# INCINERATION IN REGION THAT BELONGS TO THE REGIONAL LANDFILL MOŠĆANICA – A CHANCE?

# INCINERACIJA U REGIJI KOJA PRIPADA REGIONALNOJ DEPONIJI MOŠĆANICA – ŠANSA?

***Stručni rad***

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**REZIME**

*Incineracuja u regiji koja pripada regionalnoj deponiji Mošćanica može se posmatrati i kao šansa za grad Zenicu i okolna mjesta. Naime, zbog trenutnog stanja upravljanja otpadom, usvojenih strategija i pravilnika za raspolaganje otpadom u BiH i FBiH, kao i neophodnosti da se počnu ispunjavati obaveze iz preuzetih EU pravila o upravljanju otpadom obaveze zajednice bi mogle da se ispune izgradnjom jednog incineratorskog postrojenja. Ovo s razlogom, jer se sada prikuplja i deponuje otpad od 30 do 60% od ukupnih količina na regiji. Takođe, sistem recikliranja otpada je praktično tek u fazi razvoja i za duži niz godina neće biti moguća mjegova puna implementacija. A i kada se to dostigne, preostaće toliko otpada koji će biti dovoljan za rad jednog incineratora. Uz to na regionalnoj deponiji se već odlažu velike količine otpada, koje će biti neophodno naknadno tretirati kako bi životni vijek regionalne deponije bio što duži. Velika povoljnost za ovakvo jedno rješenje za otpad je i mogućnost da se ostvari velika efikasnost rada postrojenja, jer bi se proizvedena toplotna i električna energija mogle iskoristiti i za daljinsko grijanje grada i za produkciju električne energije neophodne za rad samog grijanja kao i industrijskih postrojenja.*

***Professional paper***

**SUMMARY**

*Regional incineration process by regional landfill site Mošćanica is a chance for municipality of Zenica and municipalities nearby. The obligations of the municipality towards EU regulations could be fulfilled by building one incinerator plant. Current waste management strategies and (role beaks) adopted for dumping waste by Bosnia and Herzegovina, Federation of BiH is not sufficient. Currently, 30 to 60 percent of total regional waste is being gathered and deposited. Full implementation of recycling waste will not be possible for a longer period of time, as it is only in it's development phase. Even after completing this recycling phase, there will be enough waste to get incinerated in a plant. Huge amounts of waste are being deposited in regional landfill sites. To extend the life of these regional landfill sites, all this waste should get treated afterwards. Distance heating of the city, the production of electricity necessary for this process, electricity and heat for industrial plants, as well as efficiency, could be achieved by using this kind of solution of waste management.*

## 1. INTRODUCTION - WASTE MANAGEMENT PLAN

Achieving waste prevention, it's reduction, waste renewal, environmentally safe disposal and establishing one integral and adequate network for every region, is one the key elements in waste management plans by the European Union. One the main aspects of this plan is getting everyone involved [1,2].

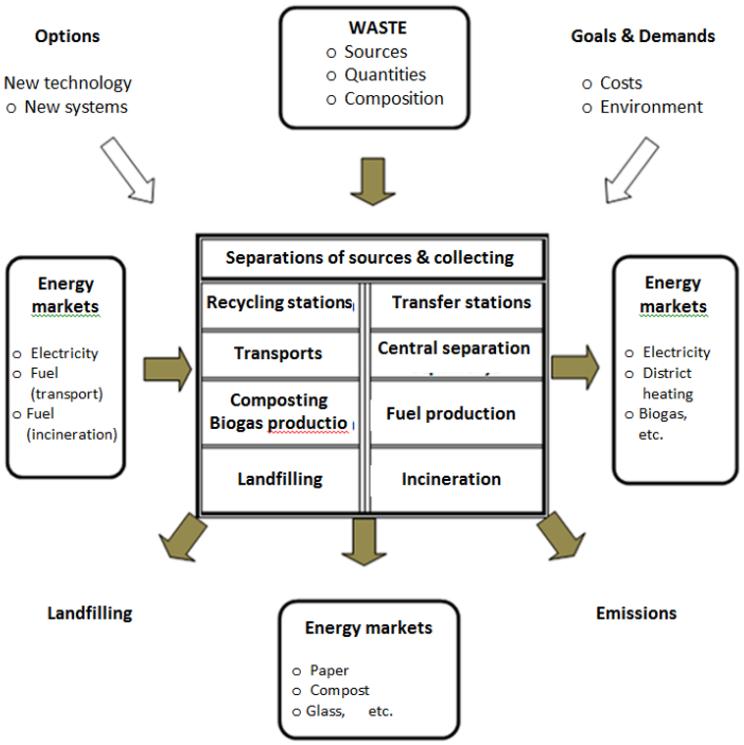
What that means is getting local governments involved, getting involvement of urban/regional organizations for planning, environmental issues institutions and health and traffic institutions. The size of the region in question, plant ownership, legislative steps, supporting taxes and its' controlling, choosing the plants for different treatments, all these questions can be considered by a waste management plan. A comprehensive look and a waste management sustainability plan can be given asking these questions. The most important status in the planning process should be given to the aspect of Time.

The first step is analyzing and evaluating the already established waste management plans. In order to create one integral waste management system, connections and mutual functions by a certain area should by evaluated. Picture 1 illustrates understanding and analyzing how different factors affect waste management systems and show it's boundaries, according to Sundberg [3]. Influential elements, what enters and what exits the system is shown by the model. The purpose of this is to create one waste management system which integrates multiple waste plants considered. Economical, social and political aspects are key during this planning process. Economy is the engine that drives development. Recycling material and compost demand and price, bioenergy demand and price, new technologies involved in waste treatment, are all key in making the decision. Future environmental goals, prohibitions and laws during the planning process should be considered by political factors. Social aspects are often neglected and undervalued during planning process. In the future, participation by the public should grow. Introducing one integral system of waste management should be the base by which the waste management plan, for a municipality of 150000 and the regional landfill site Moščanica [4], is suggested.

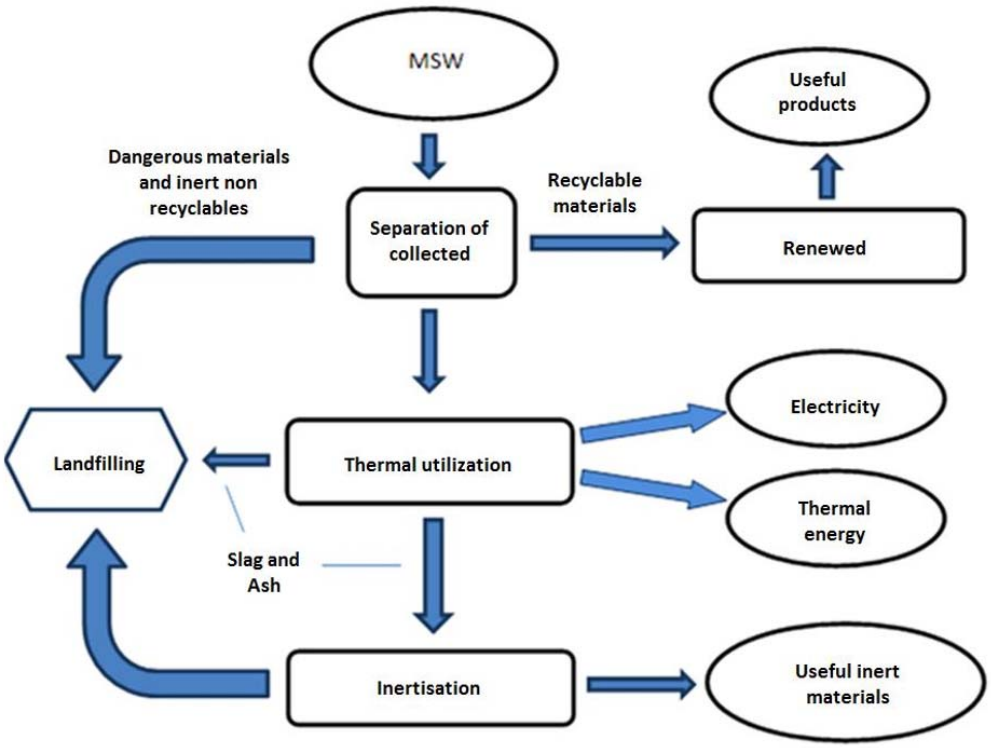
With all that has been said, it can be ascertain that waste management plan for municipality with 150 000 residents, which has been suggested for the region that belongs to the regional space of the landfill Mošćanica [4] can be base for introduction of integral system of the waste management shown with the next picture 2 [5].

## 2. CURRENT STATE OF WASTE MANAGEMENT PLAN IN MUNICIPALITY

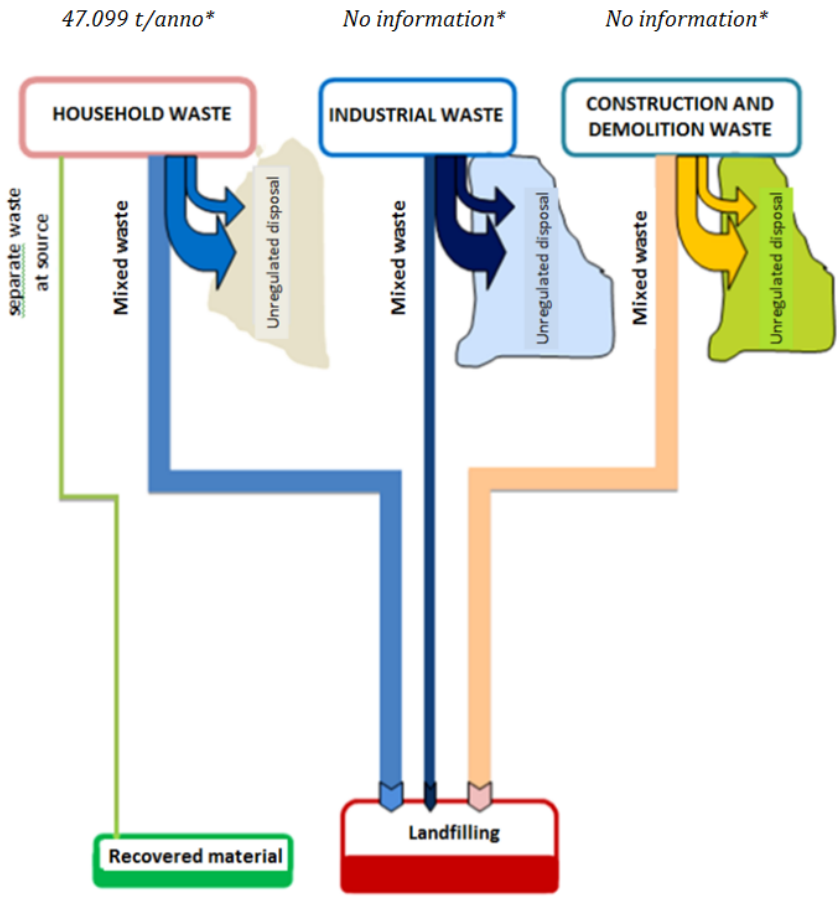
Current federal waste management plan is adopted from the EU waste management plan, by the Federation of Bosnia and Herzegovina. Considering current conditions, these plans are unrealistic and not reachable in the near future. Picture 3 shows the current state of waste management plan by our municipality, in comparison to very advanced waste management systems elsewhere in the developed world. As it's shown, the waste is dumped and only a small portion of materials is regenerated by the landfill site. Only 30 to 60 percent of total waste is collected and dumped by the municipality we are taking a look at.




***Picture 1.*** *Influential factors and limit of waste management system*




***Picture 2.*** *Integrated waste management system with the recovery of materials and energy*




***Picture 3.*** *The current status of waste management in the commune*
**47.099 t per annum – data for the regional landfill Moscanica for 2015[6]*
**No information – There is no official data on this type of waste*
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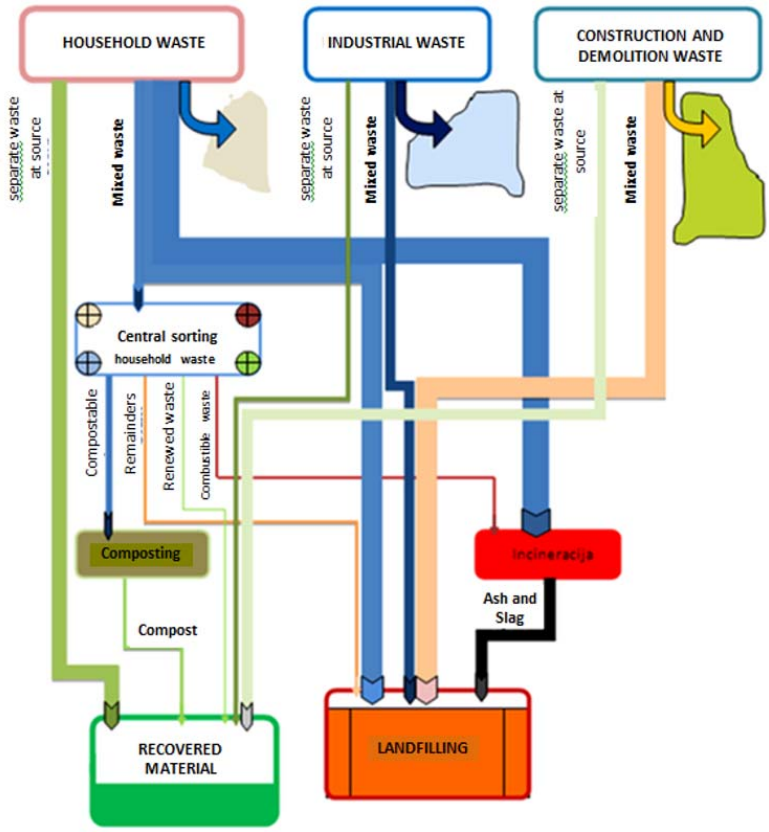
Currently, waste management and waste disposal by municipality is disorganized, whether we are talking about domestic waste, industrial or construction waste and no praxis to collect ALL the waste has been introduced. This is definitely consequenced by current economical, social and political affairs. This mostly refers to waste by housing, and city's solid waste collected by public utility organizations. To avoid waste disposal payments, industrial and construction waste is dumped on land and illegal waste dumps and nobody is looking into this matter. Useful materials from waste are collected by individuals and smaller groups and the municipality has little or no benefit from waste disposal and recyclable materials. Since the condition in them is unorganized in every way, starting with the not yet elucidated issues of whose property are they, through organizational problems concerning responsibilities for waste gathering as well as their future role in waste management plans. Also, because of the unorganized market for useful materials set aside from collected waste, these jobs are being taken care of by individuals or smaller groups. Municipality from this sort of job has none or very little benefit.

## 3. WASTE MANAGEMENT SHORT-TERM PLAN - THERMAL TREATMENT (5 TO 10 YEARS)

Considering the current state and possibilities of our municipality, a short-term plan to managing waste for around 5 to 10 years, has been given. This waste management plan would be done in phases. Picture 3 describes the current state of waste management. Organised waste collection in ZDK Canton is at about 70% of citizens, and the plan in the next few years is to raise it to 75% . Also, about 55% of waste is collected from calculated quantites by home waste. Not every firm that produces waste is listed, and neither do they release their data, therefore industrial and construction waste data is almost non-existant. As you can see, and with all the afore mentioned, it is necessary to consider integral waste management and treat waste thermaly. An incinerator should be constructed by the municipality while developing the system of reducing and recycling the waste in the area, as it is shown in picture 4.




***Picture 4.*** *Integral system of waste management for medium term period of planning.*

## 4. COMBINED THERMAL AND ELECTRICITY FROM MUNICIPAL SOLID WASTE

WtE plants used to produce energy out of waste, are located close by their energy resources, unlike fossil fuel power plants. Often those are urban or industrial zones. Because of this WtE plants can work in CHP mode (combined heat and power mode) producing both thermal and electricity. Excess heat generated by steam producing electricity, can be introduced to district heating systems or used by nearby industrial plants as processed heat.

The efficiency to generate electricity by WtE plants is 35 to 45 percent, which is less than a typical power plant with steam turbines. Although an ideal WtE plant in CHP mode can reach 85 percent efficiency rate to get thermal and electricity contained in city's solid waste [7]. Using thermal energy in district heating systems, created by WtE plants along with other renewable resources of energy, can greatly reduce carbon emissions, as in the case of Sheffield, UK [8, 9]. In some cases, reaching high energy efficiency rate by WtE plants is not practical for various technical and non-technical reasons. The construction and implementation of WtE plant in the system should be primarily lead by the available city's solid waste and not for it's energy needs. According to this, the usage of thermal heat made in WtE plant should be considered from the initial phase of planning the new facility. Often, installing smaller plants in rural areas, doesn't justify the need for thermal energy by the area. Therefore increasing the costs of running such a plant. Without recover of the energy, incineration of the waste is just a instrument for reduction of the waste disposal with landfills for ashes after volume reduction and segregation of biodegradable fractions. To distinguish energy recovery from waste disposal, a revised Framework Directive of Waste (WFD. 2008/98/EC) has been brought through by EU back in 2008 [10]. WtE plant energy efficiency is signified as "R1 Formula" by this framework.

$$\text{Energy Efficiency} = Ep - (Ef + Ei) / 0.97 * (Ew + Ef)$$

In which:

- Ep - means annual energy produced as heat or electricity. It is calculated with energy in the form of electricity being multiplied by 2.6 and heat produced for commercial use multiplied by 1.1 (GJ/year)
- Ef - means annual energy input to the system from fuels contributing to the production of steam (GJ/year)
- Ew - means annual energy contained in the treated waste calculated using the net calorific value of the waste (GJ/year)
- Ei - means annual energy imported excluding Ew and Ef (GJ/year)
- 0.97 - is a factor accounting for energy losses due to bottom ash and radiation

R1 efficiency greater or equal to 0.65 is used by newer plants (approved after December 31st 2008), where energy is being returned, while R1 efficiency of 0.60 is used by older plants. Grosso at all. [11] reports that European WtE plants have averaged R1 efficiency of 0.71 for CHP in 2004, while electricity was at 0.49 and 0.64 by thermal plants. WtE from the municipal solid waste plays an essential role in producing renewable energy supplies in many well developed countries, especially with limited natural resources like Japan, South Korea and similar. Acknowledging the importance of municipal solid waste to WtE, back in 2008, a new "Strategic Plan for Waste and Energy" [12] was introduced by the South Korean government, through which it intends to increase renewable energy gain and utilise all its' available non-recyclable waste from today's level of 32% on to 57% until 2012, up to 100% until 2020. This is one of the essential elements of the new National Energy Plan, introduced in 2008 [13]. It sets ambitious national goals and puts through many new measures for sustainable development. These goals include increase in the renewable energy production up to 11% of the entire national stake until 2030. The combined heat and electricity, produced by municipal solid waste for the commune of regional waste depot Mošćanica, meets all the requirements to achieving the afore mentioned levels of efficiency. According to the Framework Directive of waste (WFD. 2008/98/EC), WtE plant could and should be built next to the existing cities thermal plant. In this case, within the thermal power plant Arcelor Mittal. The simple and easy solution is to connect with the preheated steam boilers as well as condensation turbine to produce electric energy. That way all the advantages of combining the WtE plan with the existing power plant would be used. Those advantages are: proximity of waste sources to be treated, the ability to use excess heat and electricity throughout the year, existing infrastructure (heating station, district heating pipeline, trafo station for electricity, waste water

accumulation equipment, waste water treatment, sewer, natural gas pipeline with reduction stations, accessible roads, railroad and so on), expert staff familiar with working on boiler plants (both exploration and maintenance). Larger quantities of waste could be easily deployed from other communes of surrounding area by railway, which would increase the capacity of the plant itself, the efficiency of such plant, but also enable production of large levels of renewable energy. Renewable energy that would give a great incentive to the future obligation of commune, but also an obligation to the Federation of Bosnia and Herzegovina to increase the desirable levels of renewable energy production by 2020 (although probably more like 2030). With all the afore mentioned, a decrease in overall pollution should be expected, considering the proven high quality levels of construction and function of new WtE plants. Taking in the fact that modern WtE plants apply to strict criteria rather then existing heat and electricity plants exploiting fossil fuels.

## 5. DAILY PLAN PRODUCTION AND YEARROUND AVAILABILITY

Total amount of solid waste dumped by regional landfill site Mošćanica for 2015 equals to 47.099 t, and the total mass amount of waste ever dumped is 290.888 t. Taking this data into consideration we can take a look at the following WtE plant. WtE Plant daily capacity depends on the time through which the plant is available and the accumulative amount of city's solid waste the plant is supposed to process during one year. Empirical data shows the plant should be available at least during 11 months, that is 7920 hours (considering one month for maintenance) and 5 days would be necessary for total shutdown during a year. Since there is no other plant in the vicinity, a small unit should be constructed, while constructing the city's plant. Working two shifts a day in the plant, it's capacity would be 55000 tons per year, 150 tons per day or 9.4 tons per hour. Lower heating value of waste fuel can be taken as $Hd_0$ = 7000 kJ/kg - in reality it is always larger (8000-12000 kJ/kg), while the boiler pressure equals P=40 bar and the exiting heat temperature equals t=320 $^0$C. Using these parameters this unit could be implemented into Arcelor Mitall Zenica energy system. This unit would show all the advantages of incinerators, reliability, quality, energy efficiency and emissions, but it would also serve to qualitively define the composition of the waste burned, as well as its lower heating value. This would allow to build up quality and necessary requirements for constructing a second unit within the next 5 years. This unit would get larger in capacity as it would allow other regions to understand the ability to process their waste safely and cheaply. It's capacity could be around 100.000 to 120.000 tons per years. And all the while meeting all the EU environmental advantages. An Integral system of waste disposal management by both Zenica as well as the whole of Federation of Bosnia and Herzegovina.

## 6. POSSIBLE TECHNOLOGY FOR THERMAL TREATMENT OF WASTE

As was mentioned before, considering this areas characteristic, there is no doubt such plant would be met by EU demands, to achieve the necessary efficiency levels. Especially the aspect of wholly utilization of heat and electricity produced at the plant from waste thermal energy exploration. Main criteria for selecting the technology used are [14]:

- Technology must be demonstrated, with reference to working plants, especially in Europe, processing similar types of waste. It is essential for a small commune such as this one.
- That the proposed technology does not impose large technological risks.
- Environmental performance - technology must be clean, that is to achieve by the best European standards.
- Complexity - process must be easy to work with without extra employments, and with a clearly defined expenses and maintenances.
- The process should be renewed in the most efficient way from a waste by 150000 inhabitants, in compliance to Strategy of Solid Waste and European Waste Hierarchy.

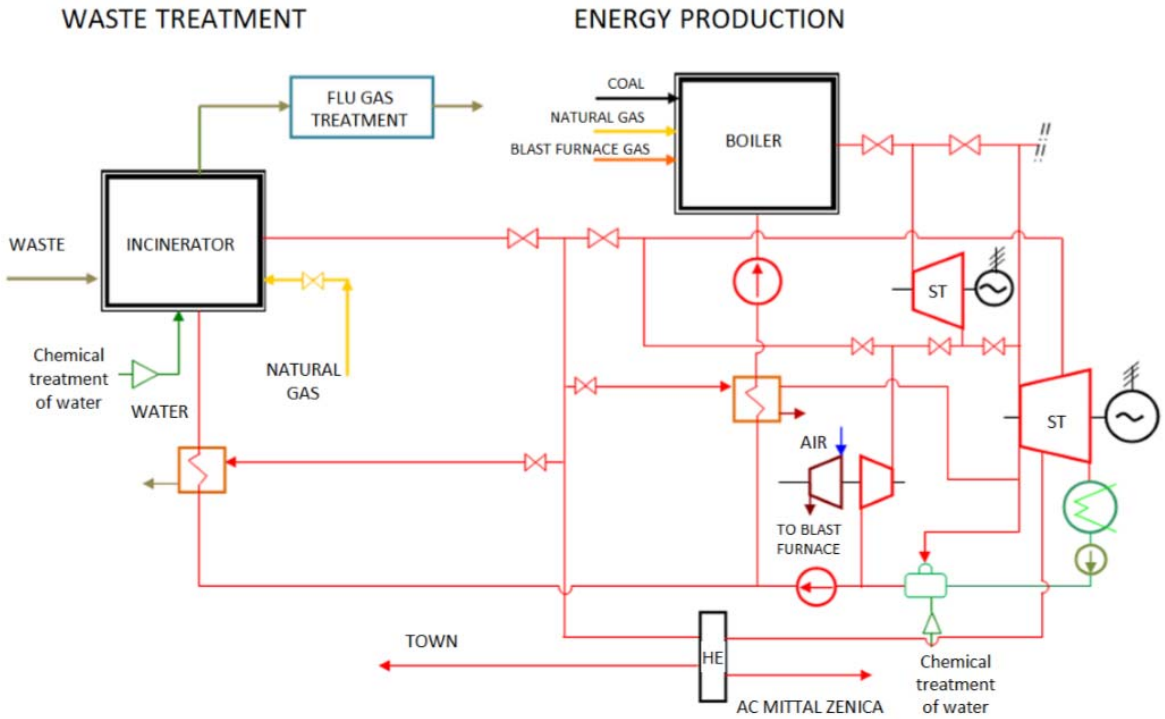
Technology of conventional incineration would be most appropriate for our commune in todays circumstances, as well as in the next 10 to 20 years. Conventional waste energy, that is incineration, using either a grill or a rotor, would dispose all of the extra communal waste, producing electrical energy as well as heating energy if necessary. Some material would remain, most of which are inert and suitable for re-use as a second group, the rest of which amounts to about 5% of the input material required by safety disposal as hazardous waste. Getting the heating energy to its final consumer is also relatively simple. Either by a combined

plant (CHP) for heat and electric energy, or through district heating system, since the existing district heating system is ready to receive heat energy.

## 7. MUNICIPAL SOLID WASTE - ISSUE OR A CHANCE?

This would be a good time to consider the solid waste by the city, as an issue or rather as a chance for the community. Considering the possibility of a WtE plant as well. Problems considering energy return within WtE plants can be minimized and controlled by applying the knowledge and experience obtained through their former and present constructions and utilization. To achieve maximum sustainability, it is necessary to fully consider all aspects of equipment design, plant utilization and potential income flows in the earliest stages of the project. Any of these and many other aspects should be considered in order avoid a project disaster. Therefore it is wise to include experts very early in the process - especially those not promoting different technology [15]. Based on data currently acciured by WtE utilization, the optimal parameters for a steam generator are a maximum of 40 bar of pressure and 400 $^0$C steam temperature. Higher pressures and temperatures would increase the systems efficiency but it would be necessary to compare the economical profits and gains by increase in maintenance expenses. It is extremely important to insure that construction and quality of all steam/water components of the cycle are optimised by both individually and a system as a whole, so that their construction is fitting for a WtE plant. Their life span, reliability and availability, if not done properly, could be disappointingly bad. There are many other options to be applied by steam, besides producing electric energy. Fully analysing these options could lead to two commercial benefits: efficiency increase in the plant itself and extra income.

Taking into consideration everything I mentioned, I propose allocating the plant for solid waste thermal treatment for our community by the energy plant of Arcelor Mittal Zenica, with possible connections to existing plant, as shown on picture 5.




***Picture 5.*** *Proposal for thermal treatment of waste within the power section of the company Arcelor Mittal Zenica*

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