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Waste Management and Waste to Energy

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Abstract : Waste is currently a critical issue for society as a whole, due to the environmental pollution it causes, the threats it poses to human health, and its impact on climate change. The amount of waste is increasing annually everywhere. Therefore, it is imperative to research and work on ways to reduce the amount of waste, while also expanding the process of recycling waste into useful materials or converting it into energy.

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I. INTRODUCTION

The waste collected daily in cities, villages and everywhere on earth becomes the biggest problem for humans, animals, plants, climate and natural disasters

These wastes, whether specific to residential areas or factories or livestock farms, are generally a problem and must be addressed because they have a significant impact on the future of the earth.

With the advancement of technology and lifestyle, the use of materials that constitute the main components of waste, such as plastic, glass, paper, and metals, to preserve the food people consume, has increased dramatically in recent years. This waste accumulates as a result of the food people consume, significantly threatening the environment and human health. Waste management is a pressing issue because it affects the entire world. Excessive waste production has negatively impacted our environment. Waste reduction and assessment efforts must be taken to a higher level, be global, and waste management must be more coordinated, because its impact affects everyone.

- *Waste: Origin, Classification, Processing, and Recycling*

Waste is currently causing environmental pollution and threatening human health. According to the World Bank reports , the annual amount of municipal solid waste that produced has increased to 2 billion tons and is expected to reach 3.4 billion tons by 2050. This is a serious warning sign regarding the global waste management issue. Therefore, waste recycling methods should be sought, and awareness and responsibility for environmental protection should be raised. Figure 1.

Fig 1 Waste Land

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- *Based on its Source, Waste is Divided into Three main Groups:*

Industrial waste, agricultural waste, and domestic human waste and Medical waste

✓ Industrial waste is generated in factories and includes types such as metals, plastics, chemicals, and others.

✓ Agricultural waste is generated from agricultural and livestock activities, including livestock waste and weeds.

✓ Domestic waste is generated from daily human activities, including food waste, packaging materials, utensils, and plastic water bottles.

Domestic waste constitutes the largest proportion, approximately 60%, of total global waste. Therefore, it is important to understand its source so that everyone can effectively sort waste and, consequently, reduce its impact on the environment.

Domestic waste can be classified into three main types: organic waste, inorganic waste, and recyclable materials. Figure 2

- Organic waste is waste derived from plants and animals, such as food scraps, fish, meat, fruits, vegetables, paper, etc.
- Inorganic waste includes materials that cannot be reused or recycled, such as rubber, broken glass, wood, stone, and bricks.

E-Medical waste is waste that is potentially infectious or biodegradable. Medical waste may include waste generated by a medical facility or laboratory, and waste generated by research centers and laboratories that contains particles or organisms that are not permitted to be released into the environment. As explained below, sharps are considered medical waste and must be disposed of, whether contaminated or not, due to the potential for blood contamination and injury if disposed of improperly. Medical waste is a type of biological waste. Medical waste can be solid or liquid. Examples of infectious medical waste include contaminated blood, sharp instruments, unwanted microorganisms, discarded body parts, other human and animal tissue, used bandages and gloves, and other medical equipment that may have come into direct contact with blood or body fluids. Laboratory waste that exhibits one of the above characteristics, and sharps waste, include contaminated needles, scalpels, and lancets, whether used or unused, that have been discarded, and other instruments capable of penetrating the skin. 1. Recyclable waste includes products such as plastic bottles, cardboard boxes (paper), and aluminum can peels.

Wastewater has varying characteristics, as it is discharged from various sources, such as homes, businesses, industries, and agricultural facilities. Some wastewater contains non-toxic inorganic materials or toxic organic materials. Households generally produce wastewater from toilets, sinks, dishwashers, washing machines, bathtubs, and showers. Wastewater is usually transported to sewer systems. A sewer system consists of pumps, filters, pipes, and conduits that transport waste from its source to a treatment or disposal point. It can also be transported through combined sewers, which contain rainwater and industrial wastewater. After treatment, wastewater is discharged into a body of water. Treated wastewater can be used for other purposes or discharged into the environment. Without proper treatment, wastewater becomes a source of water pollution. It is common to place all types of waste in a single bag. However, these waste bags often contain various types of waste, such as food scraps, beverage cans, tin can hulls, and glass jars, without undergoing any sorting procedures, reducing recyclability. The easiest way to address this problem is to separate materials at the source. If people can accurately sort waste at the source, the collection and subsequent processing process becomes faster and easier. One effective way to implement this process is to use three-compartment trash bins, similar to those often seen in public places in some countries.

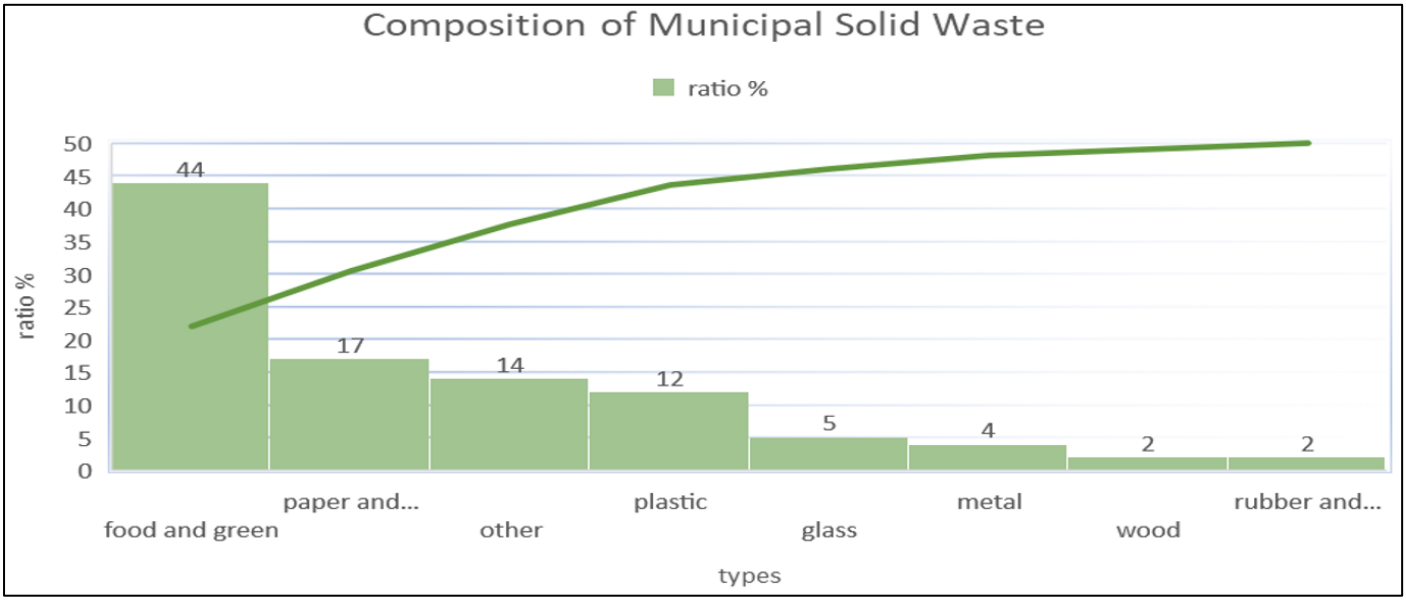

Fig 2 Composition of Municipal Solid Waste

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➢ *Waste Causes*

- *Human Causes*

✓ *Deforestation*

Plants play a major role in maintaining the ecological balance by absorbing carbon dioxide and releasing oxygen, so depleting forests for local and commercial purposes leads to an imbalance in the ecological balance, and thus increasing global warming.

✓ *Use of Fuel Vehicles*

Vehicles emit various gases even if they are for short distances, as they burn fossil fuels that emit a large amount of carbon dioxide in addition to several other gases, which leads to an increase in temperature.

✓ *Chlorofluorocarbons*

Humans have added chlorofluorocarbons to the environment, which appear in air conditioners and refrigerators, which affected the ozone layer in the atmosphere, which is the layer that works to protect the Earth's surface from harmful ultraviolet rays emitted by the sun. These compounds disrupted the balance of the ozone layer, which made way for harmful rays that led to an increase in the Earth's temperature.

✓ *Industrial Revolution*

Industrial development led to an increase in the emission of harmful gases from factories that played a major role in the rise in temperatures.

- *Natural Causes*

✓ *Volcanoes*

Among the biggest contributors to global warming, due to the ash and smoke emitted into the atmosphere as a result of volcanic eruptions, which negatively affects the climate.

✓ *Water Vapor*

The increase in the Earth's temperature causes an increase in the evaporation of water bodies, and this resulting vapor remains in the atmosphere, which increases the phenomenon of global warming.

✓ *Melting Ice*

There is a group of greenhouse gases under the ice and glaciers, which are released into the atmosphere by melting ice, affecting the Earth's temperature.

✓ *Forest Fires*

Large amounts of carbon dioxide are emitted as a result of forest fires, which leads to an increase in the Earth's temperature, and thus an increase in global warming.

➢ *Zero Waste is a Revolution*

Billions of tons of waste are produced annually. The concept of zero waste represents a revolution in the way we manage our limited natural resources. The transition to zero waste has played a key role in the growing recognition of the powerful role the waste sector plays in mitigating climate change, particularly through reducing methane emissions. The current extraction system favors the unlimited extraction of raw materials, perpetuates the waste of natural resources, and sacrifices people's health and well-being for unchecked consumption. This status quo is damaging our health and our planet, threatening life on Earth in the future. Zero waste focuses on creating systemic change by transforming the way we use materials and promoting a new regenerative cycle that puts people and planet first. Through political, financial, and rhetorical shifts, these efforts create the conditions for systematic support for zero waste systems, focusing on:

- International and domestic funding for zero waste systems and campaigns
- Zero waste roadmaps and regulatory frameworks that support their implementation and sustainability
- Inclusion of zero waste targets in local and national climate plans, such as Nationally Determined Contributions (NDCs) and methane reduction roadmaps.
- It is important to focus on reports and research that confirm the need for and effectiveness of zero waste systems.
- Preserving the definition and principles of zero waste is part of the new mission, as it is essential to protect the sustainability and legitimacy of zero waste as a solution. Preventing environmental misinformation through clear zero waste messages will help ensure that investments and efforts are effectively directed toward solutions that truly prioritize people and the planet over the long term, while foregoing some short-term and narrow interests.

➢ *Building a Zero Waste Movement*

The global transition to zero waste is a long journey that requires global support, sustained effort, and solidarity across movements by:

- Providing support to all players driving zero waste systems – from citizens and community organizers to decision-makers and officials at the local, national, and global levels.
- Facilitating the mainstream adoption of zero waste. By building more technical capacity among waste management consultants and other zero waste practitioners, we help establish zero waste practices as the most appropriate and effective approach to waste management. Zero Waste Academies, Zero Waste Master Plans, and practical tools for implementers are just a few of the technical capacity building resources available to those looking to make zero waste possible in their cities. All knowledge is based on research and field experience. Part of the mission in this regard includes recognizing and promoting local, community, and indigenous knowledge, as well as learning through practice.
- Fostering solidarity and collaboration with grassroots organizations and allies such as the International Waste Pickers Alliance, the Movement, and climate justice organizations. Building strong networks is key to maximizing local impact, reaching national bodies, and increasing community engagement and public support for achieving zero waste in order to ultimately create systemic change.

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➢ *Building Zero Waste Cities*

More than 550 municipalities around the world are already taking steps to transition to zero waste systems – and seeing the environmental, economic and social benefits.

For municipalities to implement zero waste systems, they must work on five key pillars:

- Set a goal to end waste disposal in landfills, dumps, incinerators and other methods
- Hold producers accountable for waste design and reduce material use
- Encourage responsible consumption that stays within environmental limits
- Build systems and infrastructure to recover resources at their highest and best use
- Prioritize social and environmental justice, with a special focus on waste pickers and communities on the front lines and encourage them

By providing technical assistance to municipalities, investing in a wide range of case studies that provide replicable solutions for diverse local scenarios, and producing certification systems for zero waste cities and zero waste companies.

➢ *Effective Tips for Reducing Household Waste and Achieving Sustainability*

Sustainability and reducing household waste are becoming increasingly important in our modern world, where environmental challenges are becoming more and more apparent. As we witness the increasing impacts of climate change, it is the responsibility of every individual and organization to pave the way for a sustainable future by taking practical steps to reduce waste in our homes.

In this article, we will give you some actionable tips for reducing waste and waste in the home, providing insights into how simple changes can make a big impact in reducing household waste and improving sustainability.

- *Adopt the Principles of: Reduce, Reuse, and Recycle*

The cornerstone of managing waste and waste effectively are the following three principles:

✓ *Reduce Waste*

Try to reduce the amount of things you buy and use.

✓ *Reuse*

Before throwing something away, think carefully about whether it can be used again, or reused (we will discuss more about reuse methods in point 6).

✓ *Recycle*

If something has expired, check its recycling program.

These three principles form the core of waste management and household waste reduction, as every household can make a real difference in reducing environmental pollution and promoting sustainable living. Instead of throwing away old possessions and replacing them with eco-friendly products, it is better to use them until they are completely unusable, then start switching to sustainable alternatives.

Instilling these principles in future generations also contributes to creating a more environmentally conscious future, as reducing household waste becomes a daily habit that contributes to reducing negative environmental impact in the long term.

- *Participate in Composting*

Composting is not just a trend; it is a sustainable way of life; as you can convert organic waste into nutrient-rich fertilizer by creating a special composting system for your garden or balcony, this reduces the amount of waste sent to landfills and provides an organic solution to feed plants, based on an integrated approach to waste management.

✓ Tip: Work with your friends and family to collect plant food scraps from your homes and send them to local farms that produce organic fertilizers. In this way, you are working together in a greater community effort.

- *Switch from Paper to Cloth*

We may forget about the amount of solid waste we produce daily in our homes, due to our use of single-use paper products, but by applying some simple tips, we can greatly reduce the amount of waste we produce in our homes, such as using cloth towels instead of paper towels; cloth towels or cloth table napkins are environmentally friendly and add an elegant touch to the dining table. In addition, buying high-quality cloth products is also a great step so that they do not spoil quickly and we have to throw them away, which saves money in the long run; because we will continue to use them for a longer period than low-quality products.

- *Rely on Reusable Containers*

Disposable plastic is completely rejected according to sustainable environmental laws; it greatly affects our environment. Therefore, we must choose containers that can be used multiple times and for different purposes; starting from storing food to preserving drinks. This will enable us to combat the problem of increasing plastic waste. Reusable materials can also be used, such as: water bottles, or coffee cups, which reduces our dependence on plastic. This comprehensive change in the way we deal with resources enables us to live better lives and helps us to preserve the environment in an easier and more realistic way.

- *Smart Shopping*

Smart shopping makes a big difference in reducing waste! When we buy our household supplies in bulk, we reduce the amount of boxes and packaging that comes with cleaning products or food products. In addition, choosing products with less packaging or with recyclable packaging contributes more to the mission of reducing waste.

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As consumers, we also have a big impact on this point; when we support brands that focus on sustainability, use recyclable packaging to preserve their products, or environmentally friendly manufacturing methods, we are able to direct the market in the way we want.

- *Repair Instead of Replacement*

In today's consumer culture, there is a trend towards replacement rather than repair. However, by repairing broken things, we save money and significantly reduce waste, thus reinforcing the sustainability approach. This approach also enhances the appreciation of the value of things, and encourages a culture of care and maintenance, which can extend the life of the things we own. Remember the three principles we mentioned above; they fit perfectly with the concept of repair.

- *Reduce Technology Waste*

In our digital age, waste from electronic devices is a growing problem; when old devices, batteries, and any electronics are thrown into landfills, they release harmful chemicals into the environment. Therefore, minimizing the disposal of electronic waste, which includes using electronic devices more consciously, and reducing unnecessary consumption of electronics. Recycling electronic devices, disposing of them in safe ways, or repairing and upgrading them, can make a big difference in reducing the amount of electronic waste and its harm to the environment.

- *Spread Awareness*

Sharing knowledge and spreading awareness about the need to manage waste and solid waste can change the course of events in our world forever. When we talk to friends, family, and the community about ways to reduce the amount of waste in our homes, we inspire others to live healthier and promote their concept of environmental friendliness. Whether through community workshops, or sharing

➢ *A Solution from the Source*

A local company in Kurdistan Regional Government / Duhok province, within the framework of a new initiative with the direct assistance of citizens, has installed different buckets to separate daily waste from citizens in the houses, with the aim of recycling and fighting environmental pollution.

"It used to be very difficult to separate household garbage, so we thought of going back to the source of the problem, installing the solution inside the households themselves, so we renewed the contract to install garbage separation buckets for households," he said.

The company has been collecting garbage from the three districts of Akre, Sheikhan and Bardarash since 2011, but has been implementing the initiative to separate waste by citizens for two years.

The initiative is not only for households, but the market in general covers restaurants, shops, cafes and other places, along with mosques and government offices. Everywhere there are buckets or containers for dry waste such as cardboard, glass and cans that are not mixed with wet and food waste.

In the neighborhoods where cars are not accessible, where the streets are very narrow, garbage is collected by calves, which are supervised by several citizens. They have 165 vehicles for collecting garbage, which go to different areas of the three districts daily and what they collect is delivered to the factory, for complete separation and then pass through the treatment stage.

200 to 250 tons of garbage is collected daily in all three districts, cardboard, glass, cans and food are separated, this step is easier for us and the workers who collect garbage,

Citizens are on one front and the main key to the success of the waste separation initiative in the waste separation process

The 200 to 250 tons of garbage collected daily is sent directly to the factory headquarters. The company has three recycling machines, one for iron waste, another for glass and the rest for aluminum and other waste.

"Waste such as cardboard, nylon, plastic and the like, after being dumped in a special place, move on a wide belt towards the factory and go to the workers, where a number of employees stand next to each container," he said.

It is worth mentioning that some of the separated waste is dried separately and after cleaning, with special equipment, then capsized and some of them are sold to other local companies that produce products and some are sent as raw materials to Turkey and Iran.

"Half of the revenue goes to the company and the other half to the municipalities of the three districts," the company said.

II. THE IMPACT OF HOUSEHOLD WASTE ON HUMAN HEALTH

➢ *Health Risks of Household Waste:*

- Respiratory diseases, infectious diseases, and skin diseases, such as skin allergies.
- The spread of insects that carry microbes and dirt: flies, mosquitoes, and cockroaches.
- The accumulation of animals that carry epidemics and diseases (stray dogs, cats, rats, and mice), in addition to the unpleasant odors resulting from the rotting of household waste due to germs, bacteria, and parasites.

➢ *Reasons for the Spread of Waste:*

- The use of improper waste disposal methods, such as throwing waste outside of designated containers.
- The inability to accommodate the enormous amount of waste in designated landfills, which loses its primary function and becomes a source of germs and unpleasant odors.

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- The slow disposal of waste by sanitation workers.

➢ *How to Reduce the Harmful Effects of Household Waste:*

Awareness of the dangers of household waste and its reduction must be achieved by taking the following measures:

- Educating citizens about the health and environmental risks of household waste through awareness campaigns to discourage negative behaviors such as throwing garbage in non-designated areas;
- Educating students about cleanliness and raising their environmental awareness of the dangers of household waste;
- Creating civil society organizations to promote the cleanliness of alleyways;
- Putting waste in plastic bags and sealing them tightly, ensuring they do not contain any holes;
- Preventing the indiscriminate burning of waste;
- Providing a sufficient number of containers designated for disposing of household waste within residential communities, capable of accommodating large amounts of waste throughout the day;
- Collecting household waste by sanitation workers assigned to dispose of it twice daily instead of once to prevent it from accumulating outside landfills.

➢ *Iraq's River Pollution*

Iraq's rivers are facing "catastrophic" pollution due to reasons, most notably the leakage of sewage and medical waste, which doubles the crises of Iraq, which suffers from drought, and other crises caused by decades of conflicts that destroyed its infrastructure fig3.

The government institutions themselves are behind part of the pollution of Iraq's rivers, while the competent authorities are struggling to confront this scourge that threatens public health in Iraq. Only about half of Iraq's population has access to "potable water," according to United Nations statistics. The population is 43 million.

Iraq's river pollution doubles due to drought ,In the oil-rich country whose production consumes a lot of water, the risk of pollution increases with the steady increase in water scarcity due to drought, climate change, and disputes related to the distribution of water shares between Mesopotamia and neighboring countries. The concentration of pollution in rivers increases in parallel with the decline in water levels.

"The sewage departments are dumping large quantities (of sewage) into the Tigris and Euphrates rivers, without undergoing complete treatment or after simple treatment," he said, noting that "most hospitals near the river dump their waste and discharge sewage directly" into it, and this is a "dangerous and catastrophic" matter.

Treated wastewater reused in agricultural irrigation must comply with the standard criteria and conditions specified in this regulation.

A physical and chemical analysis of the soil properties on farms benefiting from treated wastewater must be conducted in the laboratories of the Ministry of Agriculture or one of its accredited laboratories to monitor and evaluate the effects of using this water on the soil.

It is prohibited to connect or link treated wastewater pipes to well network pipes inside farms.

It is prohibited to open feed points with treated wastewater for farms except by persons accredited by the Ministry of Agriculture. Treated wastewater pipes must be distinguished from other pipes by using a specific color or clear warning tapes.

The beneficiary of treated wastewater must take the necessary measures to prevent the formation of swamps, and prevent the proliferation of flies, mosquitoes and other insects.

If a swamp forms, the beneficiary must spray and fill it within three days.

Every irrigation system that uses treated wastewater and all networks that transport this water must have signs installed in places specified by the competent authority that read: “Warning – Treated wastewater – for irrigation only.”

Fig 3 (A) Waste to River

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We see the same situation in the river that flows out of the Dokan Dam, as all the sewage enters the riverbed, which leads to water pollution and is transferred to drinking water networks, and has a disastrous effect on human health. According to follow-ups, the rate of kidney disease in these areas is high. FIG 3 /b/ waste to river.

Regarding the effect of sewage entering rivers and seas, in Canada, a species of fish that used to be abundant but is now declining after a lot of research showed that the reproductive activity of this species is very low The fish were infertile as a result of sewage entering the sea and the effects of female infertility drugs were transmitted to them from the sewage.

Fig 3 (b) Waste to River in TaqTaq City

➢ *Environmental Pollution in Erbil*

Has created a serious threat to the lives of citizens of the city, according to the latest statistics for cancer patients in the province is at a dangerous level and 50% of patients in the region are in Erbil Rezna Majid, head of the Erbil center of the Green Kurdistan Association, asked Kurdistan New about the causes of environmental pollution in Erbil. He said: Erbil as the capital of the Kurdistan Region is growing day by day and the population is increasing, so the causes of environmental pollution in Erbil in general and the air in particular is increasing Erbil There are a large number of illegal factories and refineries, which do not meet any environmental requirements and some even have licenses, but environmental requirements After the refineries, there are many vehicles in Erbil that use poor quality fuel due to the lack of public transportation. There used to be 30-meter, 60-meter and 100-meter buses in Erbil They will have to use their own cars to get around. Another reason is the large number of private generators that work for several hours a day due to lack of electricity, and another reason for environmental pollution in Erbil, especially its soil, the use of plastic materials by citizens, Unfortunately, cancer in Erbil is at a very high level, so that Erbil has the lion's share of the whole of Iraq, people are diagnosed with cancer every day, in addition to many other diseases have increased in Erbil Shortness of breath and sensitivity of the skin, throat, nose and eyes also affect agriculture and animals, especially Agricultural land near refineries and factories, some plants dry up or deciduous trees produce very little, leaves of trees, plants and greenery in general in these areas are distorted and animals suffer from various diseases.

➢ *Recycling in the Kurdistan Region*

Thousands of tons of garbage collected daily by companies in the Kurdistan Region, most of it is still buried or burned, which is harmful to the environment, air and soil, the main solution is recycling and the Ministry of Municipalities He said that some projects have been implemented in the Kurdistan Region and a number of other projects will be implemented in the future, aiming to recycle at least 90% of garbage.

Two recycling projects have started in Sulaimani and Duhok provinces, while large and small projects are underway in Erbil and other places Bring garbage from Kurdistan and recycle more than 90% of garbage.

A local company operates in Sulaimani with a recycling capacity of 90% and converts 1,100 tons of garbage into other products daily. Meanwhile, there is a factory in Duhok that recycles garbage biologically and treats 250 tons of garbage daily. It converts 1,100 tons of garbage into other products daily.

In Erbil, a Belgian company plans to recycle the garbage, the standard is much higher than others and has the ability to recycle 95% of garbage, which is a high rate and a big problem for the capital Erbil opens the door. The Ministry of Municipalities is in talks with the company and good steps have been taken to start work.

According to Shaban, a factory is under construction in Chamchamal that is 53% completed, another factory is under

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construction in Amedi that is 85% completed and other projects have started in Said Sadiq and Zakho They have been implemented.

Through recycling plants, in addition to electricity, plastic products, chemical foam and a number of other products can be made and reused, which has great economic benefits for the country, on the other hand, prevent pollution does the environment.

According to the latest statistics of the Ministry of Municipalities and Tourism, the amount of garbage collected daily in the Kurdistan Region has reached 6,829 tons.

The daily garbage collection in the Kurdistan Region has reached 6,829 tons.

Erbil, the capital of the Kurdistan Region, collects the most garbage, reaching 2,370 tons per day, followed by Sulaimani with 1,480 tons and Duhok with 1,320 tons. 113 tons of garbage will be collected in Halabja, 397 tons in Garmian, 476 tons in Raperin, 360 tons in Soran and 314 tons in Zakho.

All the garbage that is the result of spending a lot of capital can be recycled and part of that capital can be recovered and prevented from being wasted. In fig/4 show daily waste in Kurdistan reginal government in Iraq according to each provinces in 2018 it is clear that a lot of efforts need to deal with this amount of waste.

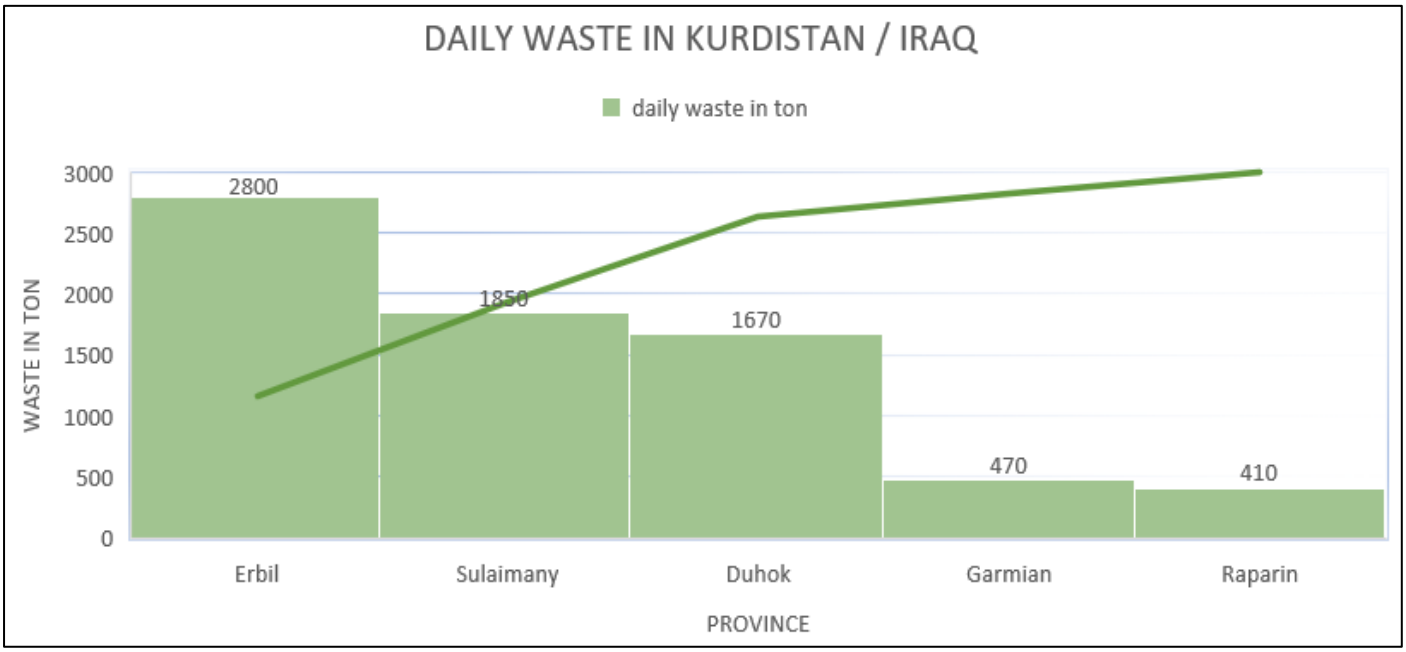

Fig 4 Daily Waste in Kurdistan / Iraq

➢ *Combustion: Burning up what's Left Behind*

First up, combustion. This is where heat produced by burning waste produces heat, driving a turbine to generate electricity. This indirect approach to generation currently has an efficiency of around 15-27%, albeit with a lot of potential for improvements. Whether any approach to generating energy from waste

A waste incineration process can be considered sustainable based on the "net calorific value" of the waste involved. For waste incineration, this figure should be 7 MJ/kg, meaning that materials such as paper, plastics and textiles are best suited to the combustion method for generating energy from waste.

➢ *Gasification: Waste's a Gas*

Gasification is not about powering turbines directly, but about producing gas from waste. The waste we throw away every day—product packaging, grass clippings, furniture, clothing, bottles, appliances, etc.—is not fuel so much as food for chemical conversion at extremely high temperatures. The waste is combined with oxygen and/or steam to produce "syngas"—gas that can then be used to make a variety of useful products, from transportation fuel to fertilizer or converted into electricity.

The problem is that gasification is often followed by combustion, which creates some of the same emissions problems as combustion. The same problem can apply to what happens after the waste has been thermally decomposed.

Gasification is also not a particularly efficient way to produce energy, as pretreatment requires a lot of energy, and reactors must be shut down for regular cleaning.

Of course, combustion produces emissions—250 to 600 kilograms of carbon dioxide per ton of waste processed—but this is offset by the fact that fossil fuels do not need to be burned. However, other pollutants are emitted from combustion in the form of flue gases. Figure 5.

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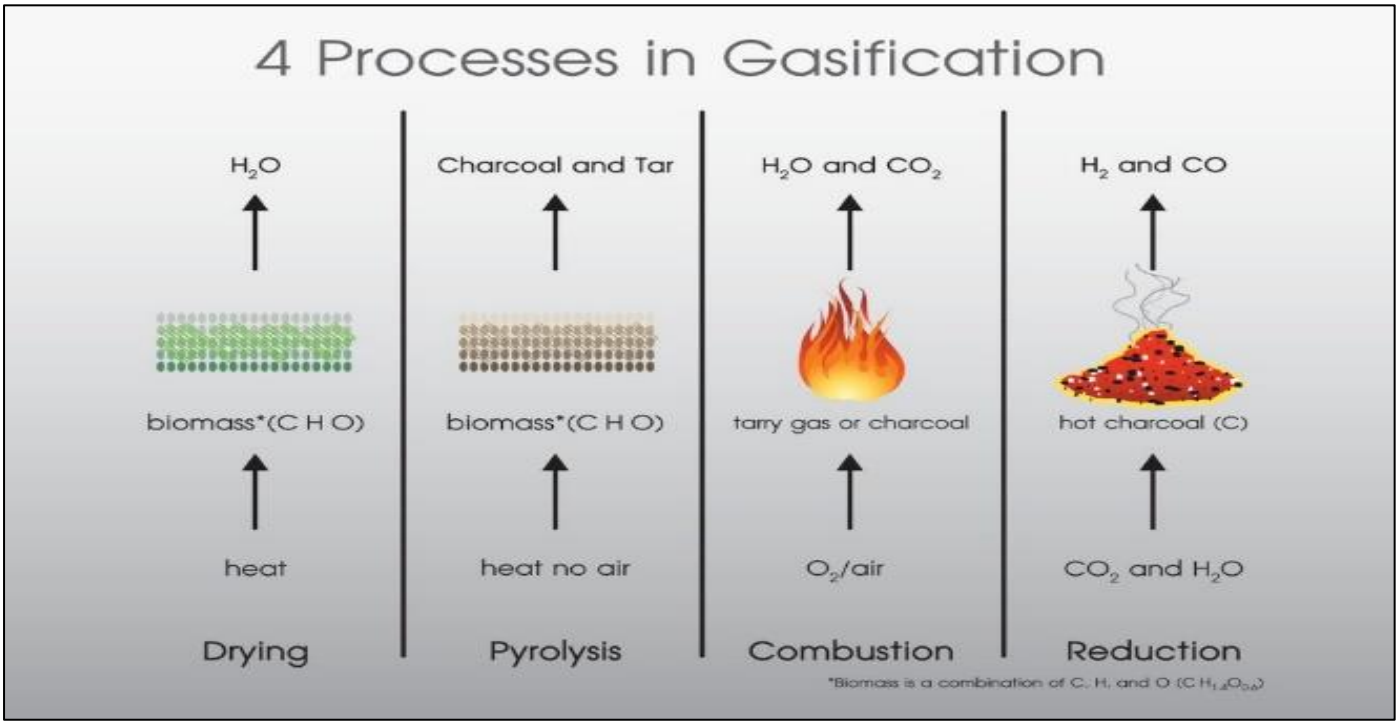

Fig 5 Gasification Process

➢ *Pyrolysis: No Oxygen, No Trouble?*

What is unique about the pyrolysis process is that the decomposition of various solid wastes takes place at high temperatures, but without oxygen or in an atmosphere of inert gases. This means that the process requires lower temperatures, and emits fewer emissions of some of the air pollutants associated with combustion. However, it should be noted that Friends of the Earth does not consider energy generated through gasification or pyrolysis to be truly "renewable" due to the fact that it releases carbon dioxide from fossil fuel sources such as plastics and synthetic textiles as well as biological materials.

➢ *Tackling Organic Matter*

Animal manure is a lost investment opportunity in a number of Arab countries. In American cow and pig farms, and a number of European countries, animal manure is collected in a large pit, mixed with water and some fermentation stimulants, which produces methane gas, which is collected and sold to a nearby power plant, or used on the farm itself either to generate electricity locally or to heat water. In short, waste-to-energy projects achieve several economic and environmental goals, in addition to serving the community. There are few projects that achieve such goals combined.

Anaerobic digestion can be used to generate energy from organic waste such as food and animal products. In an oxygen-free tank, this material is broken down into biogas and fertilizer.

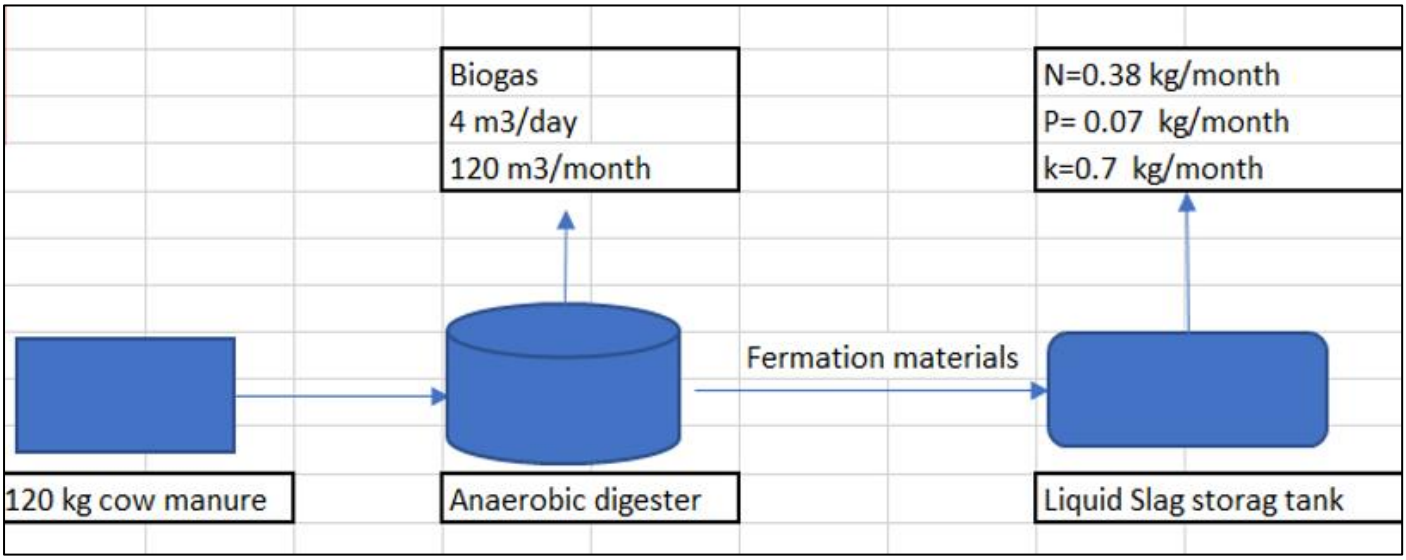

Fig 6 Energy Production

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It's an approach with huge potential. If we treated 5.5 million tonnes of food waste this way, we would generate enough energy to serve around 164,000 households while saving between 0.22 and 0.35 million tonnes of carbon dioxide, compared to composting. Extracting biogas from biodegradable materials at landfill sites is another way to get useful energy from waste. Although this approach is in decline due to the declining amount of organic material going to landfill.

➢ *Converting Biomass to Energy*

Direct combustion is the most common method of converting biomass into useful energy. Biomass can be burned entirely directly to heat buildings and hot water for residential and commercial buildings, to provide heat for industrial processes, and to generate electricity in steam turbines.

Thermochemical conversion of biomass involves pyrolysis and gasification. Both processes are pyrolysis processes in which the biomass raw material is heated in closed, pressurized vessels called gasifiers at high temperatures. The processes differ primarily in the temperatures and amount of oxygen present during conversion.

The pyrolysis process involves heating the organic material to between 800 °F and 900 °F (400 °C and 500 °C) in the near-complete absence of free oxygen. Pyrolysis of biomass produces fuels such as coal, bio-oil, renewable diesel, methane, and hydrogen.

Hydrogen processing uses hydrogen to process bio-oil (produced by fast pyrolysis) at high temperatures and pressures in the presence of a catalyst to produce renewable diesel, renewable gasoline, and renewable jet fuel.

A chemical conversion process known as transesterification is used to convert vegetable oils, animal fats, and greases into fatty acid methyl esters (FAME) for biodiesel.

Biological conversion of biomass involves fermentation to produce ethanol and anaerobic digestion to produce biogas. Ethanol is used as a vehicle fuel. Biogas, also known as biomethane or renewable natural gas, is produced in anaerobic digestion at wastewater treatment plants and in dairy and livestock operations. Biogas is also formed in solid waste landfills and can be captured from them. Properly treated renewable natural gas has the same uses as fossil fuel natural gas.

Biomass provided about 5% of U.S. energy in 2023, Figure 7.

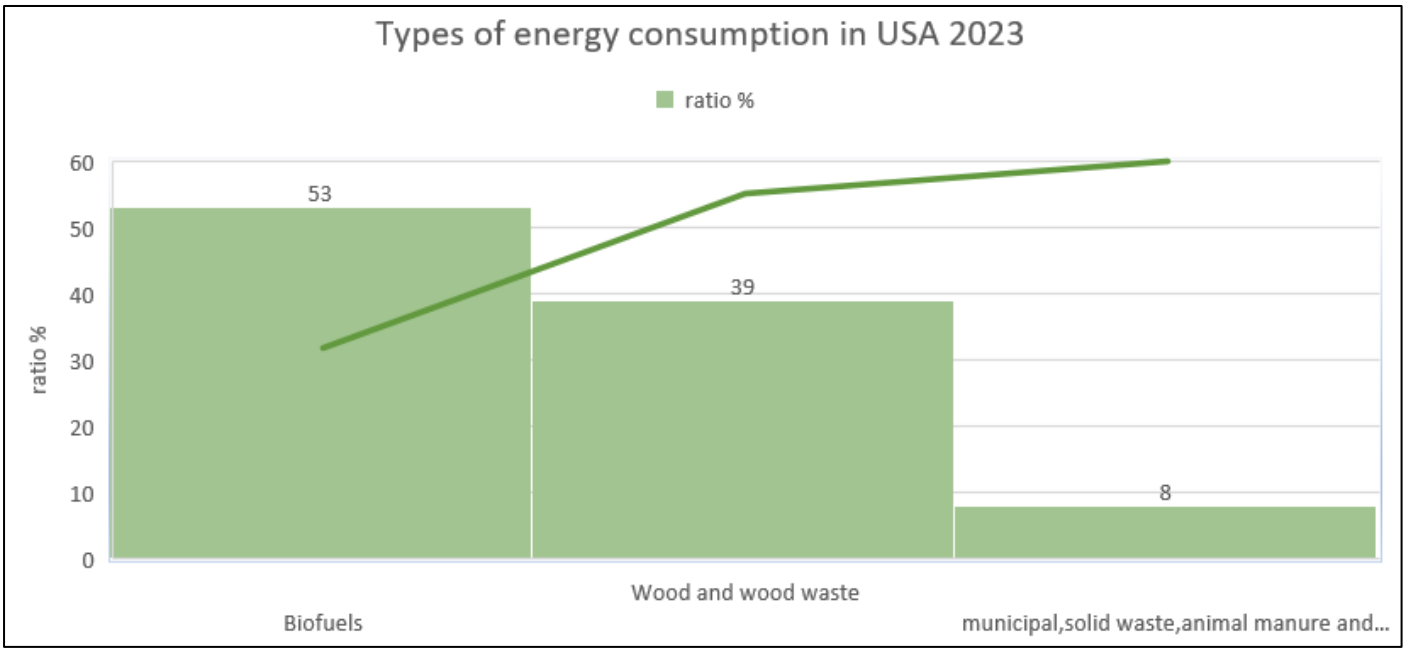

Fig 7 Types of Energy Consumption in USA 2023

➢ *What is Waste-to-Energy?*

Waste-to-energy refers to technologies that convert non-recyclable waste into usable energy sources such as heat, fuel, and electricity. Waste-to-energy, or energy from waste, is a form of energy recovery.

Using waste-to-energy technologies, non-recyclable waste is converted into valuable forms of energy. For example, waste is heated during combustion, creating superheated steam that drives turbines to produce electricity and rotates a factory.

Since most cities lack landfill sites—the traditional means of waste disposal—waste management has become essential. Governments must develop effective and sustainable waste management strategies, including waste-to-energy technologies, given the ever-decreasing amount of available land and growing urban populations.

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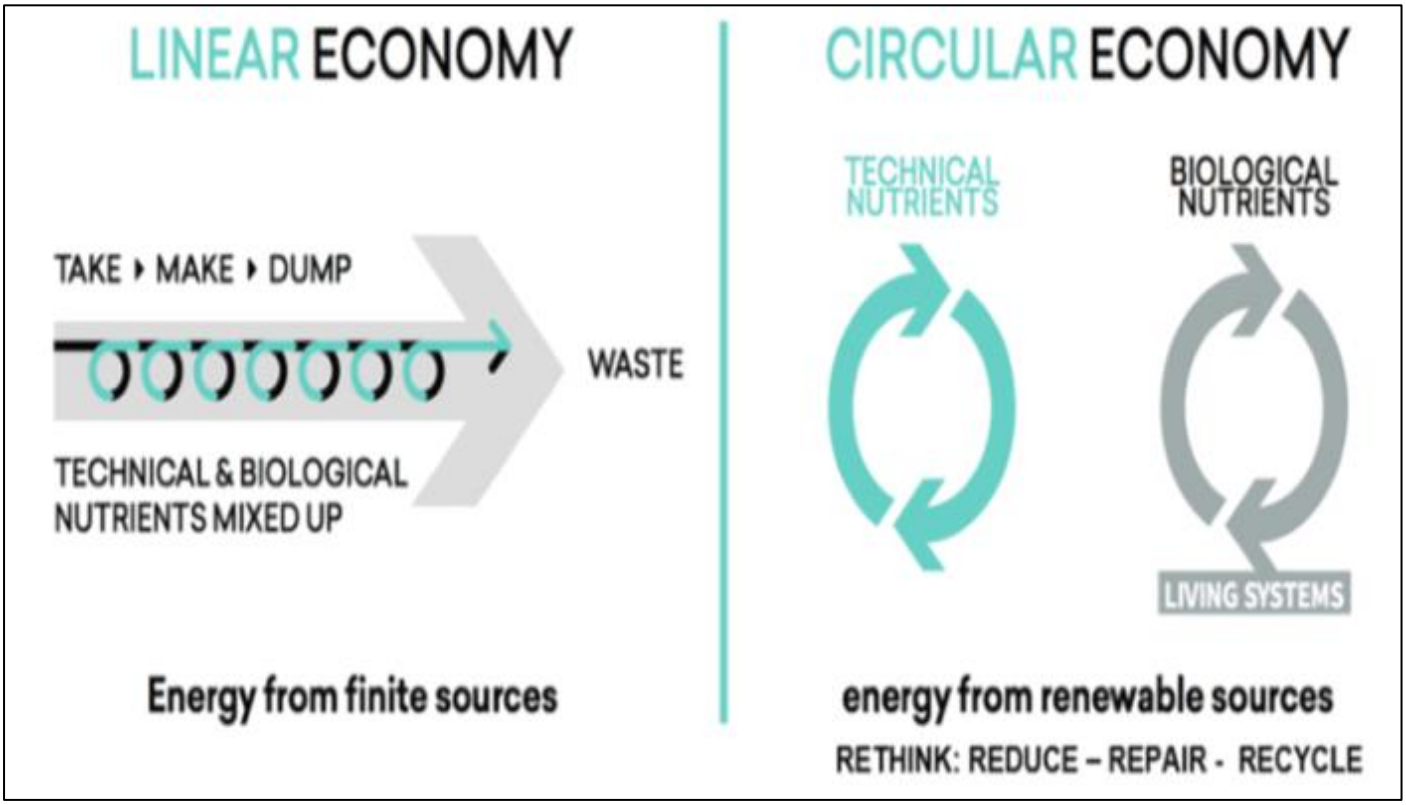

Fig 8 Energy Types

The circular economy can be thought of as a model of production and consumption that prioritizes sharing, renting, reusing, repairing and recycling existing materials and products.

➢ *Energy Generation through WTE in Different Countries.*

- *US*

There are currently 75 waste-to-energy plants in the United States, down from 87 about a decade ago. But a new $672 million incineration facility, the first in the

United States in more than 15 years, began commercial operation in Palm Beach County, Florida, in 2015. It produces 96 megawatts of electricity, enough to power about 40,000 homes and businesses.

- *Europe*

There are more than 499 waste-to-energy plants operating in Europe (not including hazardous waste incineration plants). These plants thermally process 99 million tonnes of waste each year. In 2019, 499 waste-to-energy facilities produced primary energy equivalent to 13.8 billion cubic metres of natural gas, which is about 9% of the natural gas imported into the EU from Russia. In Europe, Germany, France and the United Kingdom are the leaders in recovering energy from municipal solid waste resources, which replaces a proportion of gas.

- *China*

China has about 7.3 GW of waste-to-energy capacity, with 339 plants in 2017. • China is one of the prominent countries that installed the world's largest waste-to-energy plant (East Shenzhen Waste-to-Energy Plant) in 2019. The plant has a capacity to process 2.7 million tons of waste per year and is capable of generating 1.5 billion kWh of energy per year.

- *Thailand*

The Thailand government has created subsidies and tax incentives for various waste-to-energy plants, to encourage companies to investigate in this sector including waste incineration, gasification, fermentation and landfill gas capture. The current installed capacity is 203 MW.

- *UAE*

The UAE is at the forefront of Arab countries and the Middle East region seeking to implement waste-to-energy plants.

The UAE opened the Sharjah Waste-to-Energy Plant, contributing to diverting Sharjah's waste away from landfills completely and exploiting it, according to what was monitored by the Energy Research Unit.

The Sharjah station converts 300,000 tons of waste annually and burns it into energy, which contributes to raising the waste conversion rate from 76% to 100%.

The Sharjah station has a production capacity of about 30 megawatts of low-carbon electricity, to supply about 28,000 homes in the UAE with electricity, and contributes to saving 45 million cubic meters of natural gas annually. As a result, the Sharjah station contributes to preventing the emission of 450,000 tons of carbon dioxide annually,

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according to information monitored by the Energy Research Unit.

➢ *Waste Generation and Composition*

Fig. 9 shows the Average amount of municipal waste generated per capita in 2019. The unit generation rate in Iraq (excluding Kurdistan Region) is 1.26 kg/capita/day in 2019. The unit generation rate is calculated by dividing the waste collection amount by the population served by waste collection service .

Comparing to other countries the waste generation rate of Iraq is higher than the global average (0.75 kg/day/capita)

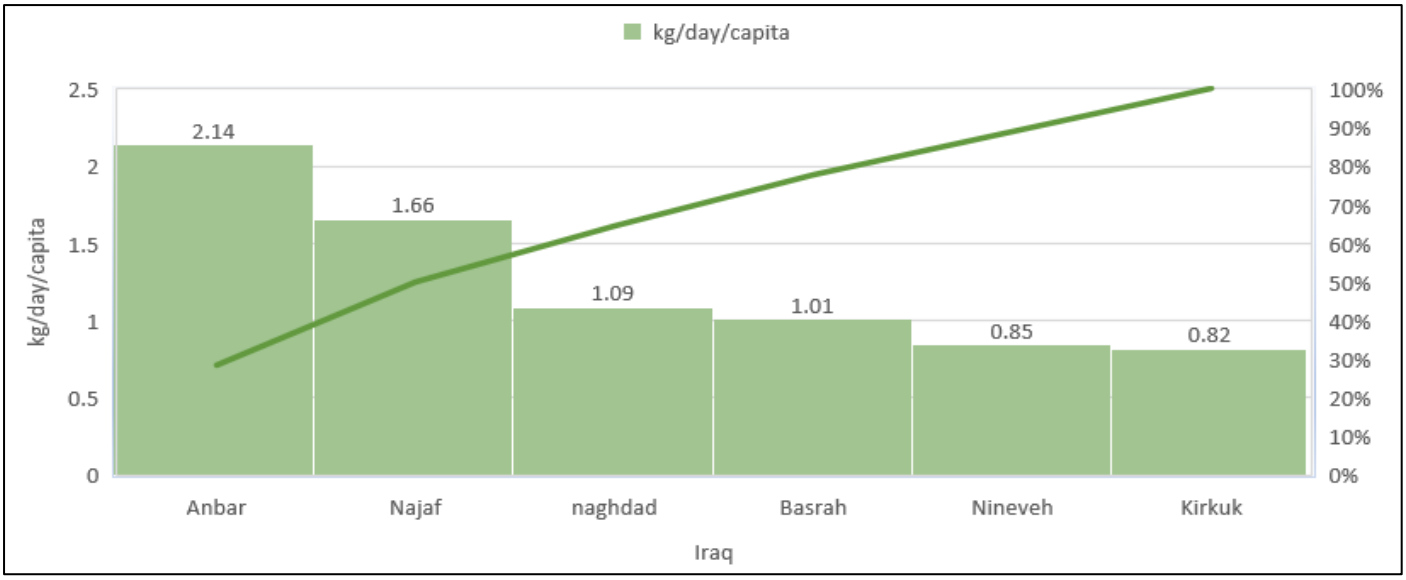

Fig 9 Waste Generation

Iraq produces 20 million tons of waste per day, while the Baghdad Municipality alone produces 9,000 tons per day. These quantities are a huge wealth waiting to be invested in through recycling to produce new usable materials, while at the same time preserving the environment and providing job opportunities for the unemployed.

Recyclable materials include metals, such as iron, aluminum, steel, plastic, glass, paper, cardboard, car tires, and textile materials. Sewage water can also be recycled.

Electronic materials are also recyclable, and according to the United Nations, 41 million tons of electronic waste were dumped in landfills in 2014, and about one-sixth of electronic waste was properly recycled in 2014.

Countries have begun to resort to recycling waste in light of the successive industrial and technological development, but in Iraq, reliance is still on traditional methods to dispose of it only without benefiting from it.

Waste covers large areas in various Iraqi governorates, making it vulnerable to burning by citizens to get rid of it and the unpleasant odors emanating from it, which causes toxic fumes to rise in those areas, and thus suffocation among the population.

Although Iraq is the country most exposed to the risk of environmental pollution due to the waste resulting from wars and the waste spread in city centers, districts, sub-districts, and even in villages and rural areas.

That is why Iraq is one of the strangest countries in terms of dealing with waste, not only because it is harmful to nature and the environment, but also because it is a huge wealth that has not been invested until now, according to environmental expert Ahmed Saleh.

➢ *A Huge Neglected Wealth*

Waste is viewed as only harmful waste, or how it can be disposed of, but rather as a huge wealth and an economic door that many countries in the world depend on, which makes energy from their waste, because decomposition produces methane gas and other gases that can be used in producing new materials.

For example, the sugar factory used to produce bakaz, and the sugar cane waste went to the paper factory, and peat moss was used as an alternative soil, and the waste of the plastic factory was used to make recycled binary tools in a good way, considering that it was recycled once.

Also, the waste of dates is used to make vinegar, jams, and others, and the waste of carpentry is used to make doors and compressed wooden panels.

The waste of vegetable oil factories is thrown into the river, and inside these factories there are accompanying factories called (powder factories) that produce a lot of waste such as sulfonic and caustic and other materials that can be converted into materials such as pesticides, fertilizers, phosphates, or trace elements that enter into the fertilizer process for nurseries.

It`s very necessity of investing in waste recycling as it gives economic value, by establishing projects that invest in waste and work on recycling it industrially in producing many products, the most important of which are organic fertilizer for

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household waste, aluminum and iron sheets, in addition to bags, storage containers and rubber materials.

The economic importance of waste recycling, according to economic researcher Ahmed Eid, lies in "providing labor and opening the field of employment, in addition to providing opportunities for self-sufficiency for many materials, and the possibility of exporting them to preserve hard currency that leaves the country towards Iran, Turkey and China to import goods and commodities that can be manufactured locally through waste recycling."

➢ *The effects of Pollution on Animals*

Pollution comes in different ways and affects several kinds of organisms. The effects of this pollution can be harmful to both animals and birds. Pollution caused by human false daily activity also leads to the elimination and die of many threatened or non-endangered species, in the same time it cause to put negative impact of pollution on humans.

Animals suffered in air pollution just like humans, and the effects of air pollution on animals are not always seen immediately, as they can develop over time and are difficult to diagnose. Here are the most important harms of air pollution on animals: Toxic fumes emitted from factories, cars, or other sources harm the development of the lungs in animals, causing them to develop respiratory diseases such as asthma in adulthood. Air pollution also affects some animals at the cellular level by causing DNA damage, leading to mutations and cancer cells that lead to elimination in the future. It also affects the ability of animals to reproduce, so there is an increased risk of infertility and congenital disabilities. Animals' immune systems are also compromised when exposed to pollutants, thus affecting the animals' natural immunity to disease, making them more susceptible to disease.

➢ *Water Pollution Damage to Animals*

Oil spills cause the elimination of a large number of wild animals, as oil covers the animals' fur and feathers, which affects the animals and exposes them to deadly toxins. Toxic chemicals found on beaches and in water lead to anemia, decreased resistance to diseases, poor reproduction, cancer, birth defects and neurological damage. In closed bodies of water such as lakes, pollutants such as oil, detergents, nitrogen and phosphates can cause a major imbalance in their ecosystems by stimulating the growth of unwanted plants, which affects the oxygen that is the basic need for fish.

➢ *The Harms of Ocean Plastic Pollution on Animals*

Plastic pollution has a direct and deadly effect on wildlife. Here is an explanation of the harms of ocean plastic pollution: [4] Fish swallowing plastic causes intestinal injuries and death. Plastic is also transmitted through the food chain to large fish, marine mammals, and people who eat seafood. A recent study found that a quarter of fish in California markets contain plastic in their guts, most of it in the form of microplastic fibers. Sea turtles are exposed to suffocation due to plastic waste, and plastic pollution is very widespread on many beaches, affecting their reproduction. Eating plastic reduces the stomach storage volume of seabirds, causing hunger, and dead seabirds are often found with their stomachs full of plastic. Marine mammals swallow plastic and become entangled in it. Entanglement in plastic debris has also led to injury and death in the endangered Steller sea lion, as packing tape is one of the most common entangled materials. Dead whales have also been found with their stomachs full of plastic

➢ *How does a WTE Power Plant Work?*

The waste is burned at very high temperatures, resulting in very high heat, which is then used to heat water and produce steam in a large boiler system.

This steam turns a turbine that produces electricity. The energy produced can be returned to the mains grid, providing electricity to homes, businesses and consumers.

To ensure that the process is environmentally safe, the gases emitted during incineration are recycled to the environment, so they must be treated with advanced filters and scrubbers to remove harmful pollutants Fly dangerous with caution handled to prevent environmental pollution.

Waste-to-energy (WTE) plants convert waste into electricity, reduce landfill size and greenhouse gas emissions. They offer the benefits of renewable energy but face challenges such as high cost and emissions concerns It is not easy compared to renewable energy.

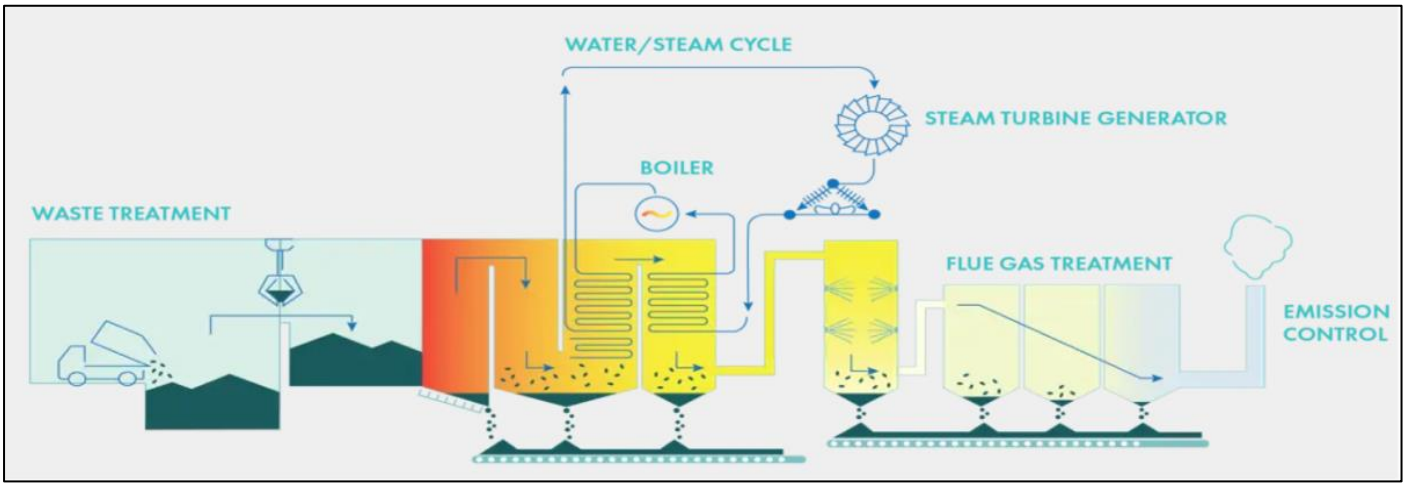

Fig10 WTE Energy Plant

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➢ *Generating Electricity from Waste in Iraq with a New Project*

Generating electricity from waste in Iraq will secure the growing local demand, in addition to finding solutions to a number of environmental crises that the country is suffering from.

In this context, the Baghdad Municipality announced its intention to establish a waste management project to generate electricity in the Iraqi capital, according to what the specialized energy platform has seen, that the National Investment Commission and the Ministries of Electricity and Environment have nominated a project to generate electricity from waste in Baghdad.

The waste-to-energy project in Iraq is one of the initiatives that the government is working on to address the environmental challenges facing the country. The Ministry of Environment has identified 3 types of pollution, including waste, that represent a challenge during the current stage in Iraq, calling for the adoption of modern technologies and renewable and clean energy as an alternative to fossil fuels.

Electricity in Iraq is one of the biggest crises facing the government in light of the high local demand, especially during the summer, limited production, and the decline in Iranian gas supplies to the stations. The waste-to-energy project in Iraq is very important and an investment opportunity, announced by the Baghdad Municipality from the National Investment Commission.

➢ *Advantages of Waste-to-Energy*

- *Economic Benefits:*

Waste collection requires large areas of land, preparing landfills is expensive and the cost of providing large landfills reaches more than $500 million. At the same time, shipping waste by land and sea to remote areas or countries for disposal is expensive. If these costs are compared to the cost of building a waste incineration plant and producing energy from it, we find that there are significant savings and the right equation.

Included in the economic benefits are revenues from the sale of electricity, hot water and minerals (scrap or scrap). In the case of oil and gas producing countries, using waste to generate electricity means saving some oil and gas for export at no additional cost, or using it in areas that produce more added value than if oil and gas were burned electricity generation.

- *Environmental Benefits:*

There is no doubt that burning waste generates carbon dioxide and some other gases, but if we look at the net gases emitted from start to finish, we find that waste-to-energy projects are environmentally friendly. For example, one of the most important gases emitted from waste is methane, which is much more dangerous than carbon dioxide. The carbon dioxide produced by combustion is less than the case of transporting waste to other countries by land and sea, as the gases emitted by the exhaust of trucks and ships are much greater. One of the environmental benefits is that the amount of gases produced by combustion is less than the amount of gases produced by burning coal or oil to generate the same amount of electricity.

- *Tourism Benefits:*

In some places, such as the Miyashima Station in Osaka, Japan, the station has been transformed into an art piece and a tourist attraction visited by tourists from all over the world, which has stimulated the economic activity of the area where the station is located, although it is far from being a tourist destination

➢ *Disadvantages of Waste to Energy:*

- *Toxic Waste Emissions*

The United States burns more than 30 million tons of trash each year—roughly 13 percent of all waste generated. The country's first attempt at incineration was a toxic disaster.

If 2,250 tons of trash were burned each day, the annual emissions would be 5 tons of lead, 17 tons of mercury, 580 pounds of cadmium, 2,248 tons of nitrous oxide, 853 tons of sulfur dioxide, 777 tons of hydrogen chloride, 87 tons of sulfuric acid, 18 tons of fluorides, and 98 tons of particles small enough to permanently lodge in the lungs. The study also found varying amounts of paper and wood involved in incineration.

Basically, inert hazardous waste is sent to an incinerator, where it releases hazardous, biologically toxic emissions.

- *Lower Productivity*

One ton of the waste an generate electricity equal to what a one third of coal can generate.

- *It is Not a Renewable form of Energy*

Some organizations and investors believe that converting waste to energy is a renewable source of energy, but it is not. Truly renewable resources like solar and wind power are inexhaustible. There is nothing renewable about burning plastic sneakers, CDs, polystyrene peanuts, and car upholstery. Waste is certainly a recyclable resource at this point, but that is only because we generate so much of it.

- *Requires Sorting of Waste*

Fun fact: If we removed all the landfills from the Earth, we would be able to free up X square kilometers of space. Which could accommodate Y million people.

➢ *Different Methods of Converting Waste to Energy*

- *Incineration*

Waste incineration is the most widely used process for waste-to-energy conversion and waste management. Organic materials from the collected waste are burned at high temperatures throughout this process. This process is called thermal processing. Thermal processing produces heat, which is then used to produce energy. more and more aware of the negative effects of incineration, whether or not energy is recovered.

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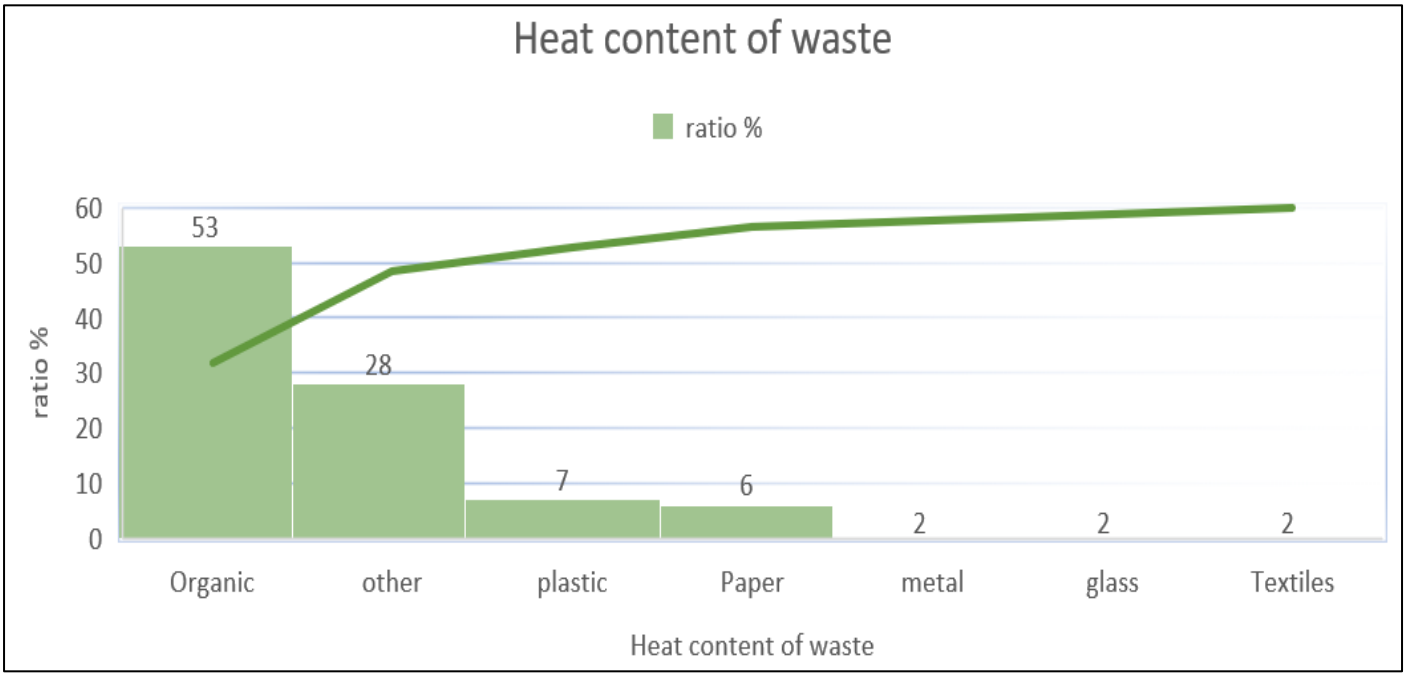

Fig 11 Waste Classification

- *Depolymerisation*

In this process, long hydrocarbon polymers contained in organic matter are broken down into several products, including crude oil. This process is known as hydrous thermal depolymerisation (HTD), which is controlled by water temperature and pressure.

When accumulated biomass is heated, and under pressure for millions of years in the earth's crust, thermal depolymerisation (TD) takes place.

This method also uses thermal decomposition but in the presence of water and controlled pressure. This procedure involves heating waste organic compounds to a high temperature in order to produce thermal energy. By using this process, we may produce fossil fuels from waste.

Depolymerisation sounds amazing since it can solve our ever-increasing scarcity of fossil fuels, but large-scale HTD processes are far from being achieved. The entire process is also very expensive.

- *Gasification*

Gasification does not require combustion, unlike waste incinerators, which burn waste and use the resulting heat to produce energy. In gasification, waste is heated in a low-oxygen environment. During the chemical process of waste gasification, the waste is separated into its individual particles. Inert slag or coal and syngas, a combustible gas, are the by-products of this process. Syngas can either be processed into a range of valuable products, such as diesel, hydrogen and useful chemicals, or it can be used directly to produce electricity.

Depending on the gasification technology, the residue from municipal waste gasification may contain various types of tar, particulate matter, halogens, heavy metals and alkaline compounds. This can cause caking in the gasification vessel, which can clog the fluidized beds and increase tar formation.

- *Composting*

The simplest of procedures for converting waste to energy. The previous methods talked about all the steps that big industrialists and governments can take up.

Automated waste separators make use of a variety of separation tools to separate organic materials, plastics, metals, bricks, stones and other materials from garbage to the maximum, to improve the recycling and recycling of waste. At the same time, separated wastes can be further reprocessed into useful resources. So, the main objective of automated waste sorting is to reduce processing and conversion of waste to treasure. fig 12.

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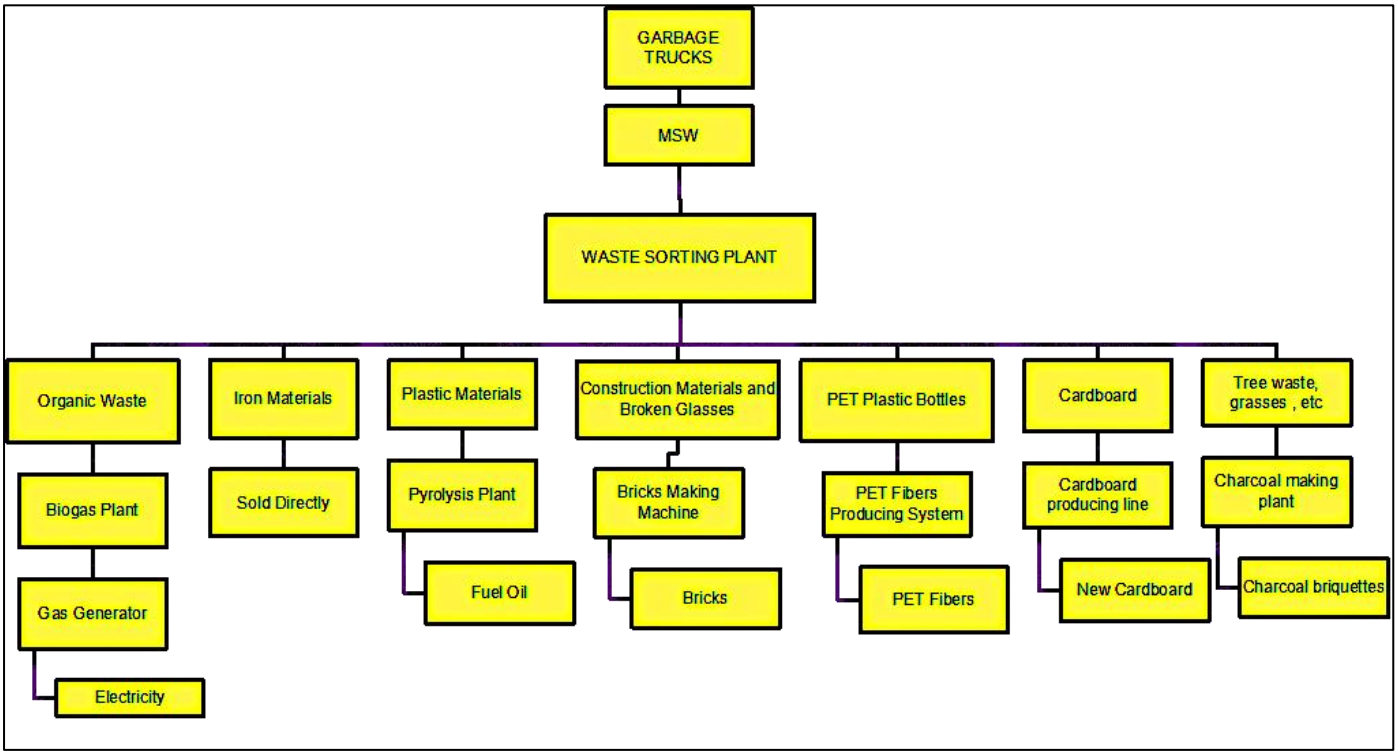

Fig 12 Automatic Waste Segregation Machine

➢ *A Low-Carbon but Expensive Alternative*

Waste-to-energy projects offer a range of options, including capturing biogas produced by bacterial decomposition of organic matter in landfills at low cost, and processing it into renewable natural gas that can be used as a clean transportation fuel.

Electricity can also be generated from burning solid waste, and the ash can be used in the construction industry, according to the report, which was monitored by the Energy Research Unit.

It is worth noting that waste-to-electricity plants rely on converting waste into steam that drives a steam turbine to generate electricity.

Fuel derived from waste is also used in many industries as a low-carbon alternative to fossil fuels.

Among these various uses of energy generated from waste, waste-to-electricity projects are very expensive, yet there are 20 gigawatts of electricity capacity installed globally based on waste, with expectations that this will rise to 142 gigawatts by 2050 to meet the increasing volume of waste.

Wood Mackenzie data shows that the value of waste-to-electricity plants' assets is currently $180 billion, rising to $1.3 trillion by 2050.

III. CONCLUSION

Waste-to-energy is a promising solution to address the challenges of waste management and energy generation. By using organic waste as a resource, the environmental impact of waste can be reduced and sustainability can be enhanced. Investing in and expanding the use of these technologies can contribute to building a more sustainable and efficient future.

A source of energy, the concept of a circular economy can be promoted, where waste is considered part of the production cycle rather than a burden.

The steps to solve the environmental problem begin with giving citizens complete clarity on how to deal with waste and separate it and to minimize the amount of waste on the other hand, work should be done to ensure that private sector companies in a programmed manner to buy reusable goods directly from citizens and provide special garbage baskets for this purpose.

The dangers of climate change should be constantly highlighted so that people feel responsible and play a role in reducing its causes.

Converting waste to energy helps reduce pollution from traditional waste burning, as harmful gas emissions are better controlled.

Regarding the environment of Erbil in Iraq, what needs to be done is to close all the illegal refineries, and those factories and refineries that are legal and do not meet the environmental requirements to be punished until they meet the requirements and reduces road congestion less environment due to noise with emissions Toxic gases from cars are being reduced, and some generators have not been timed yet, and have not planted the amount of greenery that should be planted, despite the poor fuel used, some of which emit a lot of smoke Compared to the global standard, it is therefore the duty of the stakeholders to worry about the greenness rate Increase, so that it increases annually and the amount of

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greenery is equal to the increase in the area of Erbil province and its population.

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