Sustainable solid waste management system (production renewable energy)

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The intensive use and the amounts of conventional energy, which depends on the "fossil fuel" oil and its derivatives, coal and natural gas "causing serious damage to humans and the environment and all living things, and led to environmental contamination have not been seen and to global warming, global warming and acid rain and to many of the environmental disaster that began and did not know when will it end in addition to health problems and hard-to-population and restrict them, which led to the search for sources of alternative energy and clean and that achieve sustainable development does not adversely affect human health and the environment and this is achieved in reliance on renewable energy sources, which generated naturally and in a sustainable manner and without resulting in any type of hazardous waste.

Globally, have become environmental sustainability and waste management of the main topics that has received increasing attention in industrialized countries, translate investments in the establishment of integrated infrastructure for re-use and recycling of waste and provide incentives for investors in this sector, supported the adoption of legislation prohibiting the dumping of waste or disposed of through burial or burning. According to this data has become a recycling sector today worth more than $ 500 billion. One of the options used for decades in the treatment of municipal solid waste, which has gained increasing attention in recent years is to convert waste to energy Waste To Energy, which today is a sector exceed the market value of $ 3.5 billion global. That landfill causes serious environmental problems, especially in the long run, when decomposition of organic waste in the ground emit methane, which is more damaging than carbon dioxide in terms of increasing the temperature of the earth (global warming). In addition, the fluid formed in the ground as a result of melting of these residues in the soil may lead to contamination of groundwater and thus become non-potable The benefits of sustainable waste management are :clean electric power generation (methane) ,waste disposal, which make up a scene improper, alleviate the environment from pollution and diseases use the output of the aerobic degradation of the production of organic fertilizers , provide job conserve natural resources , rationalize the use of electric power, thus reducing the pollution resulting gaseous , reduce the amount of land is wasted annually in the administration of landfill sites ,and to maintain the underground water from pollution, which is produced from landfill sites. So today is increasing interest in the development of methods of burning waste and benefit from, rather than burial. The volume of household waste in the world about 1.6 billion tons per year, according to estimates by the Organization of Economic Cooperation and Development in 2005, is expected to exceed the limits of this volume of three billion tons by 2030. On average 80 per cent of this vast amount of waste disposed of by burial at the ground in locations outside the cities in an ad hoc distributed while the proportion of the remaining 20 per cent between recycling. Recycling and disposal by burning in special furnaces Incinerators. This research addresses the issue of utilization of solid waste to produce clean energy and contribute to the sustainability of cities.

INTRODUCTION

Energy is consumed in large quantity everywhere in the world and the demand for it will inevitably increase as the population increases every year. Most of the energy used today derives from fossil fuel, if things continue at this rate, there will not be any fossil fuel left to use in the future. Not only fossil fuel is limited and highly priced, it is also very harmful to the environment. Emission released from the evaporated or combusted fossil fuel include numerous harmful compounds, such as, benzene, toluene, xylene, styrene, 1.3-butadiene, aldehydes, ketones, phenols, halogenated hydrocarbons and trace metals.

The process of creating alternative fuel from reliable sources, such as, hydropower, geothermal, wind, and solar have been presented to overcome the above mentioned problems, The use of renewable energy is not new. More than 150 years ago, wood, which is one form of biomass, supplied up to 90 percent of our energy needs. the use of coal, petroleum, and natural gas expanded, Today, we are looking again at renewable resources to find new ways to use them to help meet our energy needs. Renewable energy plays an important role in the supply of energy. When renewable energy sources are used, the demand for fossil fuels is reduced. Unlike fossil fuels, non-biomass renewable sources of energy (hydropower, geothermal, wind, and solar) do not directly emit. Increasingly, untreated municipal waste is being viewed as too valuable a commodity to relegate to disposal methods that meet objectives solely focused on environmental and public health protection and aesthetics. With anticipated global shortages of critical nutrients such as phosphorus and increasing demand for renewable energy supplies, the heating value and nutrient content of liquid and solid wastes are ripe for exploitation In the case of municipal solid waste (MSW), waste to energy applications are being implemented world-wide for the purpose of thermally treating waste and recovering energy in the process

1. solid waste management:

Waste generation increases with population expansion and economic development. Improperly managed solid waste poses a risk to human health and the environment. Uncontrolled dumping and improper waste handling causes a variety of problems, including contaminating water, attracting insects and rodents, and increasing flooding due to blocked drainage canals or gullies. In addition, it may result in safety hazards from fires or explosions. Improper waste management also increases greenhouse gas (GHG) emissions, which contribute to climate change . Planning for and implementing a comprehensive program for waste collection, transport, and disposal—along with activities to prevent or recycle waste—can eliminate these problems[1]. Solid waste should be managed through a number of activities—waste prevention, recycling, composting, controlled burning, or landfilling. Using a combination of these activities together in a way that best protects your community and the local environment is referred to as integrated solid waste management (ISWM).[2] Integrated solid waste management refers to the strategic approach to sustainable management of solid wastes covering all sources and all aspects, covering generation, segregation, transfer, sorting, treatment, recovery and disposal in an integrated manner,with an emphasis on maximizing resource use efficiency[3].

2. Waste-to-Energy as renewable energy source:

The term „*Waste-to-Energy*" means the use of modern combustion technologies to recover energy, usually in the form of electricity and steam, from mixed municipal solid wastes. These new technologies can reduce the volume of the original waste by 90%, depending upon composition and use of outputs. In OECD countries all new WtE plants must meet strict emission standards.[4]

Waste to Energy, or WTE, typically involves the conversion of solid waste to energy resulting in the generation of electricity from the recovered heat, and/or the generation of hot water or steam to be used for community-based industrial, commercial or residential heating applications. WTE technology has been adopted in many jurisdictions globally[5] Modern WtE is considered to be a source of partly renewable energy by the U.S. federal government and 15 U.S. states that have established renewable energy programs. Also some European countries that have established renewable energy programs consider energy production through WtE as renewable.[6] Municipal Solid Waste (MSW) contains organic as well as inorganic matter. The latent energy present in its organic fraction can be recovered for gain fultilisation through adoption of sustainable Waste Processing and Treatment technologies. The recovery of energy from wastes also offers a few additional benefits as follows[7]:

(i) The total quantity of waste gets reduced by nearly 60% to over 90%,depending upon the waste composition and the adopted technology;

(ii) Demand for land, which is already scarce in cities, for land filling is reduced;

(iii) The cost of transportation of waste to far-away landfill sites also gets reduced

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[1] What Is Integrated Solid Waste Management? United States Environmental Protection Agency, EPA530-F-02-026a (5306W), Solid Waste and Emergency Response,May 2002 ,www.epa.gov/globalwarming

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[4] **Waste-to-Energy**) WtE) technology, *www.moraassociates.com/.../0707%20Waste*

[5] **WASTE TO ENERGY** A Technical Review of Municipal Solid Waste**...**
*www.env.gov.bc.ca/epd/.../**pdf**s/BCMOE-WTE-Emissions-final*.pd

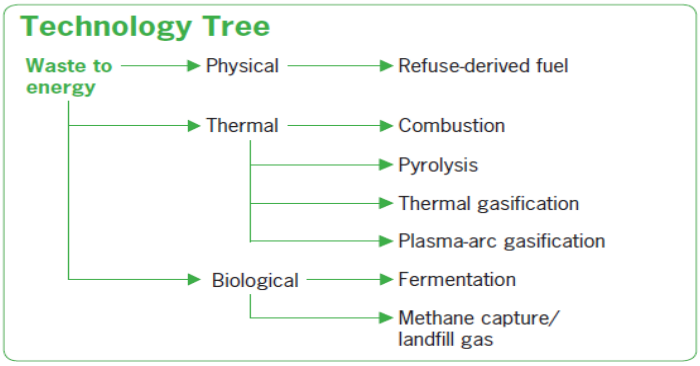
[6] **Waste-to-Energy**) WtE) technology
www.moraassociates.com/.../0707%20Waste

[7] ENERGY RECOVERY FROM MUNICIPAL SOLID WASTE, *urbanindia.nic.in/publicinfo/swm/chap15.pdf*

proportionately; and
(iv) Net reduction in environmental pollution.

3. waste to energy technologies:

The term “waste to energy” has traditionally referred to the practice of incineration of garbage. Today, a new generation of waste-to-energy technologies is emerging which hold the potential to create renewable energy from waste matter, including municipal solid waste, industrial waste, agricultural waste, and waste byproducts. The main categories of waste-to-energy technologies are physical technologies, which process waste to make it more useful as fuel; thermal technologies, which can yield heat, fuel oil, or syngas from both organic and inorganic wastes; and biological technologies, in which bacterial fermentation is used to digest organic wastes to yield fuel[1](see fig 1)



FIG(1) waste to energy technologies

Waste-to-energy technologies convert waste matter into various forms of fuel that can be used to supply energy. Waste feed stocks can include municipal solid waste (MSW); construction and demolition (C&D) debris; agricultural waste, such as crop silage and livestock manure; industrial waste from coal mining, lumber mills, or other facilities; and even the gases that are naturally produced within landfills. Energy can be derived from waste that has been treated and pressed into solid fuel, waste that has been converted into biogas or syngas, or heat and steam from waste that has been incinerated Advanced waste-to-energy technologies can be used to produce biogas (methane and carbon dioxide), syngas (hydrogen and carbon monoxide), liquid biofuels (ethanol and biodiesel), or pure hydrogen; these fuels can then be converted into electricity[2].
For many years, opposition to the use of municipal solid waste (MSW) as an energy resource has been nearly universal among activists and regulators. This opposition has been largely based on bad experiences with traditional garbage incineration facilities, which are associated with high levels of toxic emissions, as well as the perception that using MSW for energy will compete with recycling efforts. But growing climate, energy, and environmental concerns, coupled with technological developments and regulatory changes, have ignited new interest in MSW as an energy source with the potential to provide renewable energy while reducing greenhouse gas emissions and the need for landfill space.[3] The U.S. Environmental Protection Agency (EPA) defines municipal solid waste as including “durable goods, non-durable goods, containers and packaging, food wastes and yard trimmings, and miscellaneous inorganic wastes[4]

4. A number of technologies can be used to create energy from MSW:

• **Landfill Gas Capture** — Waste in landfills naturally undergoes a process called anaerobic digestion, in which bacteria in an oxygen-deprived environment break down organic material. This process emits biogas, which is composed of approximately 50 percent CO2, 50 percent methane, and a trace amount of other gases. To secure the biogas, operators dig a series of wells into the landfill, capturing between 60 and 90 percent of the gas

[1] Waste to Energy, www.e-renewables.com/.../Waste/Waste%20to%20E
[2] Waste to Energy, www.e-renewables.com/.../Waste/Waste%20to%20E
[3] Municipal Solid Waste as a Renewable Energy Feedstock, *www.seas.columbia.edu/.../eesi_msw_issuebrief_072...*-
[4] Environmental Protection Agency. “Summary of the EPA Municipal Solid Waste Program.” Environmental Protection Agency, http://www.epa.gov/reg3wcmd/solidwastesummary.htm, 2008

emitted, depending on the system design.16[1] The captured gas is then pumped to a central facility where the methane can be refined to pipeline-quality renewable natural gas, flared, or used for heat or electricity generation on site.[2]However, landfill gas systems require a large amount of landfill space, and a significant amount of climate warming methane is still released.

• **Combustion —** Also referred to as waste-to-energy, this technology involves burning waste in a chamber at high temperature, usually 1800 degrees Fahrenheit. While old combustion facilities often had high emissions toxic compounds, recent technological advances and tighter pollution regulations ensure that modern waste-to-energy facilities are cleaner than almost all major manufacturing industries. [3]

• **Pyrolysis** — MSW is heated in the absence of oxygen at temperatures ranging from 550 to 1300 degrees Fahrenheit.[4] This releases a gaseous mixture called syngas and a liquid output, both of which can be used for electricity, heat, or fuel production.

The process also creates a relatively small amount of charcoal. While this process results in relatively low net greenhouse gas emissions and has a high conversion efficiency, technical difficulties have prevented its implementation on a commercial scale. The biggest barrier has been the difficulty of removing enough oxygen from the MSW to sustain a strong reaction. [5]

• **Gasification** — MSW is heated in a chamber with a small amount of oxygen present at temperatures ranging from 750 to 3000 degrees Fahrenheit. This creates syngas, which can be burned for heat or power generation, upgraded for use in a gas turbine, or used as a chemical feedstock suitable for conversion into renewable fuels or other bio based products. [6] Gasification is economically viable at a small scale and tends to emit lower amounts of SOx, NOx, and dioxins than combustion. However, gasification has proven difficult to apply on a large scale and is not yet cost competitive with combustion. [7]

• **Plasma Arc Gasification**—Superheated plasma technology is used to gasify MSW at temperatures of 10,000 degrees Fahrenheit or higher, an environment comparable to the surface of the sun. The resulting process incinerates nearly all of the solid waste while producing from two to ten times the energy of conventional combustion. [8] The solids left over are chemically inert, and can be used in paving surfaces. [9] While the technology is still relatively immature, several demonstration facilities have been built to provide conventional electricity, while hybrid facilities that combine conventional and plasma gasification to create ethanol are also in development. [10]

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Efficiency of Energy Conversion Technologies (kWh/Ton of Waste)[12,13]	
Landfill Gas[14]	41-84
Combustion[15]	470-930
Pyrolysis	450-530
Gasification	400-650
Plasma Arc Gasification	400-1,250

Expected Landfill Diversion (% weight)[19,20]	
Landfill Gas	0
Combustion	75*
Pyrolysis	72-95
Gasification	94-100
Plasma Arc Gasification	95-100

*90% by volume

FIG(2) efficiency of energy conversion tech.

In USA , landfill gas capture has achieved by far the widest acceptance among technologies generating energy from MSW. In December 2008, there were bioenergy programs in place at 485 landfills. These projects provided 12 billion kWh of electricity per year, as well as 12 billion cubic feet of landfill gas per day for direct use applications such as household heating.[1] Together, this was enough to provide power for 870,000 homes and heat for an additional 534,000 ,Several respected national international entities have recognized MWS as a source of clean energy

– These entities include the US EPA, US Conference of Mayors, the IPCC and the World Economic Forum – These organizations have reached their conclusions using Life Cycle Assessment ("LCA") methodologies[2]. The USEPA concluded that the integrated waste management system that included waste-to-energy along with extensive recycling was the only alternative that was a net greenhouse gas reducer in comparison with alternatives that included recycling and landfill gas to energy[3]. The Kyoto Protocol has established a methodology for trading credits for greenhouse gas reduction that specifically recognizes "avoided emissions from organic waste through alternative waste treatment processes… incineration of fresh waste for energy generation … where the waste would have otherwise been disposed of in a landfill[4].(see fig 2)

5. BASIC TECHNIQUES OF ENERGY RECOVERY:

Energy can be recovered from the organic fraction of waste (biodegradable as well as non-biodegradable) basically through two methods as follows:[5]

(i) **Thermo-chemical conversion** : This process entails thermal de composition of organic matter to produce either heat energy or fuel oil or gas; and

(ii) **Bio-chemical conversion:** This process is based on enzymatic decomposition of organic matter by microbial action to produce methane gas or alcohol. The Thermo-chemical conversion processes are useful for wastes

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[5]**Waste-to-Energy**) WtE) technology, p1, *www.moraassociates.com/.../0707%20Waste*

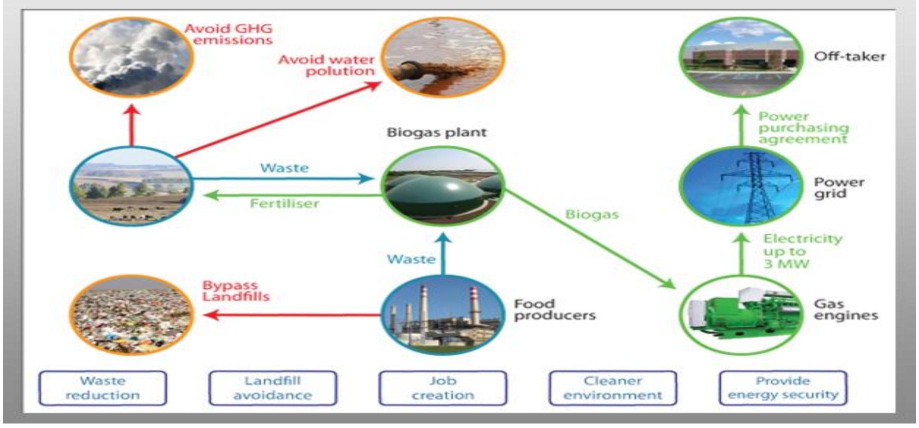
containing high percentage of organic non-biodegradable matter and low moisture content.The main technological options under this category include **Incineration and Pyrolysis/ Gasification.**
The bio-chemical conversion processes, on the other hand, are preferred for wastes having high percentage of organic bio-degradable (putrescible) matter and high level of moisture/ water content, which aids microbial activity. The main technological options under this category is **Anaerobic Digestion,** also referred to as **Bio methanation**.

6. Parameters affecting Energy Recovery:[1]

The main parameters which determine the potential of Recovery of Energy from Wastes (including MSW), are:

- Quantity of waste, and
- Physical and chemical characteristics (quality) of the waste.

The actual production of energy will depend upon specific treatment process employed, the selection of which is also critically dependent upon (apart from certain other factors described below) the above two parameters. Accurate information on the same, including % variations thereof with time (daily/ seasonal) is, therefore, of utmost importance.



FIG(3) Benefits of converting waste into energy.

Table (1) Desirable range of important waste parameters for technical viability of energy recovery:

Waste Treatment Method	Basic principle	Important Waste Parameters	Desirable Range*
Thermo-chemical conversion -Incineration -Pyrolysis -Gasification	Decomposition of organic matter by action of heat.	Moisture content Organic/ Volatile matter Fixed Carbon Total Inerts Calorific Value (Net Calorific Value)	< 45 % > 40 % < 15 % < 35 % >1200 k-cal/kg
Bio-chemical conversion	Decomposition of organic matter by microbial action.	Moisture content Organic /	>50 % > 40 %

[1]**Waste-to-Energy**) WtE) technology, p2, *www.moraassociates.com/.../0707%20Waste*

7. ENVIRONMENTAL ISSUES AND OPPORTUNITIES:[1]

Waste to energy facilities encompass a number of environmental considerations that range from emission controls to the potential generation of greenhouse gas offset credits. Potential air emission issues from waste to energy plants include the discharge of a range of contaminants including dioxins and furans, heavy metals, particulates, sulphur dioxide and nitrogen oxides. The adoption of standard operating procedures and modern air pollution control equipment effectively controls each of the contaminants listed above, ensuring that the most stringent emissions standards can be achieved. Operation of a WtE facility can result in reduced greenhouse gas emissions. One significant area of potential reductions is in avoided emissions associated with land filling of waste. Land filling of MSW results in the creation and emission of methane as the waste gradually decomposes.

Table (2) percentage of saving energy by adapting recycling process[2]

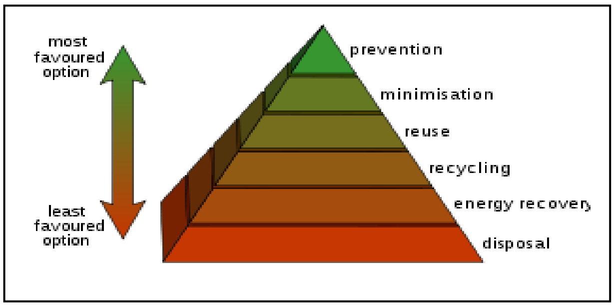
Recycling process	Percentage of saving energy
Aluminum	96%
Steel	74%
Papar	70%
glass	22%

8. Sustainable system for solid waste management:

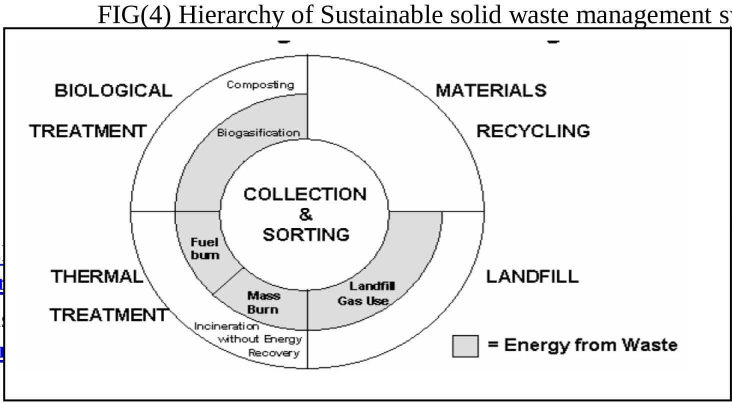
That system depend on the sustainable environmental policy that based on the 4R(see fig (4,5))

1- Reduce: the waste from the sources and reduce the material weight through the industrial process to minimize the lost in natural resources
2- Re-use : the re-use of good part of any engine or machine that can be use and not damaged to minimize the energy consumption in making new parts
3- Recycle : it mean we can minimize the energy consumption and reserve natural resources
4- Recovery : it means we can generate energy from the waste

Recycling 1Ton of steel saving 900kg of raw steel
Recycling 1 ton of glass saving 1.5 ton of sand
Recycling 1 ton of paper saving 8- 10 trees



FIG(4) Hierarchy of Sustainable solid waste management system



[1] WASTE TO E
www.yukonener

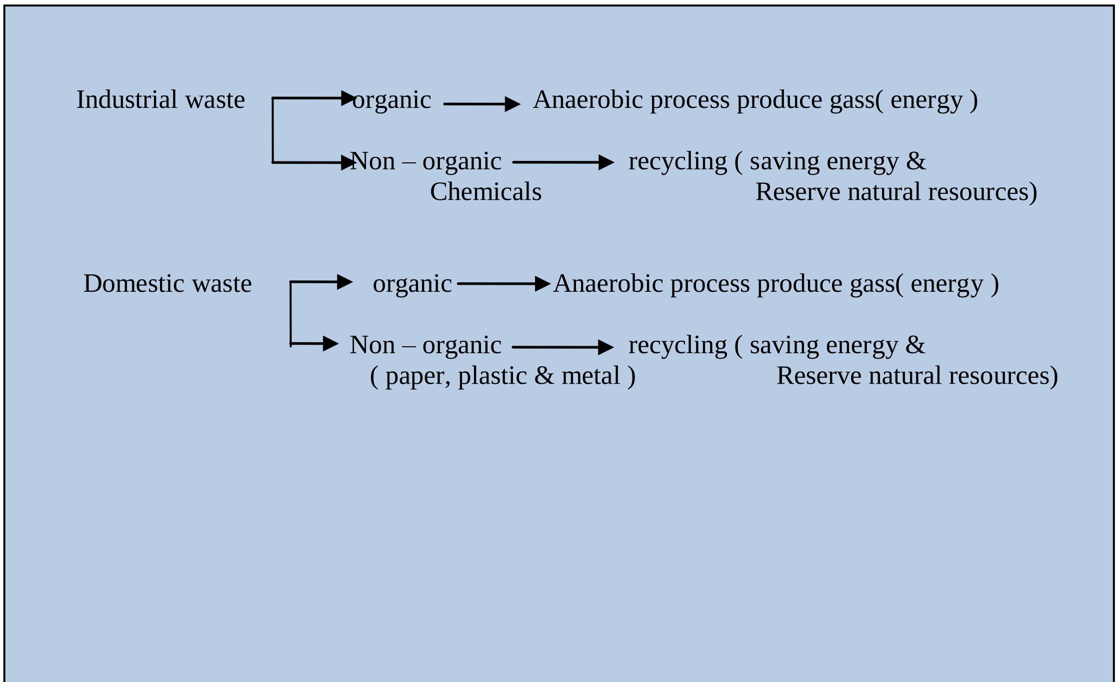
[2] **Taking** respon
www.bmu.de/e
Berlin, 2009,p.37

FIG. (5) Elements of Sustainable management system for solid waste
source http://viso.ei.jrc.it/iwmlca/

9 . The environmental planning process for the solid waste management proposal need to:

1- screening at the housing unit. Waste sorting helps to reduce the effort, time and cost.
2- Environmental Awareness.
3- raised manufacturing plants for waste sorting and baling befor recycling .
4- marketing recycling products (paper, aluminum, iron, glass, plastic)
5- enact laws that encourage the sorting and recycling
6- investment in the areas of clean energy
7- built interaction relations between sectors (energy, agriculture, industry)

10 .The search proposal



Trading waste ⟶ carton,paper & plastic ⟶ recycling (saving energy & Reserve natural resources)

Agriculture waste ⟶ organic ⟶ Anaerobic process produce gass(energy)
Then Aerobic processes(high sludge production)

The rest of all waste after all process above ⟶ recovry
Then dump the ashes

11 .The benefits of the proposal

1-generat clean electric power (methane)
2-waste disposal, which make up improper scene
3- alleviate the environment from pollution and disease
4- use the output of the aerobic degradation of the production of organic fertilizers
5-. provide jobs
6- conserve natural resources
7- rationalize the use of electric power, thus reducing the pollution resulting gaseous
8- reduce the amount of land is wasted annually in the administration of landfill sites
9 - maintain the underground water from pollution, which is produced from landfill sites

12 .conclusion :

1- Studies show that the recycling of materials has environmental and energy advantages over combustion with extraction of energy, on the condition that the recycled materials are really used to replace new raw materials, such as raw materials from forestry or crude oil.
2- The recycling of plastics yields substantial advantages over combustion, for example in terms of reduced energy usage and reduced emissions. Recycling of metals contributes to reduced energy
3- Present trends indicate a move away from single solutions such as mass burn or landfill towards the integration of more advanced WtE technologies, based on setting priorities for waste treatment methods consumption and environmental impact. For instance, it is 95% less energy-intensive to produce aluminum from recycled aluminum products than from aluminum ore.
4- These include waste minimization, recycling, materials recovery, composting, biogas production, energy recovery through RDFs, and residual land filling. This approach favors the integration of incineration within a range of complementary approaches.
5- The means for integrated waste management in order of preference, are:
   - Materials recovery by recycling.
   - For food and yard wastes only: fuel/soil recovery by anaerobic bio-conversion (generation of methane gas); or soil recovery by aerobic bio-conversion (composting).
   - Energy and materials recovery by combustion or gasification.
   - Land filling of materials that are neither recyclable nor combustible.

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