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Challenges of Waste to Energy Facility in Reppi (koshe), Addis Ababa City

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***Abstract*—*Waste to energy is internationally recognized as a powerful tool to prevent the formation of greenhouse gas emissions and to mitigate climate change. To convert municipal solid waste to energy Addis Ababa City Administration and Ethiopia Electric Power has established waste to energy plant to generate 25-MW- 50MW electricity per day. The Koshe-Reppie Waste to Energy plant has been constructed on the area of 7-hectares from the total area of 37-hectares of dumping site. The Facility is being operational the likely sources of negative and positive impacts from the waste to energy plant are leachate from storage and handling of municipal solid waste; unusable wastes for disposal; wastewater from the plant's energy generation process and from bathrooms; air emissions from the spent exhaust gases; noise emissions from the operation of the plant; and bio-char and residual ashes for management further use or disposal. The composition of waste which is delivered to WTE facility is crucial factor that determined energy efficiency and operational management of the facility, emission control and environmental impact issues. The Cambridge waste-to-energy plant at Reppie (Koshe) will use as feedstock between 1,400 tonnes per day of municipal solid waste. This amount accounts for less than 50% of the municipal solid waste collected in Addis Ababa on a daily basis. Therefore, delivery of solid waste with appropriate composition to WTE plant is very important. the Reppie WtE plant, the local site-specific environmental impacts were explained as relatively small, the summary of an EIA report indicates that the potential increase in direct air emissions is0.01–1%. In addition the Facility will operate with two lines running at a nominal design through put of 16 tones per hour (tph) for a design Net Calorific Value (NCV). Waste is combusted at a minimum temperature of 850°C with the released heat generating superheated steam. The major impacts on health and safety are related to emission from the facility. However compared to the emission levels of the open dump site, the facility will have a major reversal effect in the emissions of any toxic or greenhouse gases. In fact due to the EU Environmental Directive that is taken as a standard for the facility, the contractor will install a world class Flue Gas Treatment (FGT) that consistently monitors and reduces emission levels. Stakeholder engagement approaches and common initiatives can reduce costs, generate economies of scale, attract investments, boost financial capacity, stimulate cross-border trade and enable common progress in accelerating the deployment of waste to energy across the country and worldwide. Waste classification must be aggressively promoted at the source. In doing so, the heat value of incinerated waste will improve. WTE plant and publishing coherent real-time information regarding the plant's pollutant emissions would also help to dispel public doubts. In addition, no matter how advanced the technology of waste incineration plant is, the government should not expect citizens to voluntarily sacrifice their own interests. Thus, the government should compensate residents near incineration plants, either by giving them money, or by providing them with heat and electricity at discounted prices*.

***Keywords*—** *Reppi, kosher, Energy, Emission, municipal waste, public.*

I. INTRODUCTION

Ethiopia, one of the developing countries, is experiencing both rapid economic maturation and large-scale urbanization. Due to this fast growth and per capital income increment, large volume of solid waste has been generated from the city. In addition, increasing population due to both natural growth and rural urban migration has made significant impact on the quantity of waste produced from the city. These situations have led to waste disposal problems and the need to identify alternative solid waste management options plus energy sources.

As the fastest developing city, Addis Ababa creates considerable quantities of municipal solid waste (MSW), which is one of the most serious urban pollution sources. As the population and urbanization growing very fast the city administration is implementing different waste management alternatives to make the city clean, healthy and paradise to leave. In this perspective the city administration implemented different projects to enhance green economic development strategy. The city is faced with serious environmental and administrative challenges caused by MSW management. Accordingly, MSW to energy is a novel eco-friendly renewable energy resource and has attracted the attention of the city government. The Waste-to-energy (WTE) conversion processes are expected to play an increasingly important role in sustainable management of municipal solid waste (MSW). The primary function of WTE facility has been volume reduction of waste. The recovery of energy for heat and power production has a secondary, but increasingly important goal. The role of WTE recovery is dependent on many national and local conditions and in particular on the national waste management strategy and landfilling policy. As development and industrialization going on, the composition of waste will be changed over the time due to changing in consumption habits. The increasing contents of dry organic matter (mainly plastics and paper) in MSW have led to a continual increase in the specific heating value of MSW which is an opportunity for WTE plant. [Habitat III, 2016]

Waste to energy is internationally recognized as a powerful tool to prevent the formation of greenhouse gas emissions and to mitigate climate change. The international panel on climate change (IPCC) has recognized waste to energy as the key greenhouse gas emission mitigation technology. Over the years, there have been a number of quantitative assessments made to compare the environmental benefits associated with the processing of MSW in WTE facilities rather than disposing of MSW in landfill. A state of the art WTE facility is roughly estimated by most models to save CO_2 in the range of 100 to 350 kg CO_2 equivalent per ton of waste processed. Recently, markets have developed around the world to compensate WTE operators for the reduction in the CO_2 emissions. Currently, this CO_2 credit is higher in developing countries due to poor landfill practices. Further, the more efficient the WTE facility, the more CO_2 credit it will generate. (Hansen et al. (2000)

In short,

- ✓ The WTE process lowers, and in some cases eliminates the emission of GHGs and reduces MSW mass by an average of 90%
- ✓ Waste-to-energy recovers energy from MSW and produces electricity and/or steam for heating, which is recognized as a renewable source of energy and is playing an increasingly important role in MSW management in many countries in the world.
- ✓ Landfills and wastewater are the two greatest producers of GHGs. Not only do WTE facilities reduce these GHGs, but the energy they produce also helps substitute the need for burning fossil fuels.

TABLE 1. Shows how the GHG emissions from WTE, particularly the carbon dioxide, are significantly lower than from burning coal, oil, or natural gas.

Facility type	Emission		
	Carbon dioxide	Sulfur dioxide	Nitrogen oxides
Coal	2249	13	6
Oil	1672	12	4
Natural gas	1135	0.1	1.7
Waste to energy	838	0.8	5.4

II. METHODOLOGY

2.1. Study Area

The project area is defined by the limit of Addis Ababa City Administration. The proposed development site is located at the Reppie open dump site or commonly known as “Koshe Site” which is located in Kolfe Keraniyo subcitiy worda 01. The Reppie (Koshe) site was established 50 years ago and is located 13km from the center to the Eastern part of the city. Currently the waste has a surface area of 37 hectares and 40 meter height. This made it the largest single waste deposal site in the country. At its commencement the Reppie (Koshe) site was at remote site from business and residential communities but currently due to expansion of the city it become surrounded by of residential community and community service centers. In order To convert municipal solid waste to energy Addis Ababa City Administration and Ethiopia Electric Power has established waste to energy plant to generate 50MW electricity per day. The Koshe-Reppie Waste to Energy plant has been constructed on the area of 7-hectares from the total area of 37-hectares of dumping site.

Fig. 1. Reppi koshe dump sit Air photo graph.

Fig. 2. Kosh dumping waste time.

Fig. 3. The open dump site present problem.

Fig. 4. Reppi WTE plant can be complete and ready to function next June.

2.2. Data Required and Sources of Information

To address the objectives of this study data were collected from different government and non-government organizations which have direct and/or indirect stakes. Additional data were collected from secondary sources. To collect the primary data, the listed stakeholders were invited to workshop/panel discussionwhich was prepared specifically for this purpose. The secondary data were collected from literatures.

During the workshop information such as per capital solid waste production, location of subcity Solid Waste temporary storage (skip points), carrying capacity of each truck currently functional, average trip for each truck, Solid Waste type required for Waste to Energy plant, per day incineration capacity of the Waste to Energy plant, quantity of residue sludge (ash) production from the plant per day and related data were collected.

Participants of the workshop were from Addis Ababa City Administration (AACA), Addis Ababa City Administration - Solid Waste Recycling and Disposal Project Office (AACA-SWRDPO), Addis Ababa City Administration – Cleansing Management (AACA-CA), Ethio-France Corporation, Horn of Africa Regional Environmental Centre and Network (HoAREC), Ethiopian Electric Power (EEP), Central Statistics Agency (CSA) and Addis Ababa Environmental Protection Authority (EPA).

2.3. Data Compilation

The methods used to include desk study of the previous study on this topic matter, data collection through observations/site visits; document review on existing practices/experiences/, challenges & opportunities of implementing waste to energy; as well as deploying evidences experiences from the afore mentioned information sources. After collecting the necessary data from the workshop and secondary sources, the data were synthesized and based on its result conclusion was drown and finally recommendations were made. Finally suggested possible solutions were being forwarded and compiled. Generally, the main approaches and methodologies employed for this paper were:

- Observation of institutional set-ups, solid waste management systems, legal and policy environments, stakeholder's roles and responsibilities. This methodology provides a good basis for diagnosing the overall institutional capabilities for implementing the planned waste to energy facility.
- Consultation meetings or panel discussions with concerned stakeholders and partners
- Review the existing documentation related to Solid Waste management so as to identify the weaknesses of the existing institutional set-up
- Collect data, information and statements through panel discussions, meetings and observation/site visits

III. Result and Discussion

3.1 Addis Ababa Reppie Waste-to-Energy Facility: Expected Operational Challenges

Ethiopia has national legislation encouraging municipalities to segregate and compost household waste and use. Addis Ababa waste to energy facility, which is vital part of Ethiopia's infrastructure, is one of important options for integrated municipal waste management. It is apparent that the current WTE facility under construction in Addis Ababa is largely with an expectation of municipal solid waste disposal by burning and also with an intended plan for power generation, which relies on a technology of European standard, which is comparatively speaking, more mature and simpler than other alternatives. This WTE incineration of MSW is of its first happening. When it will begin its operation, there will be a 185 GW per year power generation. In the coming years, generating power through waste incineration might be Ethiopia's main means of waste disposal by expanding its scope to regions.

However, it is apparent that once the Facility is being operational the likely sources of negative and positive impacts from the waste to energy plant are leachate from storage and handling of municipal solid waste; unusable wastes for disposal; wastewater from the plant's energy generation process and from bathrooms; air emissions from the spent exhaust gases; noise emissions from the operation of the plant; and bio-char and residual ashes for management further use or disposal. On the contrary, some of the positive operational impacts could include employment generation for a range of workers; reduction in importation and burning of fossil fuels; production of energy from a sustainable source; and reduced land degradation and improved environmental management of the landfill. But despite the benefits of the operational impacts of the facility, there are expected difficulties in maintaining consistent operational management of the facility. Thus, so as to keep all options available while ensuring the continued and viable operation of the facility, some of challenges associated with Addis Ababa's WTE Facility and were discussed.

Accordingly, this portion of the paper reveals the problems associated with the operational management of the incineration which might involves the technology, environmental, social and public issues and make recommendations on its impacts on local residents in particular and cities residents in general.

3.2.Amount and Composition of Waste

Studies conducted by different individuals and institutions in different times showed that about 60-70 percent of Addis Ababa City's solid waste composition is organic waste (kitchen waste) mainly composed of vegetable and food wastes. These solid wastes contain high moisture and such wastes with high moisture content are not suitable for incineration. Therefore, delivery of solid waste with appropriate composition is one of the challenges to Reppi Koshe WtE facilities (IGNIS, 2013)

The Cambridge waste-to-energy plant at Reppie (Koshe) will use as feedstock between 1,400 tonnes per day of municipal solid waste. This amount accounts for less than 50% of the municipal solid waste collected in Addis Ababa on a daily basis. Therefore, delivery of solid waste with appropriate composition to WTE plant is very important. Cambridge, who has been undertaking the construction of the

Reppie Waste to energy Facility proposing the following operational requirements:

- Inputs of WtE project include waste (waste amount, water content, CV, etc.); Hydrated Lime; Activated Carbon; Water; Etc…
- Outputs of the WtE include Flue Gas, FGT Residue, Bottom Ash/Slag and Power
- Quantity of waste - Waste supply > 1400 Tone/day is required. Qualityof waste - Water content, heating value, Composition of the waste, Maximum Particle size variety, Etc…

TABLE 2. Data of collection at a time.

Description	Unit	Minimum value	Design value	Maximum value
Lower Heating value	MJ/kg	5.5	7	9.5
Constituent				
C	[%]	15.98	19.03	24.6
H	[%]	2.38	2.73	3.4
O	[%]	11.3	11.3	13.44
N	[%]	0.8	0.91	0.86
S	[%]	0.1	0.23	0.04
Cl	[%]	0.3	0.45	0.76
W	[%]	46	42.2	35.84
A	[%]	23.14	23.15	21.07

However, CAAA SWRDPO set a standardization of the composition of waste which is delivered to WTE facility is crucial factor that determines energy efficiency and operational management of the facility, emission control and environmental impact issues. The following standards and conditions should be taken into account for the sustainability of the WTE plant.

- Homogenous mixture of the waste
- The nature of the solid waste should be with:-
  - Moisture content less than 50%
  - Water content(wt%) --- below 25
  - Lower heating value (Kcal/kg) --- above 3,650
  - Ash content(wt%) ----------------- below 25
  - Chlorine content(wt%)------------- below 2.0
  - Sulfur content (wt%) -------------- below 0.6
  - Mercury (Hg) (mg/kg) ------------ below 1.0
  - Cadmium (Cd) (mg/kg) ----------- below 5.0
  - Lead (Pb) (mg/kg) -----------------below 150
  - Arsenic (As) (mg/kg) -------------- below 13
  - Chromium (Cr) (mg/kg) ----------- below 13

3.3.Collection and Transportation of the Waste

The basic procedure to deliver waste to WTE plant should start from transfer stations. First, all solid waste (except hazardous and medical wastes) should be transported to transfer stations, and then sorting, mixing, weighing and transporting with appropriate trucks to WTE plant should be from there. Currently, transfer stations have not been yet constructed, and the collection system is done both by the government and private sectors. More importantly, now days due to the participation of private sectors (who care only about the amount of waste they are collecting) and poor monitoring systems wastes from industries, hospitals (health institutions) and different organizations were being mixed with municipal solid wastes and delivered to this plant. Presumably, this condition would make the plant to be potential source of exposure to different health affecting emissions for the community living in the vicinity of the plant, and this will costly affect its sustainability.

3.3 Gate Fee

Financing of energy from waste projects can be difficult with waste companies all seeking to minimize their risks. One of the primary sources of income for energy from waste project is not just the power produced but the fee charged for accepting the waste – the gate fee. This gate fee can be discussed and decided on either a ‘per ton of waste’ or other option basis. In the case of City government of Addis Ababa, taking into account landfill operational cost, the city may pay the gate fee if and only if the WTE plant can accept and incinerate all the waste generated per day in the city. But still there are some drawbacks associated with the gate fee principle; for instance:

- Can the WTE plant accommodate all the waste generated per day irrespective of its composition?
- If the waste that is delivered to the WTE plant is supposed to be in appropriate mixture who is responsible for the cost of mixture preparation?
- How the WTE plant involves the participation of private sectors who are involved in collection and transporting of waste, especially from big private and government institutions and commercial centers?
- How the WTE plant becomes competent with recycling facilities which seek recyclable materials such as plastics with high calorific value? How it can be in agreement with principles of hierarchy of solid waste management?

3.4.Facility’s High Cost and Susceptibility to Corrosion

Compared with other MSW treatment technologies, WTE involves a large capital investment and high operating costs. As the core of the WTE incineration facilities, the incinerator accounts for approximately 50% of the cost of investing in a WTE plant (WET Germany, 1994). Imported incineration equipment is very expensive. Corrosion problems are often associated with WTE incineration. The combustion gases that contain various impurities (especially HCl and chloride salts) result in much higher corrosion rates of boiler tubes. Chlorine and sulfur have been considered key elements in the corrosion process. Because of City’s poor performance with regard to waste classification, the high moisture content of waste and its tendency to generate HCl and SO_2 and other acid gases after oxidation may erode WTE facilities.

3.5.The Low Heat of Municipal Solid Waste

In comparison with developed countries that have sophisticated approaches to the classification of waste, Addis Ababa City’s MSW classification system is not yet started and poorly developed. Its MSW has a lower heat value because of its relatively higher organic composition and moisture content, so it achieves lower energy efficiencies when incinerated. The average heat value of MSW in developed countries waste

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incineration plants is 8.4–17 MJ/kg. But studies showed that in developing countries where classification and separation of waste is less practiced the average heat value of MSW is by far less than developed countries. Because the waste contains many organic substances and nutrients, it is difficult to recycle the heat generated in the incineration process; the generated heat may be lost as smoke, which itself requires purification.

3.6. Environmental and Health Impacts

Waste-to-energy (WTE) describes a variety of technologies that convert garbage or municipal solid waste (MSW) into either heat or electricity. Incineration processes has taken place in the presence of air and at the temperature of 850°C and waste are converted to carbon dioxide, water and non-combustible materials with solid residue (Bottom ash) [DEFRA, 2007]. Incineration is burning municipal solid waste that can generate energy while reducing the amount of waste by up to 90% in volume and 75% in weight. Which can be valuable if land fill space is limited? In line to this, it is important to understand expected environmental impacts associated with waste to energy facilities. The Oxford dictionary (Brown, 1994) defines environment as "the set Of circumstances or conditions in which a person or community lives, works, develops, etc., or a thing exists or operates; the external conditions affecting the life of a plant or animal "and Environmental impact is any change to the environment or its component that may affect human health or safety, biophysical conditions, or cultural heritage, other physical structure with positive or negative consequences.

The role of waste incineration in the waste and energy systems is controversial from an environmental point of view. There are many researches which have an opinion waste to energy is best solution for the combustible waste and energy sources. But, a few researchers tried to show the environmental impacts of waste to energy incineration plants from the environmental and health point of view.

According to www.ecocycle.org /zero waste, 2011 report, Incinerators and similar facilities emit particulate matter, volatile organic compounds (VOCs), heavy metals, dioxins, sulfur dioxide, carbon monoxide, mercury, carbon dioxide and furans. Many of these chemicals are known to be persistent (very resistant to degradation in the environment), bio accumulative (build up in the tissues of living organisms) and toxic. These three properties make them arguably the most problematic chemicals to human health and the environment. Some of the emitted chemicals are carcinogenic (cancer-causing) and some are endocrine disruptors. Others, such as sulfur dioxide (SO2) and nitrogen dioxide (NO2), have been associated with adverse impacts on respiratory health and considered as the most important component of urban air pollution (Michela et al., 2004).

Incinerators are typically fed with mixed waste containing hazardous substances such as heavy metals and chlorinated organic chemicals. These substances can assume other forms during incineration that are likely to be more toxic than the original compounds. The range of metals emitted from the plants includes cadmium, thallium, lead, arsenic, antimony, chromium, cobalt, copper, manganese, nickel and mercury. Metal exposure is therefore associated with a range of adverse health effects concerning all body systems. In particular most heavy metals have been reported to be associated with kidney disease, respiratory diseases, cardiovascular damage, blood effects, and neurotoxicity (Johnson et al, 1999). Many of these pollutants are carried on the wind impacting communities and ecosystems long distances from the point of origin. (Stockholm Convention on Persistent Organic Pollutants 2001, www.pops.int)

Waste incinerators all generate ash that is contaminated with toxic heavy metals and persistent organic pollutants (POPs) such as dioxins and furans….. The levels of contamination vary according to the waste burned, the process used and configuration of the pollution controls on the smoke stack but all solid and air emissions contain contaminants, many of which can be at a level that can impact on human health and the environment depending on the disposal method and exposure.

A number of environmental impacts are linked to the incineration of waste. In addition to site- specific impacts that are studied usually in the frame of EIA Cambridge indirect impacts/emissions should be taken into account when assessing the net impacts of WtE facilities. As incineration of municipal waste should fit into the overall waste management system of the city, it should be compared withalternative waste management options. Since the Reppie WtE plant, the local site-specific environmental impacts were explained as relatively small, the summary of an EIA report indicates that the potential increase in direct air emissions is0.01–1%. In addition the Facility will operate with two lines running at a nominal design through put of 16 tones per hour (tph) for a design Net Calorific Value (NCV). Waste is combusted at a minimum temperature of 850°C with the released heat generating superheated steam. The steam is then fed to a condensing turbo-generator to produce electricity. The FGT plant is designed to process fume from a single stream municipal energy-from-waste plant in Addis Ababa, Ethiopia, and using a dry scrubbing process, reduce the level of pollutants to meet the requirements detailed in the EU Environmental Directive.

3.7. Air Pollutant Emissions and Fly Ash Management

Substandard incineration facilities and flue gas purification systems trigger a series of environmental pollution problems, and pollutants are generated in the process of incineration; in particular, emitted dioxins cause serious air pollution. The problem of dioxin emissions is one of the main reasons there is public opposition to the construction of waste incineration plants in the vicinity of residences. Therefore, WTE enterprises must improve the standards and practices of their incineration facilities and flue gas purification systems, to reduce the discharge of various pollutants, and so to protect public health. Although the volume of waste decreases rapidly during incineration, some residues remain, such as bottom and fly ash. After a stabilization treatment, bottom ash could be used as a building material. In contrast, fly ash is a hazardous waste that contains dioxin and has heavy metal content; therefore, it must be specially treated. As a requirement, the

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fly ash should first be stabilized by pretreatment technologies, and then be disposed of in a special landfill. Here, in case of the REPI WTE plant, there are some questions that need clear answer.

- What are the proposed pretreatment technologies for the fly ash?
- To what extent is the level of pretreatment?
- Who covers the cost of transportation and disposal of the pretreated fly ash, also bottom ash if it is supposed to be disposed at the landfill?

On the other hand, Cambridge reveals that:

> *"*The major impacts on health and safety are related to emission from the facility. However compared to the emission levels of the open dump site, the facility will have a major reversal effect in the emissions of any toxic or greenhouse gases. In fact due to the EU Environmental Directive that is taken as a standard for the facility, the contractor will install a world class Flue Gas Treatment (FGT) that consistently monitors and reduces emission levels."

Flue gas cleaning system is designed to fulfill EU Waste Incineration Directive. Some of the emission limits are mentioned below:

TABLE 3. Emission limits.

Pollutant	**Limit**	**Unit**
Total dust	10	mg/m3 daily average
Total organic carbon	10	mg/m3 daily average
HCl	10	mg/m3 daily average
HF	10	mg/m3 daily average
SO2	50	mg/m3 daily average
No2	200	mg/m3 daily average
Dioxins and furans	0.1	ng/m3 6-8 hour average

Source: Guideline for industrial Pollution Control in Ethiopia (EPA, September 2003) in Cambridge

3.8. Stringent Energy Policy (related with Ethiopian energy policy)

Enabling policies and regulatory frameworks create stable and predictable investment environments, which help to overcome barriers so as to ensure predictable revenue streams for projects. Setting waste to energy targets and formulating dedicated policies to implement them provides strong market signals, reflecting government commitment to the sector's development. Depending on the national context, complementary measures can level the playing field for waste to energy facilities through the introduction of institutional arrangements with their clear roles and appropriate energy pricing structures. So what?

3.9. Public Opposition to Waste-to-Energy Facility Operation

Changes in waste management arrangements in the city are gaining attention in media. With growing awareness of the need for environmental protection, public opposition might become expected opponents to this WTE facilityduring its operation. This public opposition is expected to have different causes that are discussed as follows.The site selections for MSW incineration plants might be the reason for the not in my back yard sentiments. The WtE incineration facility might have been constructed within the city close to residential areas and even schools. Besides, some expected mainstream media report that WtE incineration power plants are expected potential sources of air pollution linked to cancer, and imply that security cannot be guaranteed, even though these plants supposedly meet EU standards. Moreover, due to some expected misleading publicity of mainstream media and other factors, public opposition to the WtE incineration facility operation might occur in areas around the WtE plant in operation. This might lead to disturbances that cause fear among members of the public. This might be 'The Not in My Back Yard' phenomenon.

Public participation that might contribute to the effective and efficient operation of the WtE facility could be possibly happen at different levels. So, the lack of public participation from its starting point and as citizens' environmental consciousness is being awakened, there is growing concern about the WTE incineration plants leading to possible public opposition as they put into operation. Thus, there might have been even some sort of demonstrations against the facility operation that could attract the attention of the government.

3.10. Waste to Energy Operational Management

It is understood that the proposed Reppie WtE Facility is to operate for 24 hours per day, seven days a week. EEPCo and Cambridge has been working together to obtain details regarding the proposed source noise levels of the equipment in operation at the proposed facility. A large proportion of the equipment associated with the facility will be housed within buildings. The calculations of the plant noise emissions have been based upon the assumption that the overall average sound absorption coefficient within all areas of the plant buildings is 0.05 (which is representative of a typically reverberant space and could be considered highly conservative) and that the building cladding materials are capable of achieving the following minimum sound reduction indices:

- ✓ Wall (e.g. to Turbine Hall) – Rw 50dB
- ✓ Cladding – Rw 30dB
- ✓ Roof Cladding – Rw 30dB

The above sound reduction indices are derived from typical sound insulation WtE performances for similar building elements. The assessment has been based upon the assumption that the selected building elements will achieve this level of acoustic performance and hence it assumed that, as part of the design criteria, the relevant building elements will have an equal or better sound insulation performance and interior sound absorption coefficients. Using the Lim A software package and the equipment noise levels, noise level contours specifically attributable to the Reppie WtE scheme have been calculated to determine the likely operational noise levels at the assessment receiver locations.

3.11 Finding and Possible Solutions

3.11.1. Enhance stakeholders' engagement and cooperation on WTE plant development.

Stakeholder engagement approaches and common initiatives can reduce costs, generate economies of scale, attract investments, boost financial capacity, stimulate cross-border trade and enable common progress in accelerating the deployment of waste to energy across the country and worldwide. To meet national goals and ambitions, countries would benefit from concerted action that stakeholder's cooperation offers. Governments should tap into opportunities for engagement and cooperation on waste to energy and climate mitigation.

As a result, some public consultations have to be conducted prior to initiating WTE facilities operations, but the public participation processes are regarded as minimum effort, which is far removed from involvement at the level of citizen power.

3.11.2. Enhancing source separation and pretreatment to increase waste-to-energy efficiency

Waste separation is a precondition of WTE plant. Due to poor waste classification, our MSW has a high organic waste composition and moisture content, which results in lower heat values, low incineration efficiency, and the production of secondary pollution, such as dioxins. Therefore, waste classification must be aggressively promoted at the source. In doing so, the heat value of incinerated waste will improve. Waste separation at the source should be at least on the basis of the following five categories.

Category of waste	Definition and Composition	Remark
Kitchen waste /putrescible waste	✓Organic waste with high moisture content which is easily decomposed by bacterial action: ✓Include food waste, vegetable waste, animal dung, garden yard, etc.	✓Suitable for compositing and bio-gas facilities
Combustible waste/dry organic waste	✓Waste easily combustible and have high heat value. ✓Include paper, plastic, tyre, household waste, cardboard, wood, etc.	✓Suitable for WTE facilities
Non-combustible waste/inorganic waste	✓Neither putrescible nor combustible waste. ✓Include glass, metal scraps, aluminum tans, etc.	✓Suitable for recycling and reuse
Hazardous waste	✓Cause hazard to human being and to the environment. ✓Include medical waste, industrial waste, E-waste, etc.	✓May be suitable to bio-medical incineration, recycling and reuse
Ash and C&D waste	✓By products from incinerator facilities ✓Street sweeps (sand, dust, etc.) ✓Construction and demolished wastes	✓Suitable to landfill ✓Suitable to landfill ✓Suitable for recycle and reuse or WTE facility after separation

3.11.3. Standardize the Waste-to-Energy Plant

Formulating many standards, including standards with regard to the location of WTE sites and allowable pollutant emission levels, is a mandatory for environmentally friendly operation of WTE plant. There is a significant gap between developing and developed countries in waste management practices. Thus, it is important to learn from the developed countries, and further improve WTE technologies, to guide, and standardize the WTE market. Government supervision could be strengthened by adopting the following three strategies:

1. Establish specialized regulatory agencies to supervise the construction and operation of WTE plant, to be responsible for the daily monitoring, examination, and annual inspection of WTE plant instruments, and to track and investigate the leachate, fly ash, and slag from the plant.
2. Assign clear legal responsibility for ensuring that WTE plant meets acceptable standards for pollutant emissions, hold officials accountable for substandard pollutant emissions, and increase the penalties imposed in these instances.
3. Conduct regular monitoring of WTE plant's impacts on the environment.

3.11.4. Increase public participation to improve public understanding

It will be necessary to establish mechanisms for the effective participation of members of the public, whose interests relate to issues with waste-to-energy facilities. The following approach would be useful.

1. Residents near the WTE incineration plant must be offered a certain number of job opportunities at the plant, and be assured that the incineration is always under supervision.
2. WTE incineration plant should be constructed to ensure environmental protection, and this concern for safety should be made public and be demonstrated. Informing the public about MSW treatment-related knowledge on an on-going basis will gradually help the public understand that MSW incineration is harmless. Moreover, the government should regularly publish user-friendly information, and establish clear operational guidelines, policies, and regulations for urban public utilities.
3. Introducing third-party regulatory agencies that include those who reside near WTE plant and publishing coherent real-time information regarding the plant's pollutant emissions would also help to dispel public doubts. In addition, no matter how advanced the technology of waste incineration plant is, the government should not expect citizens to voluntarily sacrifice their own interests. Thus, the government should compensate residents near incineration plants, either by giving them money, or by providing them with heat and electricity at discounted prices.

IV. CONCLUSION

The incineration of municipal waste involves the generation of climate-relevant emissions. These are mainly emissions of CO_2, but also of N_2O, NOx, NH_3, and organic C, measured as total carbon. CH4 is not generated in waste incineration during normal operation. It only arises in particular, exceptional, cases and to a small extent (from waste remaining in the waste bunker), so that in quantitative terms

CH4 is not to be regarded as climate-relevant. In waste incineration plants, CO_2 constitutes the chief climate-relevant emission and is considerably higher, by not less than 10^2, than the other climate-relevant emissions.

An energy transformation efficiency equal to or greater than about 25 percent results in an allowable average substituted net energy potential that renders the emission of waste incineration plants (calculated as CO2 equivalents) climate-neutral due to the emission credits from the power plant mix. WTE development provides several additional benefits including investing in the future, avoiding the increasingly difficult and frequent necessity of building landfills near large population centers, reducing use of primary fossil fuels, and decreasing the greenhouse-gas emissions associated with landfilling. Final concluding that WTE plant built in Ethiopia Addis Ababa can minimize improper waste disposing, environmental and health effect in Reppi (koshe) and surrounding area living people from bad smell, burning fog,leachet and other problem.so suggest that to rehabilitate the area and surrounding place after starting WTE plant in different aesthetic aspect of the Reppi waste disposing area.

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