by ensuring that every building was pre-sold for repurposing after the Expo, preventing the site from being left semi-abandoned as had happened in previous expos.
- The residential apartments, offices, and the Vasco da Gama shopping centre are all linked to one of three underground waste transport systems. These systems also connect to the railway station, bus and metro terminal and handle waste from cinemas and museums. Approximately 27 tonnes of waste is managed by the system each day.
- Three waste collection terminals support the area due to the volume of waste.

TECHNICAL DETAILS:

TOTAL AREA: 340 hectares

WASTE TYPES: 2 fractions, general/residual and packaging (paper + plastic)

PIPE SPECS: 500 mm for waste collection and over 40 km network

NUMBER OF INLETS: over 70 outdoor inlets for commercial use, and over 1500 valves connected to multiple inlet doors

AMOUNT OF WASTE COLLECTED: 9855 tonnes per year approx.

SYSTEM AVAILABILITY: 99.99% (24/7) with regular O&M

FIRST SYSTEM OPERATION: April 1998

DRIVING LISBON'S CIRCULARITY : ZERO-WASTE CITY BY 2030

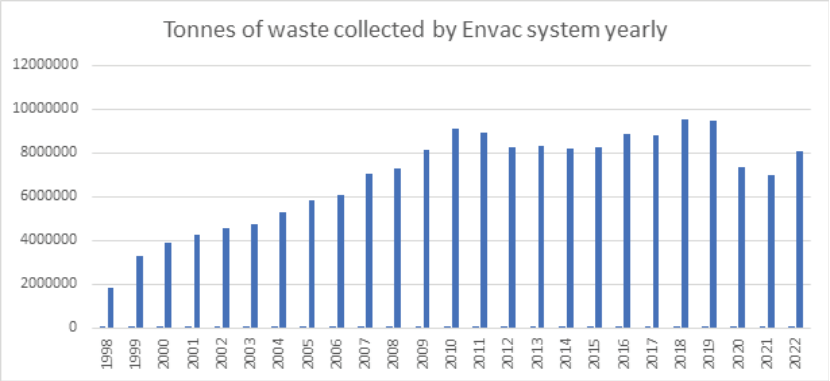
Lisbon is making significant progress towards achieving its ambitious goal of becoming a zero-waste city by 2030. The city is committed to the circular economy principles that focus on reducing waste generation and reusing and recycling materials whenever possible. The aim is to minimise landfill waste while maximising material recovery and reuse. To achieve this goal, Lisbon is implementing innovative waste management solutions tailored to meet the city's unique needs.

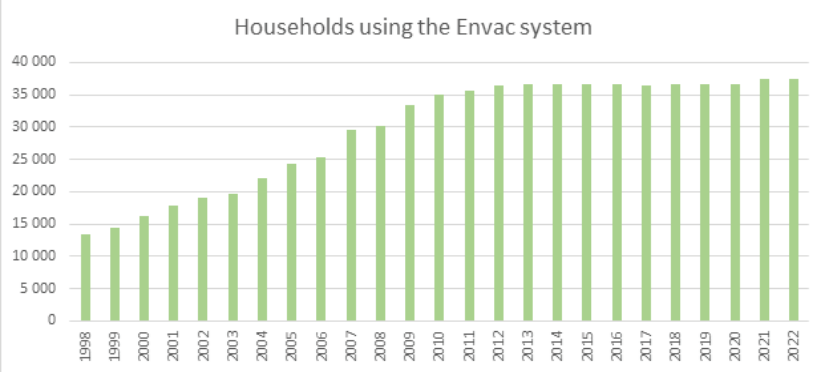
The Lisbon City Council document provides a detailed analysis of the city's waste management, including some figures from 2022. According to the municipality, each inhabitant generates 579 kg of waste, with 70% being undifferentiated collection (common waste) and 30% selective collection (separated waste). The most collected materials are bio-waste, glass, and paper. The majority of waste in Lisbon is sent to energy recovery (59%), with recycling (20%), landfilling (13%), and organic recovery (8%) also being used as final disposal methods.*

Waste-to-energy
Another innovative solution being used in Lisbon is the conversion of biowaste into energy. This involves anaerobic digestion, a process that breaks down food waste and other organic materials to produce biogas, which can then generate

*Source: Lisboa Para Pessoas

electricity. This approach helps to reduce waste while also producing renewable energy, thereby contributing to the city's goal of becoming a more sustainable and environmentally friendly place to live.





Preventing carbon emissions by adopting AWCS

As waste management becomes increasingly important for cities, reducing carbon emissions is critical to achieving sustainability goals. In Lisbon, one innovative solution being used to prevent carbon emissions from waste trucks is the Automated Waste Collection System (AWCS). AWCS involves a network of underground pipelines that transport waste from buildings to collection points using air pressure. This eliminates the need for waste trucks to collect waste from individual facilities, reducing carbon emissions from traditional collection methods. In addition to reducing carbon emissions, AWCS also improves the overall efficiency of waste collection. Since the system is automated, it eliminates the need for manual labour, reduces traffic congestion, and minimises noise pollution. Implementing AWCS in Lisbon's waste management system is a significant step towards achieving the city's goal of becoming a zero-waste city by 2030. By reducing carbon emissions and improving the efficiency of waste collection, Lisbon is setting an example for other cities to follow in creating a more sustainable and environmentally friendly future.

Overall, Lisbon's commitment to creating a sustainable future and improving the quality of life for its residents is evident in its innovative and forward-thinking approach to waste management. By implementing smart waste collection and using biowaste for energy generation, the city is well on its way towards achieving its goal of becoming a zero-waste city by 2030.

Independent study conducted by El Cubo Verde

El Cubo Verde, an environmental consulting firm, conducted a study in 2020 to assess the potential environmental impact of traditional waste collection vehicles in areas where automatic waste collection systems are currently in use. The study quantitatively evaluated the collection system and process based on the number of kilometres travelled by collection vehicles in urban areas and the amount of waste collected per day.

Automatic waste collection only uses trucks to remove containers from the collection facility and transport them to the transfer/ recycling facility. According to the El Cubo Verde study, the need is estimated at 7.7% compared to traditional collection truck movements.

Pollutant removal values according to the formulation of El Cubo Verde

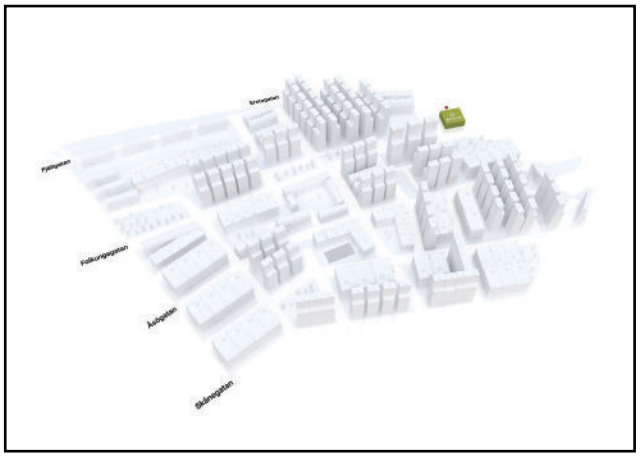
Year	Total tonnes	km travelled	Liters of fuel	CO2	No. of routes	Truck hours	NOx tonne	CO tonne
1998	1.867	2.333	1.050	**2,5200**	233	1.400	**0,1680**	**0,6300**
1999	3.269	4.087	1.839	**4,4135**	409	2.452	**0,2942**	**1,1034**
2000	3.569	4.461	2.007	**4,8179**	446	2.677	**0,3212**	**1,2045**
2001	3.868	4.836	2.176	**5,2224**	484	2.901	**0,3482**	**1,3056**
2002	4.168	5.210	2.344	**5,6268**	521	3.126	**0,3751**	**1,4067**
2003	4.733	5.916	2.662	**6,3892**	592	3.550	**0,4259**	**1,5973**
2004	5.297	6.622	2.980	**7,1515**	662	3.973	**0,4768**	**1,7879**
2005	5.862	7.328	3.297	**7,9139**	733	4.397	**0,5276**	**1,9785**
2006	6.427	8.034	3.615	**8,6763**	803	4.820	**0,5784**	**2,1691**
2007	7.045	8.806	3.963	**9,5105**	881	5.284	**0,6340**	**2,3776**
2008	7.323	9.154	4.119	**9,8862**	915	5.492	**0,6591**	**2,4716**
2009	8.135	10.169	4.576	**10,9822**	1.017	6.101	**0,7321**	**2,7456**
2010	9.145	11.431	5.144	**12,3456**	1.143	6.859	**0,8230**	**3,0864**
2011	8.958	11.197	5.039	**12,0928**	1.120	6.718	**0,8062**	**3,0232**
2012	8.281	10.352	4.658	**11,1799**	1.035	6.211	**0,7453**	**2,7950**
2013	8.323	10.403	4.682	**11,2357**	1.040	6.242	**0,7490**	**2,8089**
2014	8.200	10.250	4.612	**11,0699**	1.025	6.150	**0,7380**	**2,7675**
2015	8.266	10.332	4.650	**11,1589**	1.033	6.199	**0,7439**	**2,7897**
2016	8.866	11.083	4.987	**11,9694**	1.108	6.650	**0,7980**	**2,9924**
2017	8.813	11.016	4.957	**11,8977**	1.102	6.610	**0,7932**	**2,9744**
2018	9.556	11.945	5.375	**12,9009**	1.195	7.167	**0,8601**	**3,2252**
2019	9.471	11.838	5.327	**12,7854**	1.184	7.103	**0,8524**	**3,1964**
2020	7.344	9.180	4.131	**9,9146**	918	5.508	**0,6610**	**2,4786**
2021	6.994	8.743	3.934	**9,4424**	874	5.246	**0,6295**	**2,3606**
2022	8.116	10.145	4.565	**10,9566**	1.014	6.087	**0,7304**	**2,7391**
				232,0603			**15,4707**	**58,0151**

Comparison of emissions of gaseous pollutants in air between automatic waste collection and traditional waste collection from 1998 to 2022

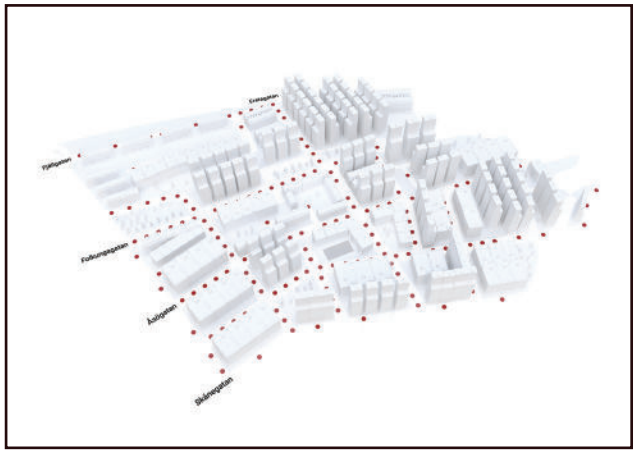
CO2 emissions in 25 years
(Automatic) 17.87 tonne vs **232.06 tonne (Traditional)**

NOx emissions in 25 years
(Automatic) 1.19 tonne vs **15.47 tonne (Traditional)**

CO emissions in 25 years
(Automatic) 4.47 tonne vs **58.02 tonne (Traditional)**



Automated waste collection system: Waste is disposed of in inlets close to the buildings and transported via underground pipes to a collection station outside the area (the green square). Minimum of truck movement in the residential area.



Manual collection (Traditional): The red dots are real collection points, where the waste truck stops to collect waste with the engine on to compact the waste.

LESS HEAVY TRAFFIC, LESS EMISSIONS

Streets in dense cities without Envac AWCS

- Congested streets, lack of space
- Open waste causing odor, vermin & unsanitary conditions
- Safety risks due to manual waste handling
- Increased pollution, unhealthy air particles, emissions from greehouse gases (GHG)
- Unhealthy environment overall
- Heavy traffic in public space

Streets in dense cities with Envac AWCS

- Closed vacuum system promotes cleanliness
- More green space for recreation
- Safer waste handling due to automation
- 90% reduction in carbon emissions
- Safe, clean environment promoting quality of life
- Positive step towards sustainable urban development
- Robust system with 24/7 operation
- Accessibility during unprecedented times

NEXT 25 YEARS

Since the installation, 25 years have passed, each with 365 days of uninterrupted operation, and some system characteristics have changed.

The Expo Park Automatic Waste Collection System (AWCS) spent its first 25 years with distinction, fulfilling the initial objectives - safety, efficiency, robustness and operability. The leap into the future forces us to face new challenges that, from now on, society puts on the table, as well as the rest of the public services.

System improvement: Prepare the mechanical infrastructure to face the next 25 years. Conform to the requirements of safety standards and conform to the strength of materials. Incorporation of Artificial Intelligence that will enable maximum efficiency in the collection process according to the current parameters. Optimisation of consumption derived from collection according to actual needs.

Improvements for users: To improve waste management services, user identification, individual aperture sensors and volume or weight counters are essential. Gathering and analysing data on waste will enable us to offer users comprehensive information about the service they can receive. This information can be accessed through websites or mobile applications. Using non-contact opening systems and information screens at the inlets on the street can also help improve the overall waste management efficiency. Additionally, incorporating new collection fractions can further enhance the waste management process.

One of the underground access for pipes in the area (used for O&M)

Aesthetical renovations: Deep cleaning of both interior and exterior areas; painting of both interior and exterior walls, with replacement of missing or damaged elements; painting of equipment; interior resurfacing; renovation of sanitary facilities; and restoration of the old filter room are some of the aesthetical improvements that will increase the longevity of the system.

Energy efficiency: There is a possibility of reducing electricity consumption by about 15% with the help of the Envac Automation Platform (EAP). This platform can configure the system requirements based on machine learning and big data, which can further reduce the cost of equipment maintenance. It also helps extend the equipment's useful life and filter service life by approximately 20%.

Finally, Envac's automated waste collection system lays the groundwork for a future of data-driven waste management. Unlike traditional waste collection methods, the system does not depend on human input to determine how it operates and where enhancements can be made.

Envac Team in Lisbon, Portugal at the waste collection terminal for Expo Park

> *Over the course of 25 years, it has become a worldwide symbol of the significance of preserving the environment and improving the quality of life in urban areas. We take pride in knowing that initiatives like this have helped Lisbon emerge as one of the world's capitals with such a unique feature.*
>
> *Carlos Bernad, President of the EMEA region of the Envac Group, about the remarkable success of the system installed at Expo Park in Lisbon*

ICONIC CASE
EXPO PARK, LISBON
25 YEAR ANNIVERSAY EDITION

www.envacgroup.com