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Electric Power Based on the Solid Urban Waste: Applied to the District of Bellaterra in Barcelona, Spain

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Abstract*— The high growth of Urban Solid Waste forces to seek measures to handle this waste. Applying advanced Thermochemical technology will take advantage of this waste in order to obtain Sustainable Energy. The objective of this study is to analyze the input, production and output behavior of this type of waste so that it can be transformed and used for energy purposes, based on the needs of the community. It is a quantitative, experimental study; after understanding the residual behavior of the community and applying the appropriate technology, it was obtained the quantified amount of energy (975'000 kWh) required for the different proposed scenarios. These scenarios are the use for public lighting, sale and domestic. The thermochemical method applied is not only efficient to extract energy from these wastes but also provides a compatible and environmentally friendly energy source. This energy source was used to supply a local school and 948 homes. The ideas es to achieve a paradigm shift, to avoid thinking that Urban Solid Waste that is generated from day to day is something useless; on the contrary, it is a vital source to provide a basic service for human beings. From a financial point a view, it is estimated that the initial investment will be recovered in the next 10 years, which, seen in the long term, is the useful life of the Pyrolysis plant due to working with the minimum raw material input standards.

***Keywords*— Urban solid waste; pyrolysis; bio-waste; energy; heat capacity.**

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I. Introduction

The rise in solid urban waste (SUW) production is directly linked to the increase in the community in the urban area and its economic development. Currently, half of the population is located in entrenched urban areas with exponential population growth. With the current demand for goods and services of the world population, it is expected that by 2025 the amount of SUW will be approximately 2,200 million tons per year [1]. Therefore, it is necessary and urgent that cities in constant development, which do not have integrated waste management programs (IWM), be implemented immediately to see the SUW can be a source of infinite resources and not as a problem should be removed immediately [2].

It is possible to propose some options for valorizing this waste, for example, recycling, composting, and bio-digestion. However, there is a type of exploitation in which SUW can generate electrical power through biochemical processes that consist of aerobic and anaerobic digestion. There is also the thermochemical process that consists of incineration, gasification, and pyrolysis processes. Of the processes, it should be mentioned that thermochemical processes have a greater energy scope, and their capacity to reduce SUW is much greater. For example, it is estimated that in the world, approximately 130 million tons of SUW are processed in plants ranging from Waste-to-Energy (WtE) and produce around 45GW-h [3].

In the case of waste whose purpose is to occupy a space for final disposal, it leads to a dilemma of why not use a clearly residual material to give it a new use and thus mitigate the pollution generated by them and intervene in such a way as to reduce energy consumption in the Bellaterra neighborhood. The study was welcomed mainly due to the pollution and by providing friendly solutions to solid waste produced by the man. This study serves more than a simple investigation in the residual field. This study also comprises a change in the human mentality of managing its resources and its residues for a variation in favor of the environment, analyzing the current residual model of the neighborhood of Bellaterra [4]. The study's main objective is to determine the amount of

SUW that can be exploited and used for energy purposes and thus minimize the impact on the environment.

II. Material and Method

A cross-sectional, experimental, descriptive, and analytical study is presented. This type of study is essential because it is an issue that affects the community, and it will solve a problem related to it. It focuses on SUW, as mentioned above, in the community of Bellaterra. As a theoretical scenario for urban waste, the following was proposed:

The classification of waste from the Bellaterra neighborhood includes organic, paper, cardboard, glass, and bulky. Quantify the inputs, production, and outputs of waste and thus rate which are usable from this classification. Mention the technologies available to obtain energy for those wastes, along with its operation. Give this renewable energy a purpose, which is beneficial to the Barcelona-Spain's Bellaterra neighborhood. The waste generated by this community will be treated in such a way that there is no reuse as much as possible, a large part (biodegradable) will be used as compost for community gardens, and the other part (not biodegradable) that interests us, will give it an energy value.

All this situation, as mentioned previously, will be valued to the maximum through the technology to be implemented and possible infrastructure, which, together with a detailed budget, will let to know the feasibility of possible scenarios. Aspects related to SUW with certain characteristics have been considered throughout the study to propose later scenarios that benefit them, whose management will have to provide daily service. Aspects related to demography regarding the generation of SUW may be associated with human activity and the economic status present in said community. A current model of organic matter will provide several guidelines to have a general vision of the waste generated by them, considering the inputs that it covers, the production, and the outputs that are being the SUW [5]–[7]

III. Results and Discussion

It began by quantifying the different types of inputs to finally obtain a value determined by the kilograms that enter during a year, as seen in Fig. 1 and its numerical balance of the organic matter model:

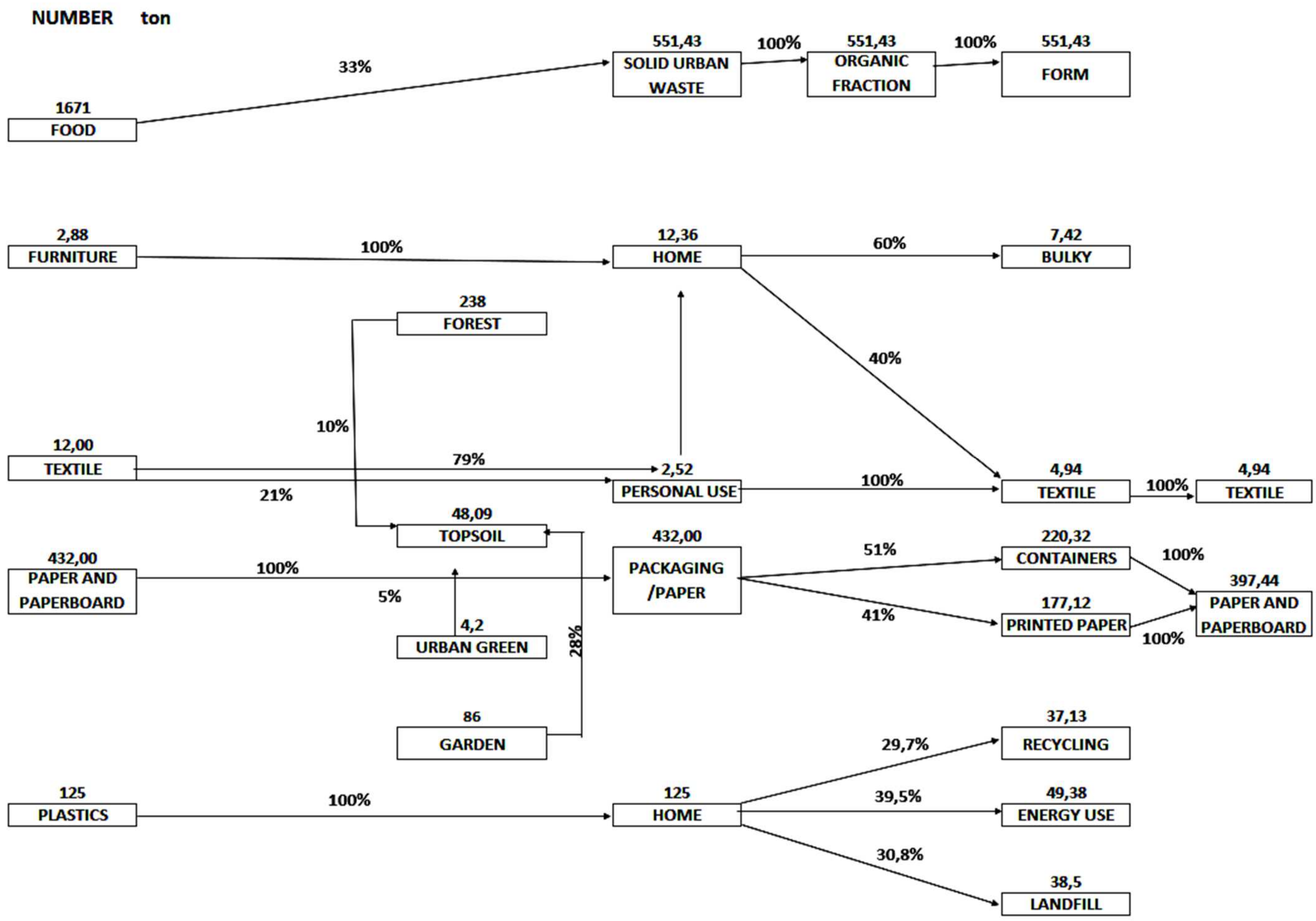

Fig. 1 General model of organic matter (*Barrio Bellaterra*)

A. *Entry Phase*

Food in Cataluña-2018: A sample of an average diet was taken that will consist of: eggs, meat, fish, liquid milk, other types of milk, dairy products, bread, pastries/cakes/biscuits/cereals, chocolate/cocoa/substitutes, coffee infusions, rice, pasta, sugar/honey/sweeteners, legumes, vegetable oil / fat, vegetables, dried fruits, olives, nuts, processed fruits, prepared dishes, broths/sauces, wine /

other alcoholic beverages, juices, mineral water, sodas / soft drinks and other products.

Giving a total value: 529.7 kg / annual person who is supported by the Alimentation's Report in Spain 2017, this report also clarifies that 10% of the total diet of a person per year is consumed outside the home, therefore:

= (592.69 kg/year.pers) * (0.1)

= 59.26 kg/year.pers.

Eating out: these kilograms can influence the number of expenses. There are 2820 people who live in Bellaterra.

= (592.69 kg/annual.pers) * (2,820pers/neighborhood)

= 1,671ton/annual.neighborhood

1) *Textile:* According to the Iberian Textile Recycling Association:

= (4.3 kg/year. Person) * (2,820 person / neighborhood)

= 12.1 ton / year. Neighborhood

2) *Animal Food:* Through surveys, it was determined that 50% of the houses have pets. With a total of 948 dwellings:

= (948 dwellings / 2)

= 474 dwellings with pets

And the amount of food per day that is given to an average animal is 0.3 kg:

= (0.3kg / day) * (474houses / neighborhood) * (365days / year)

= 52 tonnes/year.neighbourhood

3) *Paper and Cardboard:* According to Report 09 of the Spanish Association of Dough, Paper and Cardboard= (58 kg / person (magazines, newspapers, etc.) * (2,820person / neighborhood)

= 163.56 tons/year. neighborhood

= (66 kg/ person packaging) * (2,820person / neighborhood)

= 186.12 tons/year.neighborhood

= (17 kg/person toilet paper) * (2,820person/neighborhood)

= 47.94 tons/year.neighborhood (goes to the toilet)

= (12 kg/cereal boxes, etc.) * (2,820 person / neighborhood)

= 33.84 ton/year.neighborhood

= (17 kg others) * (2,820 person / neighborhood)

= 47.94 ton/annual.neighborhood

Total Income = (163.56 + 186,12-47.94 +33.84 + 47.94)

= ton / year.neighborhood = 432.46 ton / year.neighborhood [8]

4) *Furniture (Exclusive of wood):* The lifespan of a piece of furniture is 8 years, and the cost of furniture for one home = 530€, according to the Cetelem consumer observatory in Spain:

= furniture cost / furniture lifespan

=530/8 € years

=66 € per year for furniture

This means that each year would be missing the value of 66 euros that we have assumed as the investment equivalent to 6 kg of any wooden furniture would be lost (as if 6 kg of furniture entered a home per year:

= (6 kg/dwelling.year) * (948 dwellings/neighborhood)

= 6.7 tons/year.neighbourhood [9]

5) *Fertilizer for plants:* Amount of fertilizer for every 100 m^2: 6 kg Unbuilt area neighborhood: 966,960 m^2

6) *Space for the garden: 50%*

= (966,960m^2 / 2) = 483,480m^2

= (6kg/100m^2) * (483,480m^2) = 26 tons/year.neighborhood.

B. Production Phase

1) *Forest Biomass:* This data y according to the composition of the forest in Bellaterra proposed by a platform of the Diputació Barcelona, as shown in Fig. 2.

Forest area = 68.15 ha (measured from the AutoCAD plan of Bellaterra)

= (68.15 ha) * (3.5 ton/ha)

= 238.52 ton/year.neighborhood

Note: All this quantity is part of the stock, which means it does not add up, but remains there for possible use.

Fig. 2 Illustrative plan of Bellaterra, forest area and residential complex

2) *Forest Production in Private Plots:* In Bellaterra there are 360 m^2 of gardens per inhabitant.

= (360 m^2 / pers) * (2820 pers/neighborhood)

= 101.52 ha / neighborhood

It is assumed that this garden area is divided as follows:

30% are trees = 30.45 ha

= 43, 7 tons / year.neighborhood (1.43 tons / ha of pruning and gardening)

20% are shrubs = 20.30 ha

= 17.3 tons / year.neighborhood (0.85 tons/ha ton of pruning and gardening)

3) *Total of forest matter in Private Plots:* = 61 tons/year.neighborhood

4) *Forest Production in Urban Green:* Green area is 20 m^2 / person.

= (20 m^2 / pers) * (2820 pers/neighborhood)

= 5 ha of Bellaterra are green areas

(5 ha) * (20% shrubs)

= (1 ha) * (1.43 ton pruning/ha) = 1.43 ton

(5 ha) * (30% trees)

= (1.5 ha) * (0.85 ton pruning/ha)

= 2.77 ton

5) *Total Urban Green Pruning:* (1.43 ton) + (2.77 ton) = 4.2 ton/year.neighborhood

6) *Existing Vegetable Layer:* Composition of the topsoil layer is 114 kg / ha of which:

= (102.52 ha in private plots) + (68.15 ha of forest measured from the AutoCAD plan of Bellaterra)
= (170.67 ha) * (114 kg / ha) = 19.45 ton / neighborhood

7) *Orchards / Lawn:* Number of homes in the neighborhood: 948 houses

Only 10% are active due to leisure.
= (948) * (0.1)
= 95 homes
Minimum of a garden: 12 m^2
= (95) * (12 m^2)
= 1140 m^2

8) *Theoretical production per m2 is 2.5 kg / m2:*

= (1140 m^2) * (2.5 kg / m^2) /1,000
= 3 tons / year.neighborhood

9) *Grass:* 50% is grass = 50, 77 ha

26.0 tons/year.neighborhood (0.51 ton / ha of pruning and gardening)

10) *Total Orchard / Grass:* = 29 tons/year. neighbourhood.

C. *Outgoing Phase*

For the outgoing phase, in which a general audit was carried out, and the classification and quantification of urban solid waste that is generated in it is immersed, as shown in the following Table I and II

TABLE I
SOLID URBAN WASTE IN THE BELLATERRA NEIGHBORHOOD

Bellaterra Population = 2820			Production = 1.17 kg/hab.day		
Waste Categories	**Waste Categories**	**Solid Waste %**	**Solid Waste Person per year (kg)**	**Solid Waste Neighborhood per year (tons)**	**Solid Waste Neighborhood per year (kg)**
Organic and Gardening	Feeding	36.6	156.3	440.8	440800
	Gardening	7.2	30.2	86.5	86500
	Textile	0.2	0.9	2.5	2540
Paper	Paper	9.2	41.3	116.4	116400
Paperboard	Paperboard	7.4	31.8	89.7	89730
Glass	Glass	11	47.3	131.4	131380
Packaging	Packaging	8.7	37.4	102.5	102460
Remains	Scrap	0.5	2.2	6.2	6204
	Debris	4.2	18.1	51	51042
	Specials	0.26	1.1	3.1	3102
	Others	1.3	5.6	15.8	15792
Feces			56	117.49	117490
Urine			367	1057.41	1057410
Bulky	Electrical and electrical devices	2.9	12.5	35.3	35250
	Bulky waste	10.5	45.1	127.3	127300

It is essential to know the calorific value of the waste that will be used in order to have an estimate of the energy scope that can be obtained from them. For this reason, it is important to know the components to be analyzed together with their PCI expressed in Kilocalories/kilogram and another value of ash with another type of rejection that would generate mentioned residues.

TABLE II
BALANCE SHEET OF THE ORGANIC MATTER MODEL

Entry	**ton/year. neighborhood**
Food (At Home)	1671.00
Food (Away from Home)	52.26
Textile	12.00
Paper And Paperboard	432.46
Furniture	2.88
Animals Food	54.00
Fertilizer	35.00
Total Income	2207.34
Production	
Vegetable Plot	3.00
Grass	26.00
Forest Biomass (Forest)	238.52
Forest Biomass (Plots)	61.00
Forest Biomass (Urban Green)	4.20
Topsoil (Stock)	19.45
Total Production	94.20
Total Income + Production	2301.54
Departures	
Organic Fraction	594.00
Vegetable Fraction	49.00
Feces	117.49
Urine	1057.41
Textile	39.00
Paper And Paperboard	366.00
Bulky	7.00
General Waste (Animal)	54.00
Total Expenses	2283.90

We proceed to quantify how much energy can be extracted from the aforementioned waste in the General Model of Organic Matter, in mass per unit to get an idea of how much is the energy use, taking into account that 1 kcal = 0.00116222 kWh the following Table III shows:

TABLE III
QUANTIFICATION OF RAW MATERIAL TO BE USED

Component	**Quantity (ton/year)**	**Quantity (kg/year)**	**Density (kg/m^3)**	**Volume (m^3/year)**
Food (RSU)	551.43	551430	291	1895
Furniture (home bulky)	7.42	7420	237	31
Furniture (home textile)	4.94	4940	237	21
Textile (personal use)	2.52	2520	65	39
Paper and paperboard	220.32	220320	50	4406
Paper and paperboard (packaging)	177.12	177120	50	3542
Forest	238.00	238000	101	2356
Topsoil	48.1	48100	101	476
Urban green	4.2	4200	101	42
Gardens	86.00	86000	101	851
Total	1340	1340050		13600

Quantity of raw material supplied:
Production of raw material in ton = 1340 ton/year
Production of raw material in ton = 4 ton/day
Production capacity of raw material in m^3 = 13660 m^3 / year
Production capacity of raw material in m^3 = 37.4 m^3 / day

TABLE IV
ENERGY CONTENT OF SOLID URBAN WASTE (SUW)

Component	Quantity (kg)	Quantity (kCal)	Energy (Kw/h)
Food (RSU)	554130	700	448618.08
Furniture (home bulky)	7.420	4600	39668.89
Furniture (home textile)	4940	3400	19520.65
Textile (personal use)	2520	3400	9957.90
Paper and paperboard	220320	2500	640150.78
Paper and paperboard (packaging)	177120	2500	514631.02
Forest	238000	4600	1272398.46
Topsoil	48100	800	44722.23
Urban green	4200	800	3905.06
Gardens	86000	800	79960.74

Table IV shows the gross net energy used from the SUW shown, giving a value of around 3,000,000 kWh. The amount of material collected is 4 tons per day, and pyrolysis will be chosen and, as its application range is 10 to 100 tons per day, it is possible to apply it on this occasion. Pyrolysis is that thermal technique or thermochemical process that leads to the degradation of the material, in this case, SUW in an inert atmosphere, that is, in the absence of oxygen. This process can be applied to almost all materials such as domestic, urban and industrial waste (although this is not the case), mentioning with emphasis that in the Pyrolysis process, there is no incineration. In addition, there are dangerous gases that are the product of the pyrolysis process, as well as:

PCDD: polychlorinated dibenzodioxins and PCDF: polychlorinated dibenzofurans. Whose mandate establishes control measures for the mentioned harmful gases, through the implementation of chimneys capable of containing them and thus preventing them from polluting the environment.

As previously established, the applied technology would be thermal conversion by pyrolysis, taking into account, according to the calculations of the Organic Matter Model, that around 4 tons / day would be administered. It would be recommended to implement a small continuous pyrolysis plant. It is a reliable technology if the construction standards are followed properly, its cost compared to other plants is low and it has no environmental problems. It has durability and ease maintenance and components that are present in the pyrolysis system.

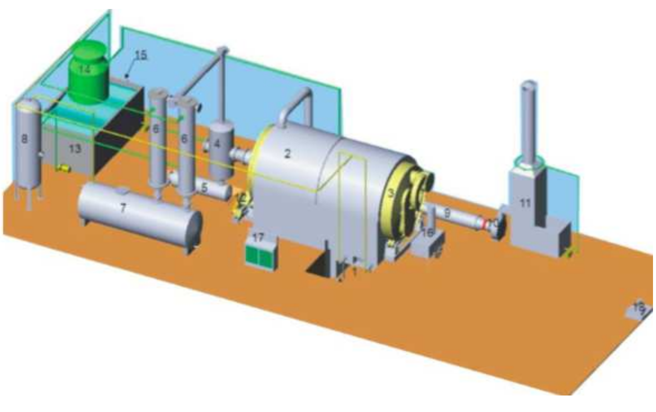

Fig. 3 Pyrolysis plant to be implemented in the study

TABLE V
PARTS OF A PYROLYSIS PLANT

N°	Parts	N°	Parts
1.	Burner	9.	Fuel capacitor
2.	Case	10	Fireplace
3.	Rotary reactor	11.	Speeder
4.	Collector tube	12.	Water tank
5.	Fuel tank	13.	Cooling tower
6.	Condenser	14.	Fuel burner
7.	Storage tank	15.	Element to remove coal
8.	Water barrier	16.	Control system

As can be seen in Fig. 3, and 4, and in Table V and VI, the pyrolysis plant (and the costs it generates) to be implemented is described, and its characteristics are presented below:

- Brand: Jinpeng
- Model: XY-9 continuous pyrolysis plant
- Daily capacity = 4-12 ton / day
- Certification: CE, ISO, sgs.
- Raw Material: SUW, city garbage (SUW)
- Final product: Electricity, fuel, gas and coal.
- Reactor material: Q245R / Q345R steel boiler
- Power: 110 kW
- Cooling mode: Cooling water recycling service
- Lifespan = more than 10 years
- Voltage: 380 V / 220 V
- Weight: 55-65 ton
- Operating pressure: Micro negative pressure [10]

Plot of approximately = 1275 m^2 (located next to the Ramón Fuster School), of which = 225 m^2 will be used for the raw material warehouse.

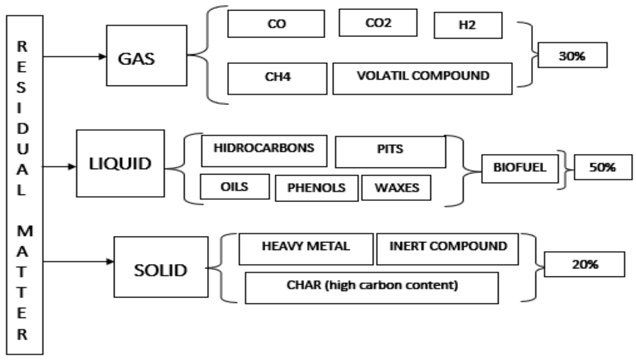

Fig. 4 Matter resulting from the Pyrolysis process [10]

TABLE VI
DETAILED INVESTMENT OF THE PYROLYSIS PLANT PROJECT

	Budget of a pyrolysis plant	
Civil Work	Earth movements Foundation Structural enclosure On-site installations Mansory and carpentry Occupational health and safety	
Total	100000	€
Equipment	Raw material storage Complete process equipment Gasometer Water treatment equipment Electrical installations Protection and safety facilities Auxiliars Engineering and labour management	
Total	1100000	€
Total Project	1200000	€

Regarding the available energy, although data of the amount of gross net energy of the SUW was given at 3'000,000 kWh, and due to the losses, that occur in the Pyrolysis process, the energy that will be obtained at the end of the process is equivalent to 1,500,000 kWh. The useful energy is the result of the remainder of the Pyrolysis plant, the liquid waste being a type of Biofuel where there are hydrocarbons, that energy must be extracted from that material by means of a Generating Set. As mentioned above, we start with gross energy of 3,000,000 kWh, and due to the Pyrolysis processes, the reduction is almost 50%, which is why we obtain the energy of 1,500,000 kWh, now with the generator set that will be capable of transforming the Bio-fuel into energy will have a loss of around 35% of loss due to operation so that as a result the own energy to be implemented in future scenarios would be around 975'000 kWh [11]. Price of electricity for sale = € 0.1198 / kWh. Recovered Investment: (975,000 kWh) * (€ 0.1198 / kWh) = € 117,000 / year

Therefore, the price of electricity in kWh, together with useful energy production, can be recovered from the initial investment in 10 years, which coincidentally is almost the lifetime of the pyrolysis plant. First, it is worth mentioning that the land to implement the Pyrolysis plant had to be strategically located in order to provide the energy obtained by the fuel so that it is not too far from the benefited area (Fig. 5 and 6). Therefore, a land of around 1500 m^2 was found, an area spacious enough to locate the structure of the plant together with the raw material warehouses [12], [13]

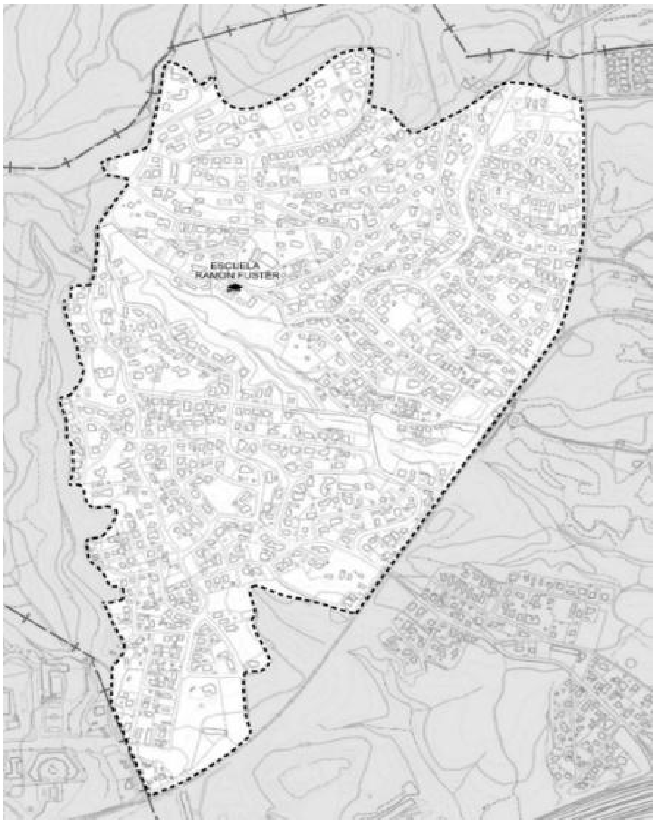

Fig. 5 Superior view of the Bellaterra neighbourhood scoring the Ramón Fuster School

Fig. 6 Space Destined for the Pyrolysis plant and the raw material warehouse

D. Environmental Impact Assessment

This type of assessment that is used by Leopold's matrices is a type of instrument that will allow foreseeing negative aspects of the activities carried out in any project such as the construction phase, operation phase, and completion phase, stating the most important in the study area. [14], [15]. As a point of comparison, the impacts generated by each action carried out in the project are verified, whether it generates impacts on the socio-economic, physical or biological environment and what type of environmental impact they are immersed. For this reason, the following main activities to be carried out once the study is applied will be enunciated:

- Fencing the land
- Cleaning and clearing the land.
- Installation of the plant (Pyrolysis)
- Selection of waste to use.
- Transport of waste to the plant
- Maintenance of the plant Pyrolysis
- Transport of ashes to landfill
- Gases produced by the plant.
- Educational-social impact

The methodology is based on a set of matrices with different quantifications that will be used to use an environmental impact assessment, and this will indicate which action is the one that generates the most impact on the environment and thus take preventive measures.

E. Scenario Benefited

1) Scenario 1: Destined to the equipment located next to the Pyrolysis plant, the Ramón Fuster School, together with the public lighting and finally to sell the surplus energy to a market to recover the investment of the Pyrolysis plant.

2) Scenario 2: As it is solid waste generated by all the houses in the neighborhood, allocate the final product to benefit these houses.

F. Energy Demands of Each Scenario

1) Scenario 1: In the Ramón Fuster School case, the energy obtained by the Pyrolysis plant will be implemented in heating as a priority need. For this, it is necessary to know the useful spaces that are intended for heating, taken from the cadastral headquarters (Table VII).

TABLE VII
USEFUL AREA OF THE RAMÓN FUSTER SCHOOL

Ramon Fuster	**Useful area (m^2)**
Sport	968
Teaching 1	980
Teaching 2	553
Warehouse 1	89
Teaching 3	553
Teaching 4	445
Teaching 5	283
Warehouse 2	78
Teaching 6	267
Teaching 7	297
Total	4513
Total to heat	**3378**

According to the CTE standard, around 20are needed kWh / m^2 annually, so it should cover an area of approximately 3,378 m^2, as described in Table VII; therefore, the heating demand would be 67,560 kWh / annual. Since that around the area are needed 70,000 kWh to heat the Ramón Fuster School 100% during the winter days, another suggestion would be to benefit or provide energy to public lighting.

TABLE VIII
ENERGY DEMAND FOR PUBLIC LIGHTING IN BELLATERRA

Data	**Dates**	**Days**	**Power (Kw)**	**Use (Hour /day)**	**Quanty lamps**
Equinox	20 march-20 June	93	124	12	1018
Solstice V	21 june-21 September	92	124	9	1018
Equinox	22 September-20 December	90	124	12	1018
Solstice I	21 December-19 Marches	90	124	15	1018

Neighborhood	**Consumption (Kwh /day)**	**Consumption (Kwh /year)**	**Person Consumption (Kwh /day)**	**Consumption (Kwh /year)**
	1514.8	140874.91	538.5	50080.0
	1136.1	104520.10	403.9	37156.5
	1514.8	136330.56	538.5	48464.5
	1893.5	170413.20	673.1	60580.6
Total	**6059.1**	**552138.77**	**829.3**	**196281.1**

Giving an approximate total of 550,000 kWh as the demand for Public lighting (Table VIII). Moreover, with the surplus energy, to be able to sell it to the highest bidder to recover the pyrolysis plant's initial investment. With this sale of 355,000 kWh, the investment of the plant will be recovered in the useful time of the plant, which is 10 years; of course, it is worth mentioning that the Ramón Fuster School and the public lighting of the neighborhood will be benefited (See Fig. 7).

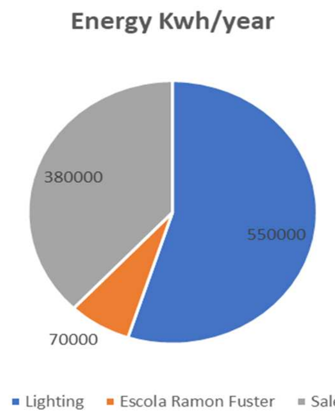

Fig. 7 Energy distributed according to Scenario1.

2) *Scenario 2:* Another option would be that each of the authors who provide the raw material for obtaining energy is those who benefit from it. That is why it is necessary to know the energy demand of the homes in the Bellaterra neighborhood and an estimate of how much it will cover according to the total kWh generated by the Pyrolysis plant and thus be able to allocate this energy for a common good, covering (Table IX).

TABLE IX
ENERGY DEMAND OF THE HOUSES IN THE BELLATERRA NEIGHBORHOOD

		Heating	Electrical apparatus	Hot water	Lighting
Total Energy Demand (Kwh/year)		16442320.0	5532923.0	3078999.0	1952411.0
Total Generated (Kwh)	**975000.0**	**5.93%**	**17.62%**	**31.67%**	**49.94%**

The best option to use the energy produced by the Pyrolysis plant It would be used for lighting that would cover 50% of it, and even for hot water that would cover almost 30% and to be bio-fuel the product generated by the plant this would be the best option (See Fig. 8). However, you can think of different alternatives in order to make the most of all the energy for a common good.

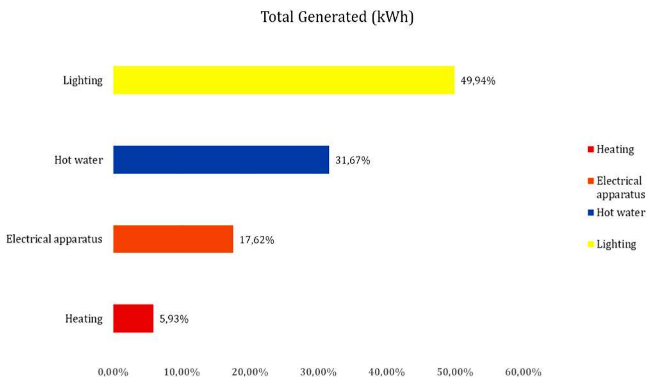

Fig. 8 Coverage of the energy produced to the energy demand of the homes in Bellaterra

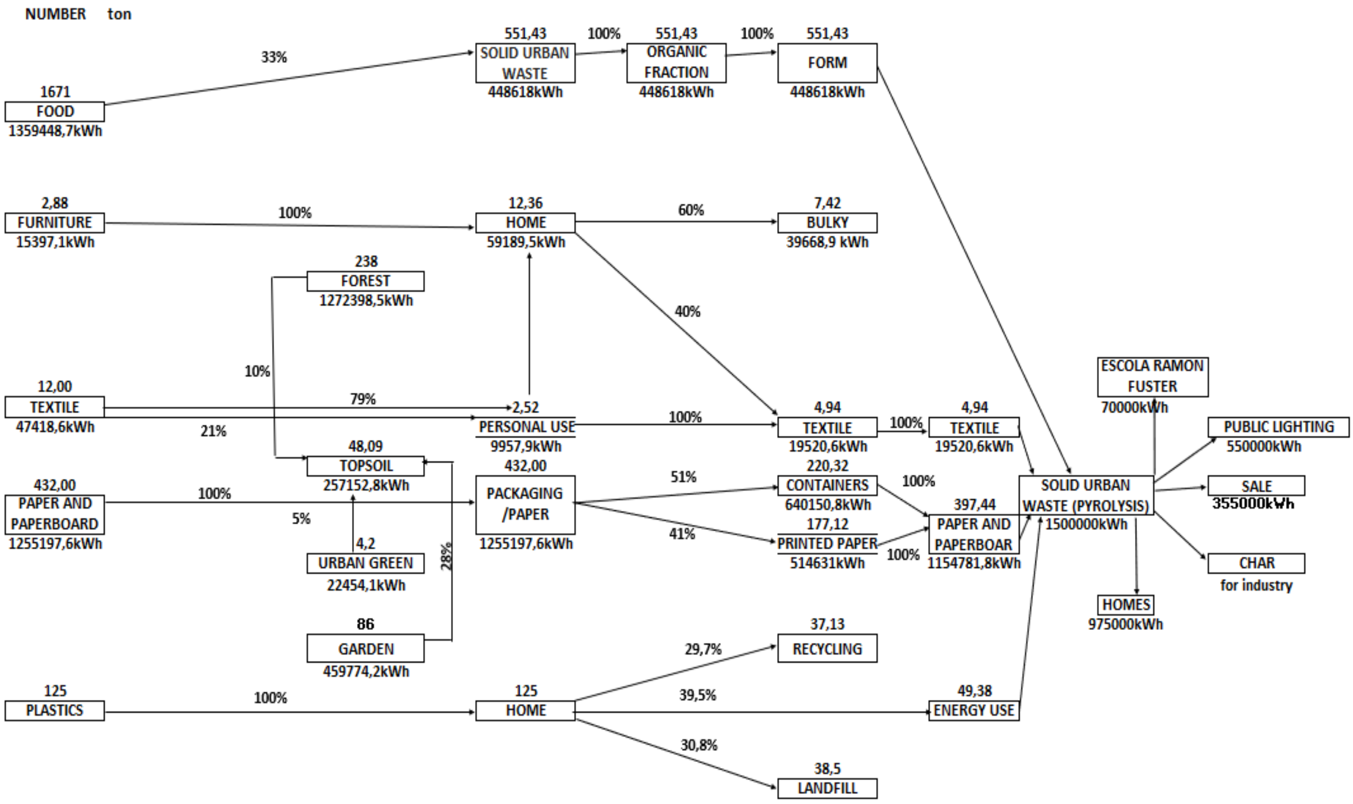

Fig. 9 Coverage of the energy produced to the energy demand of the homes in Bellaterra

IV. Conclusion

Thermal conversion plants such as pyrolysis solve and mitigate two major problems: efficiently recovering the energy extracted from solid urban waste (SUW) and controlling the emissions of the main polluting gases. In addition to providing a compatible and stable energy source to the environment (See Fig. 9), it is acquired from the waste that the Bellaterra neighborhood generates for its benefit; It is important to emphasize that both scenarios were presented to the city government for them to decide which is the best option.

Heating being a big problem in this neighborhood, either due to a large amount of consumption or the high prices that it entails, that is why the energy acquired by waste is directed to this end. From a financial point of view, the initial investment in this project will be recovered within the following 10 years, which, seen in the long term, is the Pyrolysis plant's useful life due to working with the minimum raw material input standards.

This mechanism complies with the Kyoto Protocol in which Spain is committed, which consists of any means or project that includes a considerable reduction in greenhouse gases harmful to the environment. Both alternatives are feasible; one, on the one hand, satisfies an educational entity and at the same time the neighborhood itself with electric lighting; on the other hand, alternative 2 provides those people who contributed the raw material to make this possible, contributing directly to their homes, both scenarios they are beneficial depending on the public or private point of view.

As a key point and of utmost importance is to be able to implement a paradigm shift for the people of this community, to stop thinking that solid waste from day to day is something useless and without any other use, generating energy from it is a great challenge not only for society but also for private companies and the government itself.

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