

Urban Waste Management: A Waste-to-Energy Plant to Improve the Barrio San Martín Dump in Paraná

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Summary:

Currently, the city of Paraná, Entre Ríos, faces the production of large amounts of waste generated daily and the problems derived from them. As a solution to this, the construction of A Waste-to-Energy Plant is proposed in the same area of the city where the current waste classification plant is located on the same property as the waste classification plant in the above-mentioned city. The new plant will have waste burning, ash treatment and energy production facilities. It should be noted that this solution is a simpler adaptation to the measures carried out in countries with greater development in this area.

Keywords: Waste-to-Energy Plant, waste burning, ash treatment, energy production facilities.

Resumen:

Actualmente la ciudad de Paraná, Entre Ríos, se enfrenta a la producción de grandes cantidades de residuos generados diariamente y los problemas derivados por los mismos. Como solución a esto, se propone la construcción de una planta de valorización energética en el mismo predio que la planta de clasificación de residuos en dicha ciudad. La nueva planta contará con instalaciones de quema de residuos, tratamiento de cenizas y producción energética. Cabe destacar que dicha solución es una adaptación más sencilla a las medidas realizadas en países con mayor desarrollo en dicha área.

Palabras clave: planta de valorización energética, quema de residuos, tratamiento de cenizas, producción energética.

I. INTRODUCTION

This presentation is based on the city of Paraná, which is the capital of the Entre Ríos Province. There are 270 neighborhoods in Paraná and it has a population of 247.863, spread in 137 km² (according to the 2010 Census). In Paraná, citizens produce a kilo of garbage per day, and only 40% of this garbage is recyclable. The city generates about 300 tons per day. Although people separate the rubbish in different containers, and Paraná has got 5 recycling plants, there is still a lot to do.[1]

Our work aims to study and develop new forms of waste management which are used in developed countries to improve the current situation at the city's dump, usually called Volcadero De Parana. These management strategies are focused on obtaining maximum efficiency in the recycling of waste. A waste-to-energy plant is proposed.

In order to achieve this aim this work is organized as follows. Firstly, we are going to tour the city and slowly enter the area of the city that is the focus of this work. Second, we are going to present and discuss the problem in relation to garbage management in the Barrio San Martin, indicating the causes that give rise to this problem. After this, we are going to talk about the impact that this has these days and how this is affecting the city and our lives. Finally, we are going to present our action plan and different ideas to deal with the problem.

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II. PROBLEM DEFINITION AND ANALYSIS

A. Description of the context

The dump is in the city of Paraná. Paraná is a big city that lies on the Paraná river.

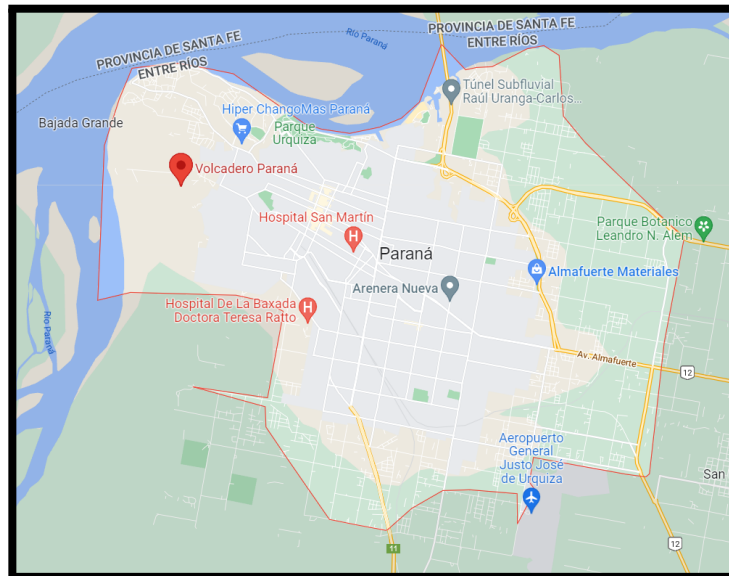


Fig. 1. Paraná city map.

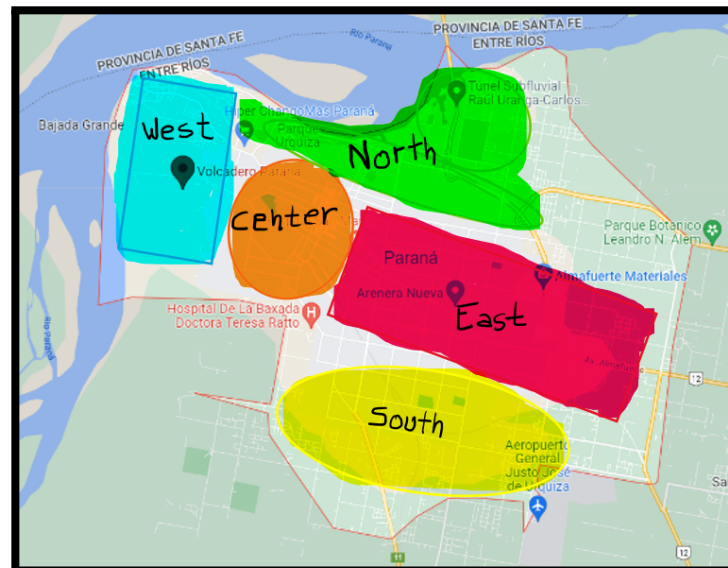


Fig. 2. Map of the areas of the city of Paraná

In the south of Paraná there are many party halls and, in this part, there is access to Oro Verde, a university city near Paraná. Also, to the southwest of Paraná there is a hospital, De La Baxada Doctora Teresa Ratto Hospital.

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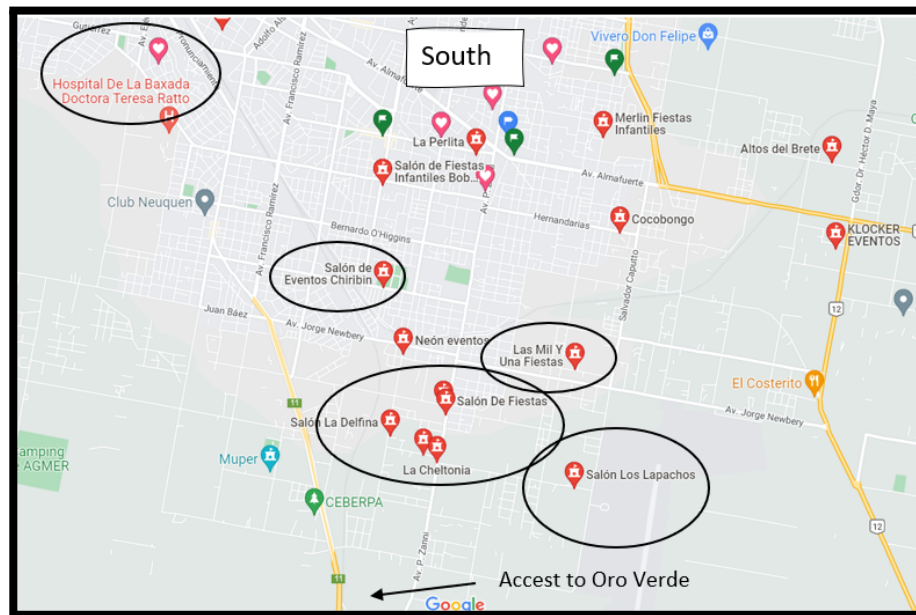


Fig. 3. Landmarks in the southern zone

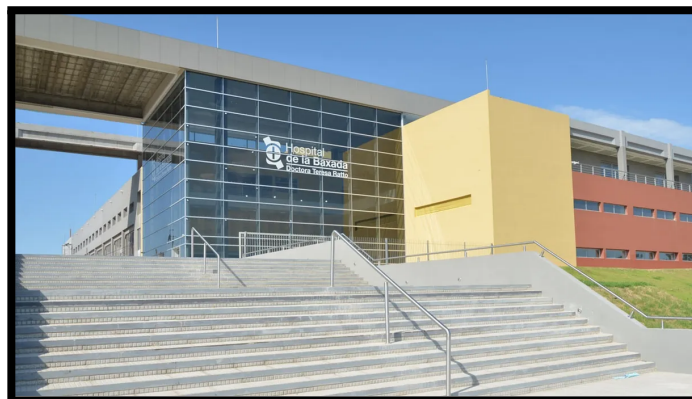


Fig. 4. De La Baxada Doctora Teresa Ratto Hospital

In the east of Paraná, there are two access roads, one leads to San Benito and the other one to Colonia Avellaneda. Also, in the east area we can see National Technological University, Paraná Regional School. “Las Cinco Esquinas” is near UTN University. It is called “las Cinco Esquinas” because it is made up of five corners, the 911 corner, the headquarters of the Municipality, the Evangelical Baptist Church and the gas station. These areas are three blocks away from San Martin Hospital.

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Fig. 7. Square “1ro de Mayo”



Fig. 8. Province’s Government House

In the north of Paraná lies the Subfluvial Tunnel, which connects Paraná with the city of Santa Fe. In this area of the city, you can find Urquiza Park and La Costanera.

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Fig. 9. Landmarks in the northern area

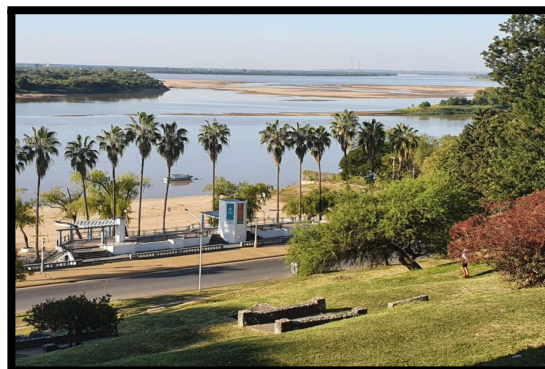


Fig. 10. "La Costanera"

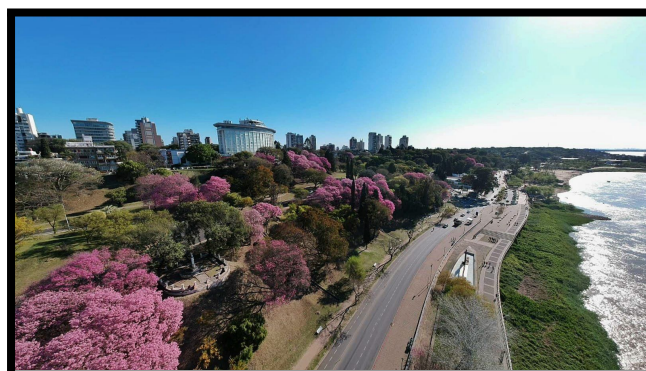


Fig. 11. Urquiza Park

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In the west of Paraná you can see the wetlands, to the right of the Paraná River. Just south of the wetlands, there is a street, Camino de las Piedras. On that street there is a private school, Los Nazarenos. Close to this school, you can find the place of this study: the dump of Paraná.

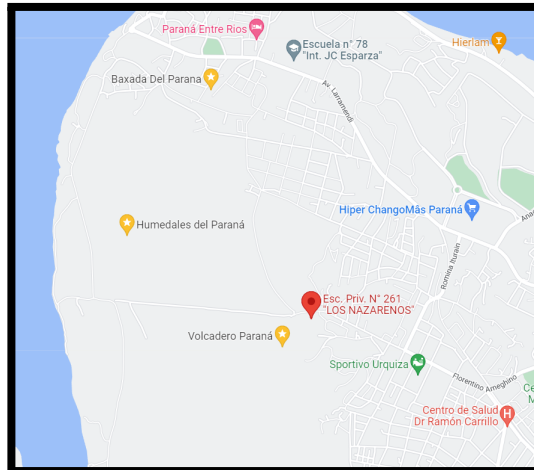


Fig. 12. Landmarks in the west area



Fig. 13. The wetlands

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Fig. 14. The dump of Paraná

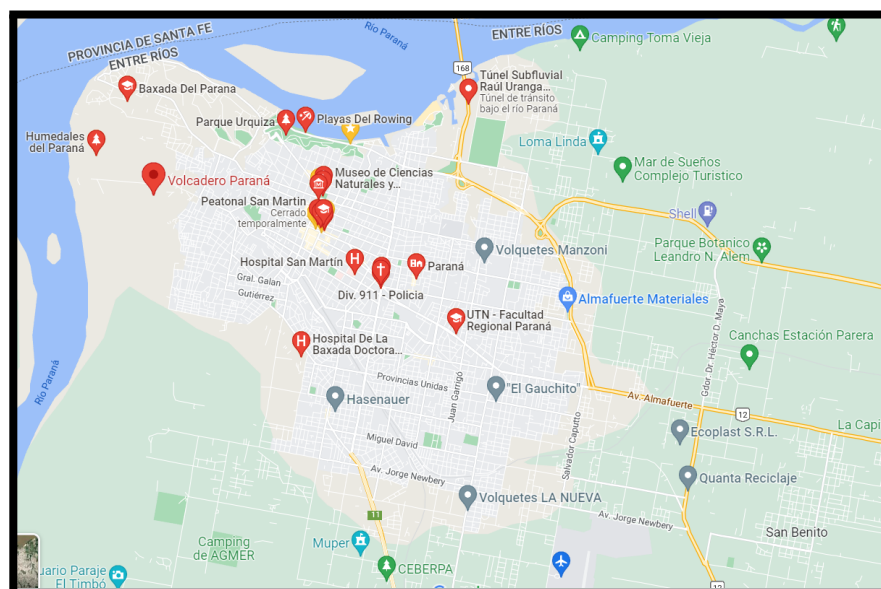


Fig. 15. The dump of Paraná in the map

B. Problem statement

At this moment, thousands of tons of recyclable garbage are being wasted due to the inefficiency of production processes and technological underdevelopment. The generation of waste is directly related to the degree of industrial development of a country and the increase in its urbanization rate. World experience shows that the amount of waste changes not only with the number of inhabitants, but also with the standard of living and purchasing power (translated into consumption habits), with production systems, packaging methods and, in general, with the economic growth of the countries.

Unfortunately, in Argentina, Controlled Landfills (CL) and Open Air Dumps (OAD) prevail. The first do not have the infrastructure of a sanitary landfill, although they have some control measures, such as waterproofing of the bottom and the side walls of the

well. In these landfills, once the rubbish is dumped, it is covered every day with a thin layer of earth that hinders the proliferation of rats and bad odors and reduces the risk of fires. However, OAD is the worst option because it is a site where all kinds of waste (including dangerous and pathogenic) arrive without any control or prior treatment[1].

Most of the largest municipalities in the Argentine Republic (more than 500,000 inhabitants) already use the solid waste system (SWS) and, to a lesser extent, the CL system. At the same time, 70% of the municipalities with populations of less than 10,000 citizens dump their waste in OAD. The percentages remain high up to populations of 100,000 inhabitants, where the use of OAD exceeds 50% [1].

Entre Ríos has 87.5% coverage of waste collection, which places it below the 91% national average; and with a scant 9% of the population covered by landfills, it is below the 61% national average. In the province, approximately 1 kg per inhabitant per day of Urban Solid Waste (USW) is generated, which includes household, sweeping and pruning, rubble and bulky waste [1].

Garbage and the existence of the dump are the main socio-environmental problems in the city of Paraná. Until the year 2014, all the collected garbage was deposited in the city's dump. This entailed 40 trucks that unloaded about 300 tons of garbage in the open in an area of 30 hectares. It received 100% of the waste formally collected throughout the city. However, there was also an unquantified percentage of informal collection whose destination was the dump or one of the micro-dumps scattered throughout the city in peripheral neighborhoods, near streams and railroad tracks [1].

Due to the great amount of contamination produced, on Tuesday, December 30, 2014, The Manuel Belgrano Waste Classification and Treatment Plant was created with a processing capacity for 250 tons of waste per day [1].

The plant was created with the following purposes:

- 1) Minimization of the amount of waste disposed of in the open dump.
- 2) Recovery of waste with economic value.
- 3) Social inclusion of current informal recyclers.
- 4) Consolidation of a key stage in the city's Comprehensive Management of Urban Solid Waste(CMUSW or GIRSU).

Today the recycling plant receives 100% of the city's waste but it only recycles 40%, which is inorganic. The other 60% of garbage is discarded in the city's municipal dump. This is the focus of the present work[1].

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C. *Description of scenes that help picture the problematic situation*



Fig. 16. Paraná sorting plant (front area) [1]

This is not a picture of any shed. This is a picture of a waste sorting plant and it is located inside the dump of the city. The classifier plant has a very important role in the city, since it was created with the idea of reducing the garbage that is deposited in the dump.

You can see how the plant is made of materials that are considered basic but that fulfill their purpose. This is made of sheet metal and iron rods, which provides a structure that fulfills its purpose, in addition to being located on a concrete base as a floor.

On the left of the image you can see how part of the inorganic waste is already classified, to later be compacted and sold. Also, on the right side you can see one of the many people who work in this complex.

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-Characteristics of the Plant:



Fig. 17. Paran sorting plant (building building) [1]

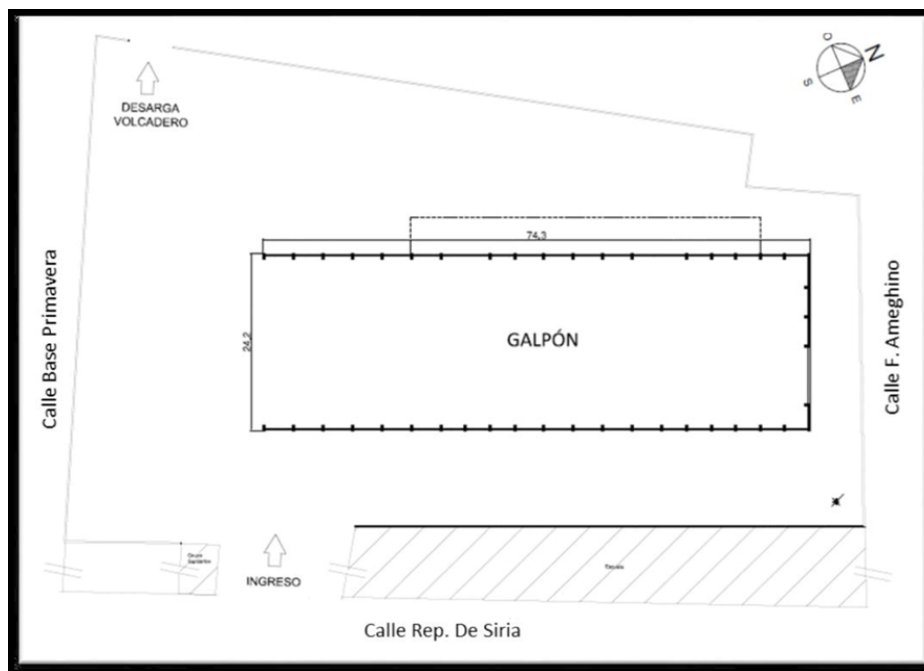


Fig. 18. Blueprints/Plans of the sorting plant [1]

The Manuel Belgrano separation plant is located between Repblica de Siria, Base Primavera and Florencio Ameghino streets. It consists of a shed of 74.3 m x 24.2 m. In this place, workers carry out waste sorting operations. The plant currently has a labor capacity of approximately 150 workers[1].

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Fig. 19. Machinery used in the plant [1]

Basically, the workers carry out the separation of the inorganic waste for later sale. The separation of waste consists in filtering the garbage in a large orange machine with different conveyor meshes. The machine separates the organic from the inorganic and the meshes separate the inorganic waste into the different types of plastics, cardboard and dry waste. Therefore, what is separated in the meshes is compacted in bales except for glass, cans and aluminum.

Regarding the economic benefits, the waste in bales is sold to companies in Buenos Aires that buy these bales and the companies take them to the recycling plants.



Fig. 20. Compacted garbage to be sold [1]

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The capacity of the plant to process inorganic waste is large. Organic waste, unfortunately, has no other destination than its disposal at this moment.



Fig. 21. Open air dump [1]

This is not an image of a plateau or plain. This is a photo of an Open Air Landfill. This dump is located a few kilometers from the city, as you can see. Therefore, this dump is not located in the right place since it is close to a tourist attraction in Paraná and it is also very close to the city.

In the foreground of the photo there is garbage, which is overflowing into the Paraná River. This pollutes the river and the river's biodiversity. This will bring in the future many pests and bad odors in the river water, harming not only the people of Paraná but also all the people who border the river.

In the middle of the picture, there is land, which is where the garbage is compacted. The garbage is deposited in the place by means of dump trucks and then soil is poured over it. Later, the compacting machines go over it so that a compacted surface is left.

In the background of the picture, there is an elevated area of land and garbage, which is a very elevated part and causes many problems. Because it is a high ground, it makes it easier for bad odors to reach the city along with the polluted air.

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Fig. 22. Open air dump area near the river [1]

In this photo, there is a new perspective of the OAD. In the foreground, we can see the trash that is not recycled or sold. Accumulation of waste like this one is the reason why we started our search for solutions to improve this situation in Parana.

In the middle of the picture, there are many trees. This is part of the vegetation of the wetlands that surround the dump. Also among trees we can appreciate one of these that does not have any leaves. One reason for this can be the time of the year or the uncontrolled fires that occur in the OAD.

In the background, you can see the Parana River and this is one of the principal areas affected by the contamination from the dump and its overflow. In this photo, we can better appreciate the height of the hill in relation to the level of the river.



Fig. 23. People collecting garbage at the landfill

In this last picture, we can see a lot of people and they are collecting garbage because, unfortunately, collecting garbage is their economic livelihood. Sadly, this is part of the life of some people from Paraná.

In the foreground of the picture, there are a lot of adult men and women and they are looking for something to sell. However, this activity probably is not only for adults because there are a lot of families that live here. Probably, in other zones there are many kids doing the same task.

In the middle of the picture, there is a lot of garbage on the floor so this part is in the OAD. In this part of the picture we can understand why the OAD needs the implementation of new methods that can reduce the accumulation of so much waste. This garbage probably generates a lot of health problems for the people who live inside the dump.

In the background of the image, there is a lot of air pollution because the waste on the floor of the OAD all day is burned to reduce it. The air pollution and smoke generated are often to blame for bad odors in the city.

D. Identification and analysis of causes or factors that give rise to the problem:

The causes for this problem are:

- Lack of awareness
- Lack of planning
- Lack of productive diversity
- Lack of political commitment

The lack of social awareness is one of the most important causes, since it is why so much waste is generated daily. As well as this, the lack of classification in homes makes it a more inefficient job, since when it comes to separating waste in the classification plant, this takes much more time when all types of waste are in the same bag.

The lack of planning is a cause to be highlighted, since for this reason the dump is very close to the wetlands, the river and the city. This means that the dump is so limited in its surroundings that it cannot expand anywhere.

The lack of productive diversity means that only 40% of the waste can be recycled. This is due to a lack of projection when analyzing the growth of the city and, therefore, the growth of garbage generated.

The aforementioned will cause the landfill to grow faster and faster and will not have the capacity to store so much garbage, causing two possible cases. The first case is that the City Hall must promote another new landfill. The second case is that the landfill grows more over time and this will result in the people who live around it having to vacate their homes since the landfill will begin to take over that territory.

The lack of political commitment caused the delay in the creation of the Manuel Belgrano classification plant, whose construction took approximately two years. At that time the plant was urgently needed because the volume that the landfill acquired daily was not controlled properly. However, its creation should have been done years before, since in 2005 the landfill already had an uncontrollable volume.

E. Identification and description of the consequences:

The main consequences of this situation are:

- **Overflow from the dump hill**
The first consequence refers to the accumulation of garbage that is produced by the process of compaction with the earth and the accumulation of soil and garbage in this area of the city. This accumulation is what generates the overflow and the overflow causes the garbage to fall into the Paraná River.
- **Environmental pollution**
Another impact is the environmental pollution generated, which can be in water, land or air. Water pollution is a product of the garbage falling into the Paraná River and this affects the water biodiversity composed of fishes, plants and other microorganisms.
- **Spread of bad odors**
The smoke generated by the burning of garbage is responsible for the bad odors in the city on days when the wind blows southward. Garbage burning is common on the site because the people who live in the dump usually burn garbage for different reasons. The bad odors spread through the city on windy days because the dump's zone is in a high area of the city, as it was explained before.
- **Spread of diseases**
The accumulation of garbage is a good environment for microorganisms. These viruses and bacteria can be carriers of different diseases and they can reach the rest of the city by means such as the wind, animals or by people who live in the vicinity of the dump.

III. THE WAY FORWARD

A. Problem approach

The solution proposed here starts by researching into how developing countries, like Switzerland, Norway, France and Austria, address this problem. There is an organization called Waste-to-Energy (WTE) which has many incineration, recycling and energy production plants in these countries. The plants that use this method of waste management are called Waste-to-Energy plants[4].

This project aims to replicate the experience in the countries mentioned above. The idea is to turn the Volcadero waste sorting plant into an incineration, recycling and energy production plant, by which the new plant is the basis of the production process required for a more environmentally productive plant[4].

A WTE plant performs many more actions than just producing energy. It carries processes like:

- Sorting and separating waste
- Transporting the waste to the incinerator
- Incinerating waste
- Heating water
- Filtering of ashes and gases produced
- Generating energy through water vapor
- Transporting water vapor through pipes to distribute hot water
- Transporting heat to heat homes
- Separating the fine ashes from the coarse
- Magnetically separating coarse ash from remaining metals
- Transporting and burying the remaining ashes in the landfill

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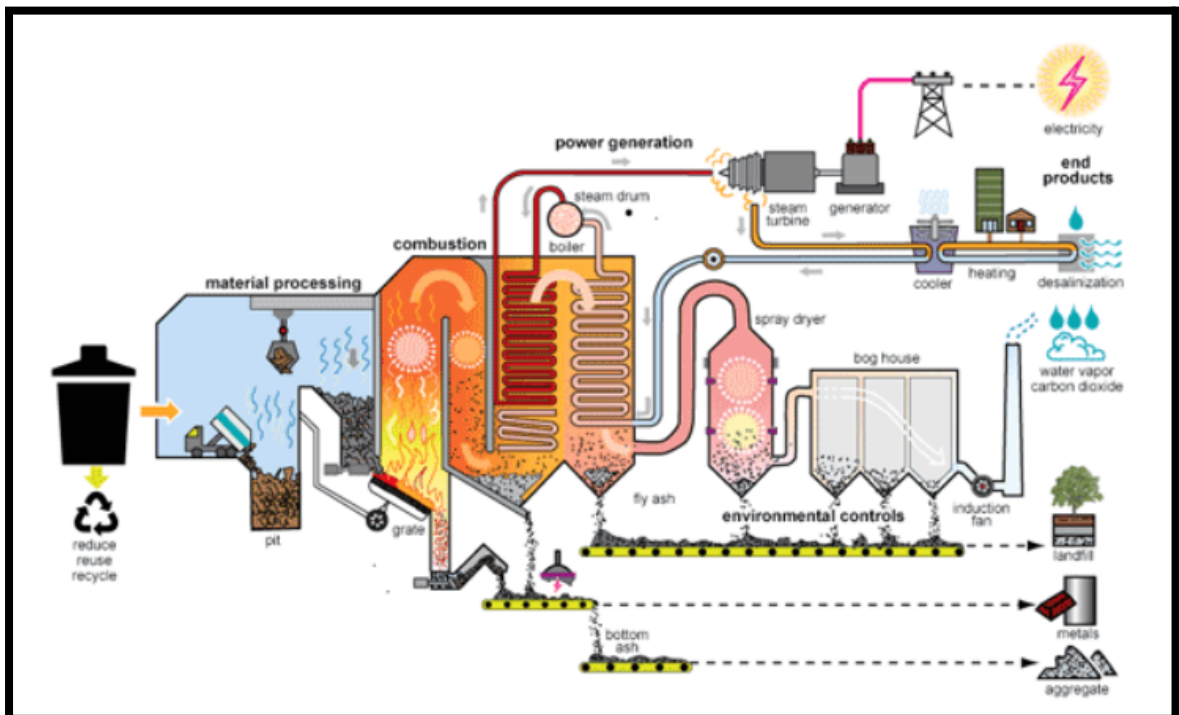


Fig. 24. Stages and machines used by the organization "Waste-to-Energy" [4]

The solution is based on taking as an example to follow certain stages of what a WTE urban waste treatment plant consists of. In this way, the current sorting plant is complemented by an incinerator plant that:

- Does not generate significant emissions through three filtering processes.
- Generates electrical energy through incineration.
- Replaces trash with ashes in the landfill.

The garbage process will begin as it normally does, by separating and classifying the waste into organic and inorganic, trying to use the old mechanism and continuing with the sale of what can be recycled. Then new processes will be added which will make the recycling plant more efficient: now inorganic waste is used in its entirety and organic waste is recycled. In addition to that, it has the space and capacity to implement more improvements, such as taking advantage of the hot water that comes from the condenser[4].

One of the key issues is where to locate these new areas of incineration and energy generation, since we need a large space that is accessible from the sorting plant itself. Analyzing this, the best area is towards the northwest of the shed where the waste is classified. The reason for this is that it is a fairly large area to build the plant without space concerns, and being close to the classification plant, there are no transportation expenses between one area and the other. In addition to this, in the mentioned area garbage burning is already carried out. However, with the new system this would be

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regulated and would have all the safety guidelines and would not cause conflicts with the environment[4].

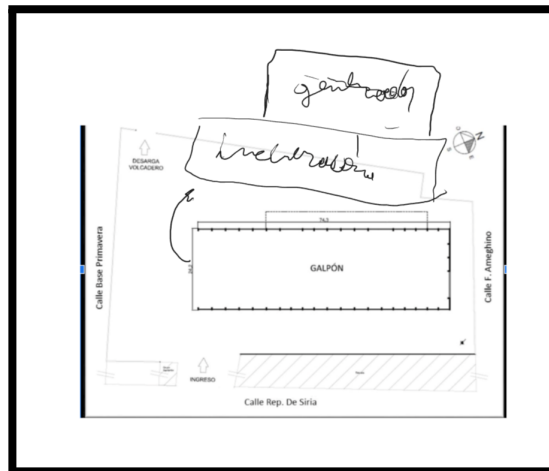


Fig. 25. Sketch of the construction area of the new incineration plant

- Waste incineration

Once the inorganic and organic waste is separated, everything with recycling potential is sold. Then, the waste that could not be commercialized is transferred to be burned in an incinerator. This plant will implement the moving grate furnace or also called a grill system[2].

The grill system consists of a series of rows of iron grills that move the waste with a back-and-forth movement. The use of hydraulic cylinders in the grills allows the process to be divided into three parts: drying, combustion and ash formation[2].

The grill works in conjunction with an incinerator furnace, which heats the waste at a constant temperature until the waste is reduced. The high temperatures in the furnace allow minimizing the contamination caused by gases. Furnace ventilation is a U-shaped injection that first passes through a boiler and then to a gas filtering system[2].

- Water heating

All the hot gas generated by the combustion will go to the boiler stage. The boilers are formed by tubes with water, heated by the heat generated, forming water vapor. The steam generated becomes the driving force of the turbines[5].

Boilers are the place where steam is generated by boiling water. Thanks to these, the steam generated becomes the driving force of the turbines[5].

In relation to the volume of the combustion chamber, it is necessary to fix its dimensions so that the equilibrium temperature of the gases does not exceed 1350°C and in this way the metal of the tubes does not deform[5].

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- Filtering of gases and ashes produced

Once all the hot gases have passed through the boiler, they will pass through a duct for filtering. In this first part, activated carbon is injected into the gas. This through its porous structure helps trap toxins and chemicals[3].

In a second stage, hydrated and pulverized dry lime is injected into the gas to then reach the bag filter. The bag filter is a bag-shaped fabric capable of retaining solid particles. Once passed through the bag filter, the decontaminated gas is released to the outside[3].

It is important to note that, at each stage through which the gases pass, there is an opening for the ashes to fall. The final destination of this incinerated waste is the landfill[3].

- Energy Generation

The steam from the boilers will be transported through tubes that support high pressure to reach the steam turbine. Power generation consists of three phases:

First Phase: Heating of the water by means of the generated heat.

Second Phase: Movement of the blades of a generator through the force of the generated steam.

Third Phase: Condensation of water vapor and restart of the process.

B. Strength and Weaknesses of the Proposal

The main advantage that can be attributed to this proposal in the environmental part is to put to use the excessive amount of garbage that we have in the city, which brings with it the reduction of the dump, the waste generated, pollution and diseases. Economically, it allows profits from the sale of the part of the garbage that is recycled, in addition to the generation of new jobs within the plant and, most importantly, the generation of energy through biomass.

On the negative side, it can be mentioned that this plant represents working with high temperatures and, therefore, the work can be considered risky. In addition to this, the transition would not be complete, since the use of fossil fuels for burning garbage would continue to be used until a method is found to make this process completely comprehensive.

IV. CONCLUSION

In conclusion, today's society faces the production of large amounts of waste that is generated daily. It is the root of many problems that affect society and that is the result of an inefficient urban waste management system.

As a solution to this, the construction of a waste-to-energy plant is proposed on the same property where the classification plant is. It will have facilities that allow the burning of waste, the treatment of ashes and the production of energy with the heat generated.

The solution is adapted from a larger project in more developed countries. The proposal is to build less complex facilities more in line with the possibilities of the city, which makes it more feasible from the beginning. The existing space would be used, solving the problem of location and the necessary land. Still, the biggest problem to face is obtaining the workforce for the construction in the first place and the operation of the new plant afterwards. The project requires a lot of effort to be carried out but it is still with the resources available in the city and the country.

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The present project is a skills integration activity in Inglés I at Universidad Tecnológica Nacional, Facultad Regional Paraná, carried out by EFL engineering students. The yearlong project requires students to delve into a problem in the city where they live and to address it by means of a simple project in English. Should the reader have any questions regarding this work, please contact Graciela Yugdar Tófaló, Senior Lecturer, at gyugdar@frp.utn.edu.ar.