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**O 19. THE CHALLENGES OF MUNICIPAL SOLID WASTE MANAGEMENT IN ALBANIA
AND IMPLEMENTATION OF WASTE INCENERATION**

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ABSTRACT: Despite years of efforts to improve the management of municipal solid waste (MSW) in Albania, this activity again poses a challenge for the country. The predominant method of waste disposal is landfilling, while in 2017 the construction of the first incinerator of MSW with energy recovery in Elbasan was completed and now is in operation. Incineration of MSW is a well-known method for waste disposal, but in Albania it is being applied in recent years. Currently, two other incinerators are under construction: in Tirana (the capital of Albania) and in Fier. Such a large number of incinerators and consequently small capacity, is associated with higher disposal costs per ton, and higher levelized cost of energy (LCOE), without exploiting and benefiting from economies of scale. LCOE for an incinerator with a treatment capacity of 120 tons/day, resulted 0.1013 USD / kWh and for another one of 300 tons/day, it resulted 0.0523 USD/kWh. In this paper I will address a general view of the current state of MSW management, the legal framework for this sector, objectives set for the period 2020 - 2035 and the estimation of LCOE for two incineration facilities.

Keywords: *Municipal solid waste, Legal framework, Incineration*

INTRODUCTION

Based on the legal framework in Albania, the municipalities are responsible for municipal solid waste (MSW) treatment and disposal as well as for the management of their treatment plants. Nearly 200 illegal and legal landfills of MSW were identified in 2018 throughout the country (Ministry of Tourism and Environment of Albania, 2020), and only 4 of them are landfills. Most landfills do not meet sanitary requirements. Elbasan region has solved waste management through incineration, where an incinerator and two landfills are in operation since 2017. Currently, two other incinerators are under construction, one to cover the Fier area and the other for the Tirana area. Another problem affecting waste management analyzes has been and continues to be the accuracy of a data system for the generation and collection of MSW, the data which are collected and managed by local government. The amount of solid waste generated per person for 2018 was 0.383 ton/capita/year and the quantity of inert waste of 0.079 ton/capita/year (INSTAT 2019), with an increasing trend from year to year.

Incineration of MSW with energy recovery is a disposal method which is generally applied in countries that have a sustainable MSW management system and in developed countries. Although Albania does not meet the first condition and is a developing country, those conditions have not been a prerequisite for the implementation of that method of disposing of MSW in our country. Implementation of MSW incineration with energy recovery is considered as an option for MSW disposal in the framework of integrated waste management in Albania (Ministry of Tourism and Environment of Albania, 2010). Generation of electricity from the incineration of MSW and the purchase of it by the Albanian Electro-energetic Corporation, regulated by the legal framework, creates opportunities to cover partly the significant cost of combustion disposal of MSW. Compared to the cost of generating electricity from other renewable and conventional sources, the cost of generating electricity from MSW incineration is of course higher, because the main goal in this case is the safe disposal of MSW, a significant reduction of their initial volume and reduction of landfill areas.

LEGAL BASIS AND QUANTITATIVE DATA FOR MSW IN ALBANIA

Legal basis

In recent years Albania has made considerable progress in developing the regulatory framework of the waste management sector in line with European Union policies. However, implementation at the

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regional or local level and the achievement of predetermined objectives is still lagging behind the goals of improving urban infrastructure and related services in order to guarantee a healthy environment and improving the living conditions of population. The key point between planning and implementation is the financial aspect (Ministry of Infrastructure and Energy of Albania, 2020). During the 8-year period (2011-2019), the Albanian Government provided in the field of waste management: an increasing budget for preparation and updating the legal basis; greater investments in infrastructure; as well as the increase in expenditures dedicated to improve the MSW management, especially the extension of the waste collection service throughout the country (Ministry of Tourism and Environment of Albania, 2020).

The National Environment Management Plan for the period 2013 - 2020 in our country [MEFWA, 2010] set some targets for integrated management of MSW (Law no. 10463, 22.09.2011 "Integrated waste management", amended), such as:

1. Disposal of waste sent into landfills up to 45%;
2. Recycling of urban waste up to 55%;
3. Preparation of regional waste management plans and the development of regional landfills.
4. Separate collection of certain fractions of SW.

But how much have those targets been pursued and achieved? I referred to the National Plan of Integrated Waste Management 2020-2035 [Ministry of Tourism and Environment of Albania, 2020]:

Referring to objective 2: in 2018, [INSTAT, 2018], reported that in Albania are recycled about 245,040 tons waste/year, or as much as 18.5% of the total municipal solid waste (including non-urban ones that accompany household solid waste (household and other similar) and the level of recycling in Albania was 10% vs. 45% set as target. There are discrepancies for the figures in the various documents for the same issue!

Referring to objective 3: during the period 2010-2020, regional solid waste management plans have been drafted and approved, but the waste collection system was extended to only 65.7 % of Albania area, as presented in Table 1 (INSTAT, 2018):

Table 1. Basic data on municipal waste management, 2018 (INSTAT, 2018)

Country	Population	Generated MSW (t/year)	Generation of other waste (t/year)	Country's covering with MSW collection (%)	Collected MSW (t/year)	Solid waste that is sent to dumpsites and landfills (t/year)	Solid waste that is sent to dumpsites and landfills (%)	Solid waste that is not collected (t/year)	Solid waste that is not collected (%)
Total	2,866,537	1,523,226	198,185	65.7	1,325,071	1,012,517	66.5	4979	0.3

Referring to the objective 4: Currently in Albania there is no separate waste collection, regardless of the objectives set from time to time for that.

Municipal solid waste disposal in Albania

Based on the legal framework in Albania, municipalities are responsible for waste management as well as for their treatment facilities.

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The main method of waste disposal is sending it to landfills, uncontrolled and controlled. Nearly 200 illegal and legal landfills of MSW were identified throughout the country in 2018 (Ministry of Tourism and Environment of Albania, 2020), and only 4 of them are landfills: Bakaj (Saranda), Bushat (Shkodra), Maliq (Korca) and Sharra (Tirana). Most landfills do not meet sanitary requirements. It is reported that during 2018 in those landfills were deposited about 923,316 tons/year (or 60.61% of the waste in total), which are calculated as the amount generated in the country, of which only 401,755 tons/year (or 26.37% of them) are disposed of in sanitary landfills, while the rest or 13.01% of household solid waste is disposed of in a completely uncontrolled way.

Recycling of MSW

Albania has a developed and active recycling industry. There are 32 private recycling companies that operate in Albania. Due to the lack of raw materials, this industry has used only 26.8% of processing capacity or 133,592 tons/year, which accounts for around 10% of the total municipal solid waste (including non-urban ones that accompany household solid waste (family and other similar) (INSTAT, 2018). For that reason some of the companies have reduced their activity, some have closes, while some others are planning to relocate their facilities to other locations.

The data of generation, collection and disposal of MSW

Due to inaccuracy of data on MSW generation and disposal by the local government and inconsistencies of data for the sector reported by various institutions, such as INSTAT, the National Environment Agency and the Ministry of Infrastructure and Energy, among the three main goals of the National Integrated Waste Management Plan 2020-2035 (Ministry of Tourism and Environment of Albania, 2020) in terms of creating an accurate database for the MSW generation and disposal is also: *Approach and review of the strategic document with the requirements of Decision of the Council of Ministers (DCM no. 290, 11.3.2020, "The creation of the state database of the integrated planning information system (SIPI/IPSIS), to ensure compliance with the IPSIS System"*.

Household solid waste generation (divided into household and other solid waste, which is considered as inert waste collected together with household waste and similar with it) is estimated 0.383 ton/capita in 2018, and 0.079 ton/capita year for inert waste collected together with solid waste from households (INSTAT, 2018).

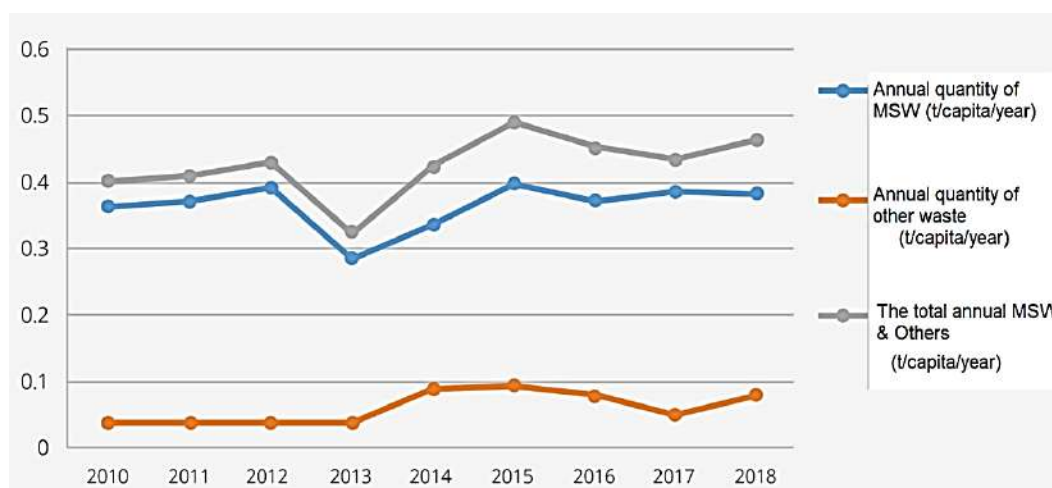


Figure 1. Annual average waste generation kg/capita/year, 2010 - 2018 (INSTAT, 2018)

Based on INSTAT data for the period 2010-2018 (Fig. 1), it can be seen there is an increasing trend for solid waste generation per capita per year, which requires the improvement of MSW management. There are 4 landfills in Albania: Bakaj (Saranda), Bushat (Shkodra), Maliq (Korca) and Sharra (Tirana), while most landfills do not meet sanitary requirements. Elbasan region has solved waste management using incineration method, where an incinerator and two landfills are in operation since 2017. Currently,

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two other incinerators are under construction, one to cover Fier area region and the other for Tirana area region.



Figure 2. Locations of incinerators in Albania: Elbasan, Tirana and Fier

Integrated management of MSW in Albania

An innovation in solid waste management, according to the strategic policy document, is that the integrated waste management will be performed on the basis of Waste Management Areas, defined on the basis of the principles of proximity and affordability and not only on the basis of counties or prefectures (Ministry of Tourism and Environment of Albania, 2020). According to the plan, the integrated municipal waste management will guarantee the collection of waste throughout the country and their integrated management in accordance with the minimum basic standards. The main treatment options for household solid waste are defined in that plan (Fig. 3):

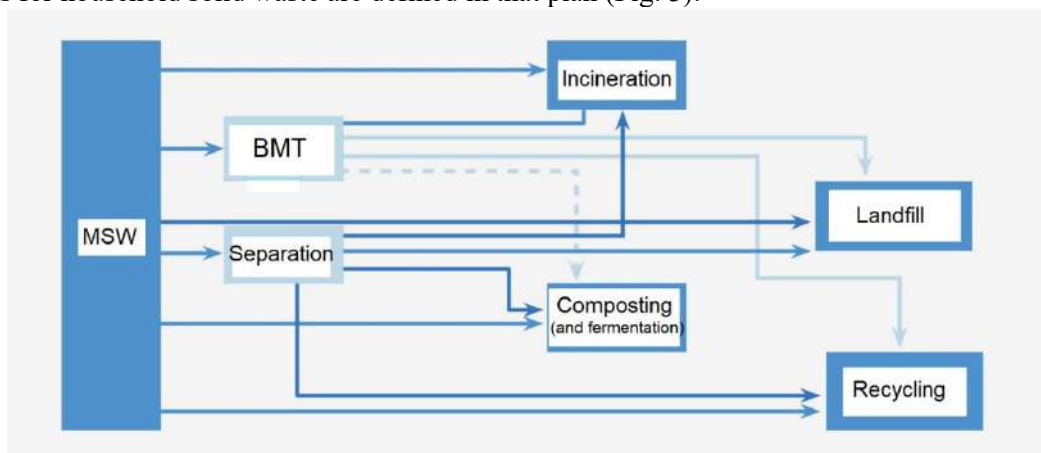


Figure 3. The main treatment options for household solid waste

- BMT - Biological Mechanical Treatment

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The concept of waste management will be based on a system with four levels of treatment:

- Waste collection and transport (including separate collection at source)
- Pre-treatment (via transfer stations, material recovery facilities, mechanical and biological treatment).
- Recovery (through recycling centers for various waste streams, composting, and capture of gas generated by composting).
- Final treatment (landfill or incinerators, with and without effective energy recovery)

Separate collection of MSW

In general, the amount of household solid waste increases in parallel with the economic growth of the country. Only the separation at the source and the separate collection of special solid waste streams can result in a reduction of the amount of waste, which are destined to be sent to landfills.

Separation of waste at source and separate collection of MSW is carried out gradually through separate collection systems (including door-to-door systems and public road containers, bags or other accessories). Further efforts will be focused to promote the separate collection of recyclable materials in urban areas and the separate management of organic waste in rural areas, like decentralized composting and home composting.

Objectives of the national action plan for MSW 2020-2035

Four strategic goals of the national integrated waste management strategy and national action plan 2020-2035 (Ministry of Tourism and Environment of Albania, 2020) are:

- 1) To improve waste management by meeting key planning principles and legal requirements;
- 2) Improving the legal framework of waste management;
- 3) Sustainable financing of waste management;
- 4) Human resources: awareness and participation of the population in waste management.

The indicators for special waste streams: very ambitious objectives are set in that plan, like:

a) Waste from packaging

2025:

- Recovery: Not less than 10% of the total waste must be recovered.
- Recycling:
 - Not less than 10% of the total weight of paper and cardboard
 - Not less than 10% of the total weight of metals
 - Not less than 6% of the total weight of the plastic
 - Not less than 10% of the total weight of the glass
 - Not less than 5% of the total weight of wood waste

2030:

- Recovery: Not less than 30% of the total weight of waste must be recovered
- Recycling:
 - Not less than 30% of the total weight of paper and cardboard
 - Not less than 30% of the total weight of metals
 - Not less than 12% of the total weight of the plastic
 - Not less than 30% of the total weight of the glass
 - Not less than 10% of the total weight of wood waste

b) Biodegradable waste

2035:

- Recovery: Not less than 60% of the total weight of waste must be recovered
- Recycling: Not less than 60% of the total weight of paper and cardboard
 - Not less than 50% of the total weight of the metal
 - Not less than 22.5% of the total weight of the plastic

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- Not less than 60% of the total weight of the glass
- Not less than 15% of the total weight of wood waste.

Referring to the sector strategy (Ministry of Infrastructure and Energy of Albania, 2020), the National Waste Management Plan set to increase the materials recovery from municipal waste through recycling, composting and energy conversion by 25% in 2015, 55% in 2020 and 75% in 2025. Furthermore, the amount of waste sent to landfills would be reduced to 45% in 2020 and 25 % in 2025. But some of those objectives, referred to solid waste reports in subsequent years, have not been met. According to the composition of waste presented in the report “National sectorial plan for solid waste management” (Ministry of Infrastructure and Energy of Albania, 2020), approximately one third of the municipal solid waste generated in Albania is potentially recyclable. The largest percentages of recyclable waste are plastic, paper and cardboard waste.

INCINERATION OF MSW - A NEW DISPOSAL METHOD IN ALBANIA

Incineration of MSW with energy recovery, although a method known and used in many European countries, in Albania is being applied in recent years.

Among the most widely used technologies for MSW combustion with energy recovery are: moving grate furnaces and fluidized bed furnaces. Referring to those two technologies, currently the moving grate furnace is the most widespread and well-tested technology for MSW incineration.

The energy recovered from the MSW combustion treatment can be used as steam for various technological processes, for regional heating and for electricity generation. The best option for our country conditions is the electricity production, for which we will calculate the levelized cost of electricity (LCOE) for two plants with different capacities, to identify the advantage of incinerator plants with higher capacity versus those with smaller capacity.

The formula used for calculating the LCOE of renewable energy technologies is:

$$LCOE = \frac{\sum_{t=0}^n \frac{C_{I,t} + C_{fuel,t} + C_{O\&M,t}}{(1+r)^t}}{\sum_{t=0}^n \frac{E_t}{(1+r)^t}}$$

where:

- LCOE -the average lifetime leveled cost of electricity generation;
- $C_{I,t}$ - investment expenditures in the year t
- $C_{O\&M}$ - operation and maintenance expenditures in the year t
- $C_{fuel,t}$ - fuel expenditures in the year t (in our case = 0)
- E_t - electricity generated in the year t;
- r - discount rate = 10%;
- n – economic life of the system = 20 years.

To estimate the different costs, (in USD) I referred to the study: “IRENA, 2012: Renewable Energy Technologies: Cost analysis series”:

- for MSW combustion technologies, the following are recommended:

- 1) The investment cost: $C_1 = 1880 - 4260$ USD /kW

From that range of values for C_1 , the lowest values are considered for plants with large treatment capacities (over 10 MW_e), which benefit from economies of scale, while the highest values are for the ones with smaller treatment capacities (up to 10 MW_e).

- 2) The operation and maintenance costs: O&M costs (USD/year)

- $C_{O\&M, fixed} = (2 - 7) \% \text{ of } C_1 / \text{year}$

- $C_{O\&M, variable} = 0.005 \text{ (USD / kWh)} \times 7500 \text{ hours / year} \text{ (USD / year)}$

For the two study cases I chose:

a) The plant with capacity $P = 2$ MW_e:

$C_1 = (4.260 \text{ million USD / MW}) \times 2 \text{ MW} = 8.52 \text{ million USD.}$

$C_{O\&M, fixed} = 0.07 \cdot C_1 = 0.5964 \text{ (Million USD)/year}$

$C_{O\&M, variable} = 0.005 \text{ (USD/kWh)} \cdot P \cdot 7500 \text{ h/year} = 0.005 \cdot 2000 \cdot 7500 = 75,000 \text{ USD/year}$

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LCOE = 0.1013 USD / kWh

b) Plant with capacity 10 MWe:

$C_1 = (2.5 \text{ million USD/MW}) \cdot 10 \text{ MW} = 25 \text{ million USD.}$

$C_{O\&M, fikse} = 0.04 \cdot 25 = 1 \text{ milion USD/year}$

$C_{O\&M, variable} = 0.005 \cdot 10 \cdot 7500 = 375,000 \text{ USD/year}$

LCOE = 0.0523 USD / kWh

CONCLUSIONS

Although the legal basis for MSW management in Albania is complete and in accordance with EU legislation in the field of MSW management, the safe collection and disposed of it is not yet at the level required by the standards of the sector. In the management plans of MSW over the years have been set objectives, like: to cover the whole territory of the country with the correct service of collection and disposal of MSW; to applicate the separate collection of recyclable fractions; to dispose of all the MSW in sanitary landfill, but those objectives have not been fulfilled and some of the problems listed above still persist.

It is positive that in addition to the disposed of MSW in landfills, the incineration of it with energy recovery has also begun to be used. The first incinerator (in Elbasan, only 42 km from Tirana, the capital of Albania) began to operate in 2017 with a capacity of 2 MWe (the quantity of the municipal solid waste generated at Elbasan area is 113,690 tons or 10.8 % of total in 2016 (Raport Gjendja e Mjedisit 2016, Agjencia Kombetare e Mjedisit) and 2 more incinerators are being built (one in Fier and one in Tirana, while the distance Tirana-Fier is about 110 km). The quantity of the municipal solid waste generated for Fier region is 130,172 tons or 12.3 % of total in 2016 and and the quantity of the MSW for Tirana region is 268,278 tons or 25.4 % of total in 2016 (National Environmental Agency of Albania, 2016), with capacities less than 5 MWe each. It seems from the data that those incinerators serve to a small area and consequently result in small capacity. The LCOE for a plant with a power 2 MWe resulted equal to 0.1013 USD/kWh. But an incinerator with a larger capacity could benefit more related to economies of scale. Thus, for an incinerator with power 10 MWe, the LCOE resulted 0.0523 USD / kWh, with approximately 60% of the first case. The higher capacity plants can also benefit from the advantages of smaller capacity plants because they can be composed of modular units.

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