

امكانية استخدام الغاز الحيوي في انتاج الطاقة النظيفة من مكبات النفايات البلدية/ دراسة

حالة

Utilizing of Biogas to Produce Clean Energy from Landfills /
Case study



From Waste to Energy

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وزارة العلوم والتكنولوجيا-دائرة البيئة والمياه

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- ❑ Energy recovery from the combustion of municipal solid waste is a key part of the non-hazardous waste management hierarchy, which ranks various management strategies from most to least environmentally preferred.
- ❑ Energy recovery ranks below source reduction and recycling/reuse but above treatment and disposal. Confined and controlled burning, known as combustion, can not only decrease the volume of solid waste destined for landfills, but can also recover energy from the waste burning process.
- ❑ generates a renewable energy source and reduces carbon emissions by offsetting the need for energy from fossil sources and reduces methane generation from landfills.
- ❑ Technologies to directly recover materials or energy from the waste stream including: aerobic composting; anaerobic digestion; mechanical separation and sizing; and / or thermal processing.
- ❑ A conversion technology facility uses *thermal, chemical, mechanical and/or biological processes* to convert separated organic solid waste (a specific solid waste that contains carbon molecules, such as waste plastic or rubber) into fuels, chemicals or other useful products.

Need to Waste to energy



The amount of solid waste generated each year has been increasing much faster than population growth.

Growing demand of energy is also increases.

Today, we face numerous environmental & economic challenges:

- Population growth and associate waste disposal needs
- Global Warming
- Dependence on fossil fuels

There is a common solution for all of these challenges.

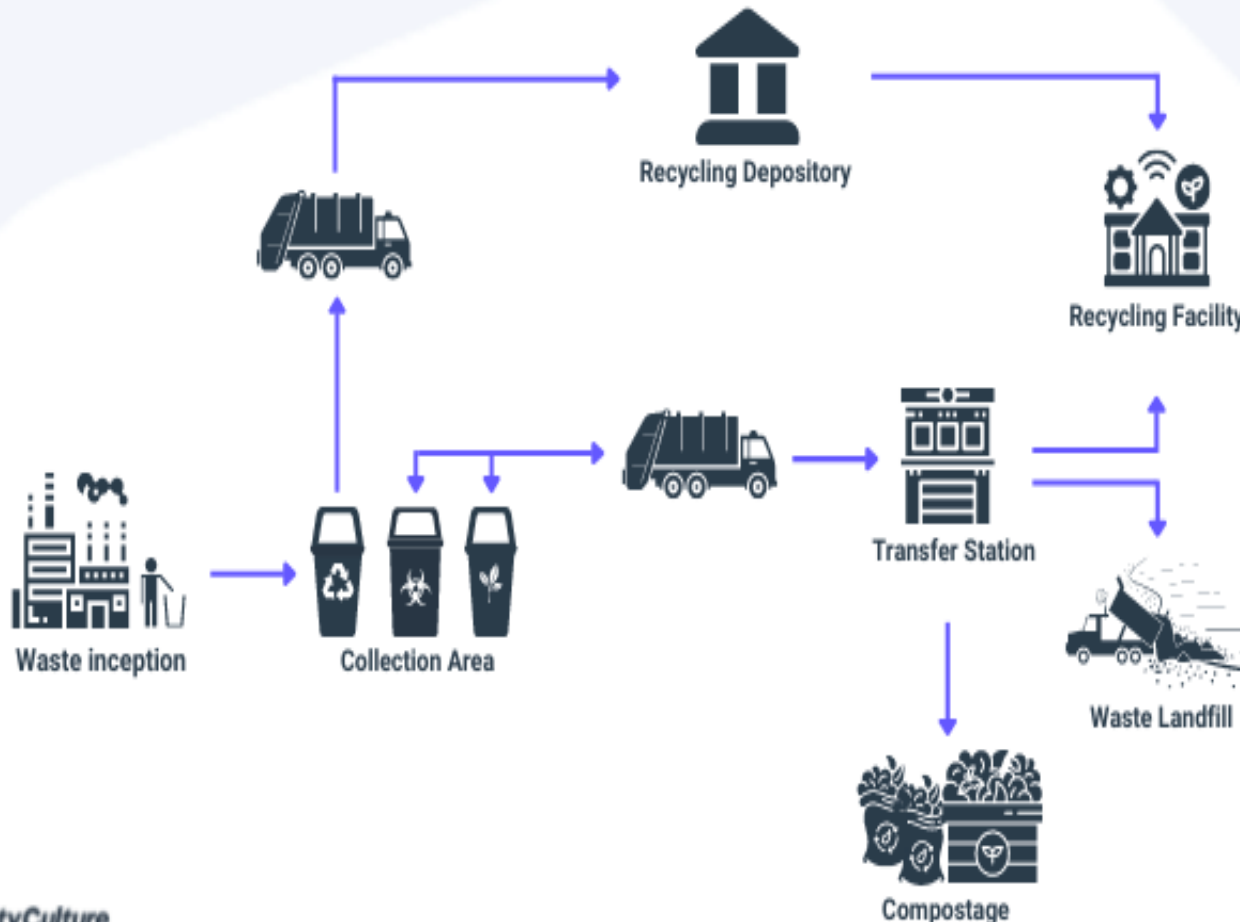
Energy-from-Waste (EfW) provides:

- Safe, economic waste disposal
- Greenhouse gas reduction
- Renewable energy



Waste Management

Waste Management Life Cycle



Waste management or **waste disposal** includes the processes and actions required to manage waste from its inception to its final disposal. This includes the collection, transport, treatment and disposal of waste, together with monitoring and regulation of the waste management process and waste-related laws, technologies, economic mechanisms.

Waste to Energy



Waste-To-Energy (WTE) technologies recover the energy from the waste. Waste can include:

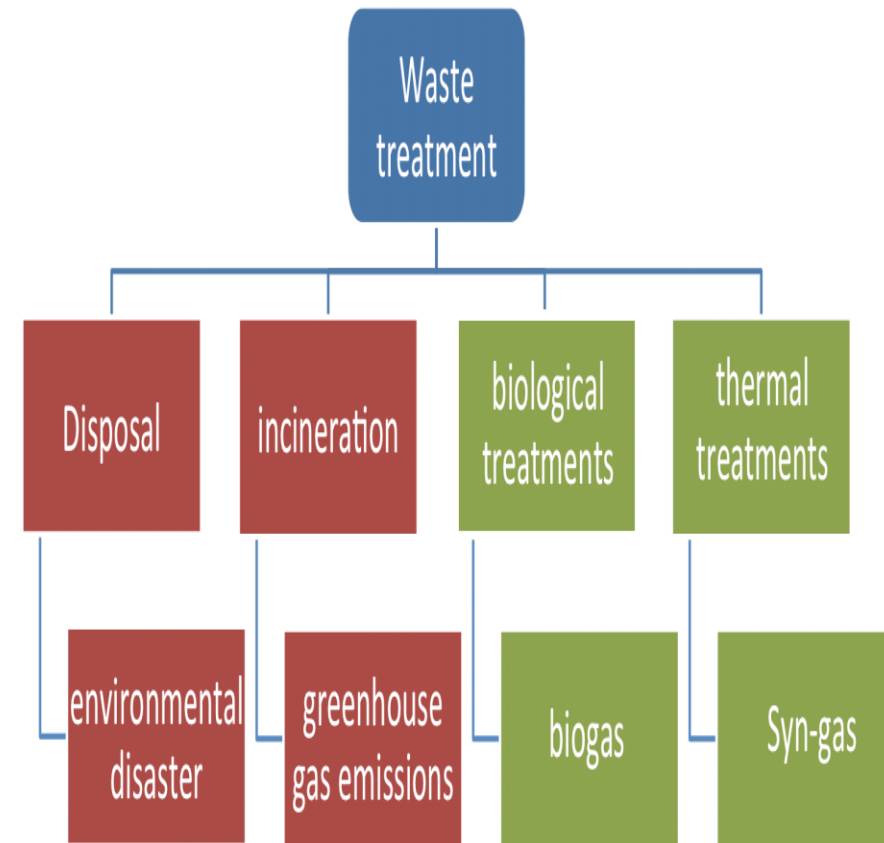
- Residential
- Industrial
- Commercial
- Institutional
- Construction and demolition

All of the above included as municipal solid waste (MSW).

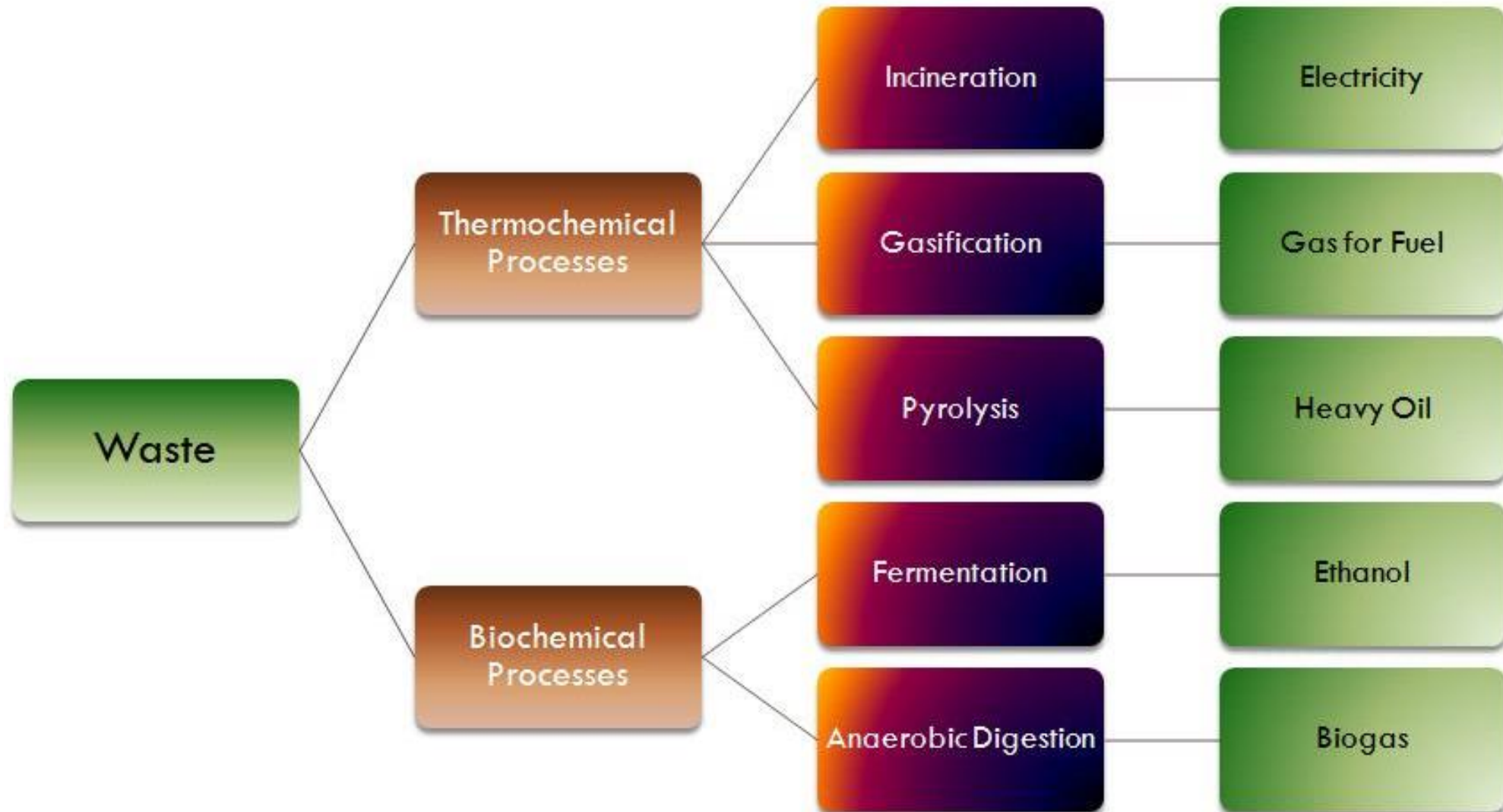
- Agriculture

Why Use Waste?

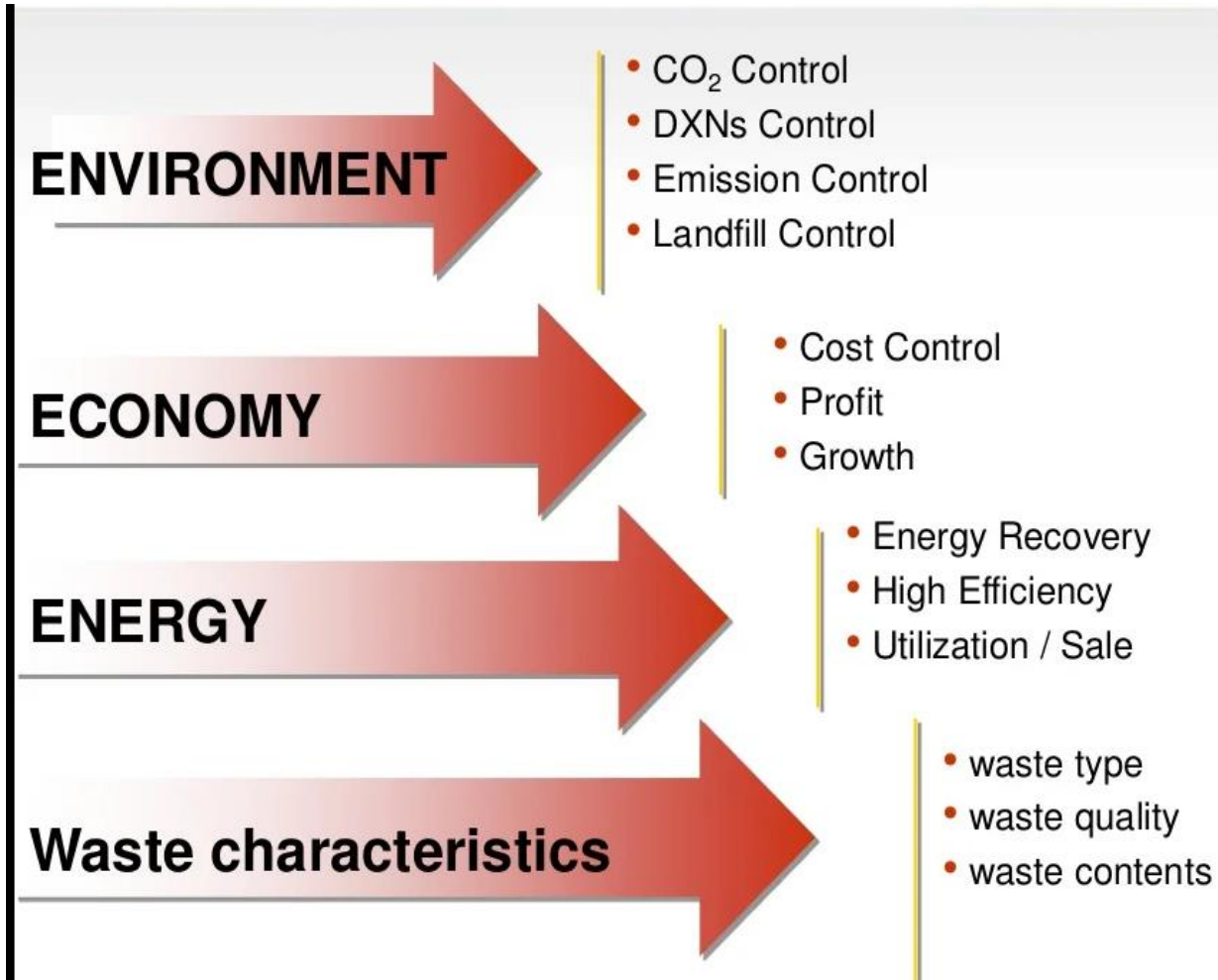
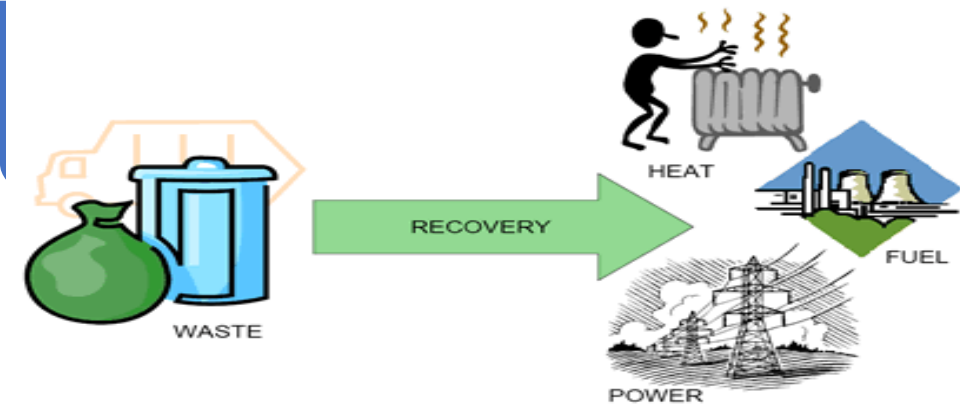
- ❑ **Waste-to-Energy (or energy-from-waste) facilities provide a safe, technologically advanced means of waste disposal that reduces greenhouse gases, generates clean energy and recycles metal.**
- ❑ **Waste-to-Energy (WTE) is widely recognized as a technology that can help mitigate climate change. This is because the waste combusted at a WTE facility doesn't generate methane, as it would at a landfill; the metals that would have been sent to the landfill are recovered for recycling instead of being thrown out; and the electricity generated offsets the greenhouse gases that would otherwise have been generated from coal and natural gas plants. WTE facilities are the only form of energy generation that actually reduces greenhouse gases.**
- ❑ **Additionally, the energy produced at waste-to-energy facilities is reliable baseload power, meaning that it is generated 24 hours a day, seven days a week. That provides the opportunity to not only sell electricity onto the grid, but also provide steam delivered to houses, public buildings and industry.**



Type of Energy from Waste



Amount of Energy from Waste



Type of waste	Energy content (Btu/lb)
Mixed paper	6800
Mixed food waste	2400
Mixed green yard waste	2700
Mixed plastic	14,000
Rubber	11,200
Leather	8000
Textiles	8100
Demolition softwood	7300
Waste hardwood	6500
Coal	12,300
Fuel, oil	18,300
Natural gas	23,700

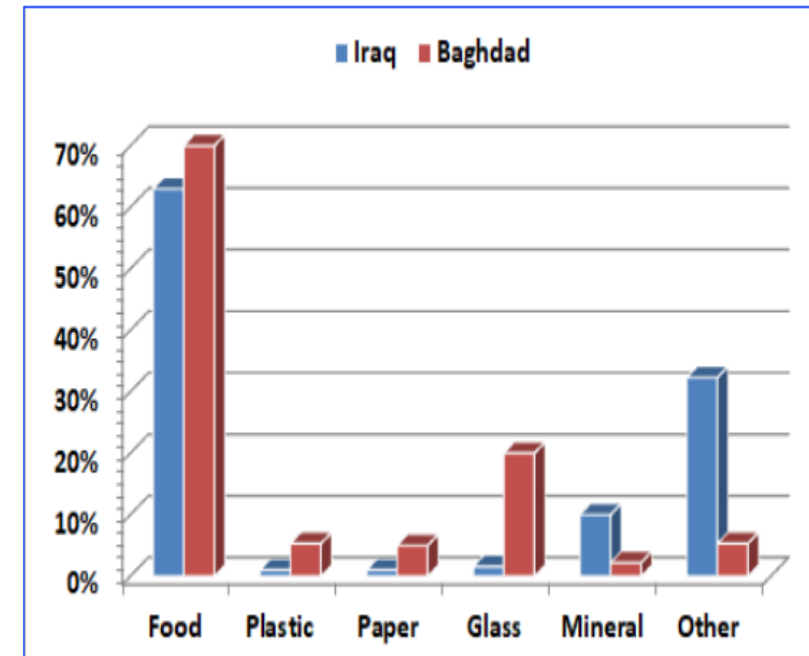
Case Study

Utilizing of Biogas to Produce Clean Energy from Landfills in Al-Karkh, Baghdad, Iraq

- ❑ In Iraq, solid waste is a pollution source, especially at the last years due to the war conditions and embargo imposed on the country at the beginning of the ninetenths where there is an absence of modern, efficient waste handling and disposal infrastructure as well as general lack of interest in awareness of health and environmental issues. Municipal solid waste management (MSWM) problem has become severe in Baghdad and it is one of the significant challenges for the Baghdad Mayoralty.
- ❑ The total urban population in Baghdad went up from 2.14 million in 1970 to 6.7 million in 2005 and increased to 7.0 million in 2015 , and 8.558 million in 2020. MSWM became one of the major environmental problems in Iraq especially in Baghdad in the last ten years after 2003 since the sharp increase in the volume of solid waste generated as well as quantitative changes in its composition.
- ❑ The gaseous emissions that are emitted from solid waste without treatment or investment are one of the problems that Baghdad suffers from, because of its environmental and health effects, both on the man, animal, or land.
- ❑ The research aims to study the geographical distribution and quality of waste dumps in Al-Karkh in Baghdad, and measure the concentrations of methane gas (CH₄) emitted from the waste balers and landfill in the study area, which is the basis for biogas production to determine the possibility of investing it in energy production and other purposes, and finding appropriate solutions to dispose of waste by appropriate scientific methods.

Municipal Solid Waste in Baghdad city/ Al-Karkh side

- ❑ There are 16 waste dumps in the Baghdad distributed between Al-Karkh and Al-Rusafa, including landfill sites, 10 sites in Al-Karkh side (4 Typical balers, 5 Normal stations and 1 Sanitary Landfill), and in Al-Rusafa side (5 Normal stations an 1 Sanitary Landfill).
- ❑ These dumps receive waste from many areas, this waste consists of household and commercial waste only, represented by waste from commercial streets, malls, restaurants, and others, and in a very rare case unintentionally, there are some medical waste as a result of unintentional random mixing.
- ❑ Most of the composition of this waste is from organic materials. No waste treatment takes place. Just collecting, compressing and landfilling.
- ❑ As for the juice released from compressing the waste, it is diluted in water and dumped with sewage.
- ❑ There are no sorting or recycling plants, manufacture of waste or special incinerators for waste, but there are potential projects in order to benefit from industrial sorting of waste



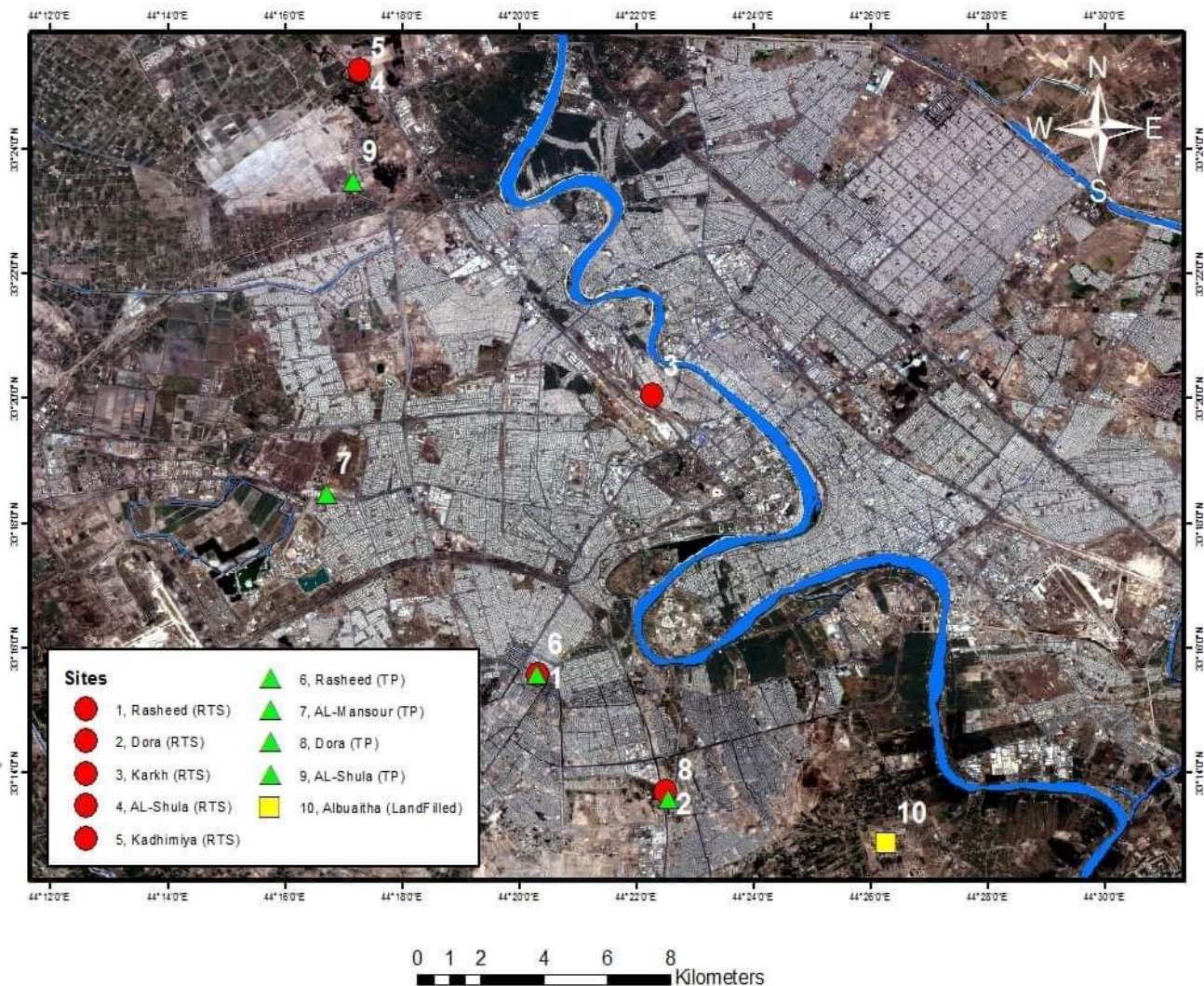
Municipal Solid Waste in Baghdad city/ Al-Karkh side

- ❑ For Al-Karakh district, we note that most of the solid waste comes from domestic and commercial sources, and small amount of the medical waste, with large quantities ranging between 270-400 tons per day for the waste balers and landfills in the study area (Table 1).
- ❑ As for the amount of organic matter, Table 2 shows that it occupies the highest values among all materials, as it is estimated at 42% of the amount of solid waste received in the landfills of the study area, followed by paper and plastic, and other materials in varying proportions.
- ❑ There is an increase in the percentage of solid waste generated in the study area, where one person generates waste in the city of Baghdad (0.655) kg/day / per person, or about 239 kg per person per year, and this figure corresponds to the amount of waste generation in major cities.
- ❑ For middle-income countries, which amount to 273-164 kg per person per year, compared to 2015, where it ranged (0.6-1.2) kg/day/per capita or about 216-438 kg per person per year.
- ❑ We can invest this waste in generating alternative electric energy in the future (by treating organic solid waste and releasing methane gas, and exploiting it as clean and environmentally friendly energy), as well as using the remaining materials when decomposing as high-quality organic fertilizer, establishing special incinerators and monitoring the environment to recover energy from waste , being a method of reducing the amount of these harmful gases emitted into the atmosphere as part of the NDCs to climate change.
- ❑ At present, all solid waste is randomly dumped without separation of composition and recycling processes.

Baghdad City's waste output of Al- Karkh

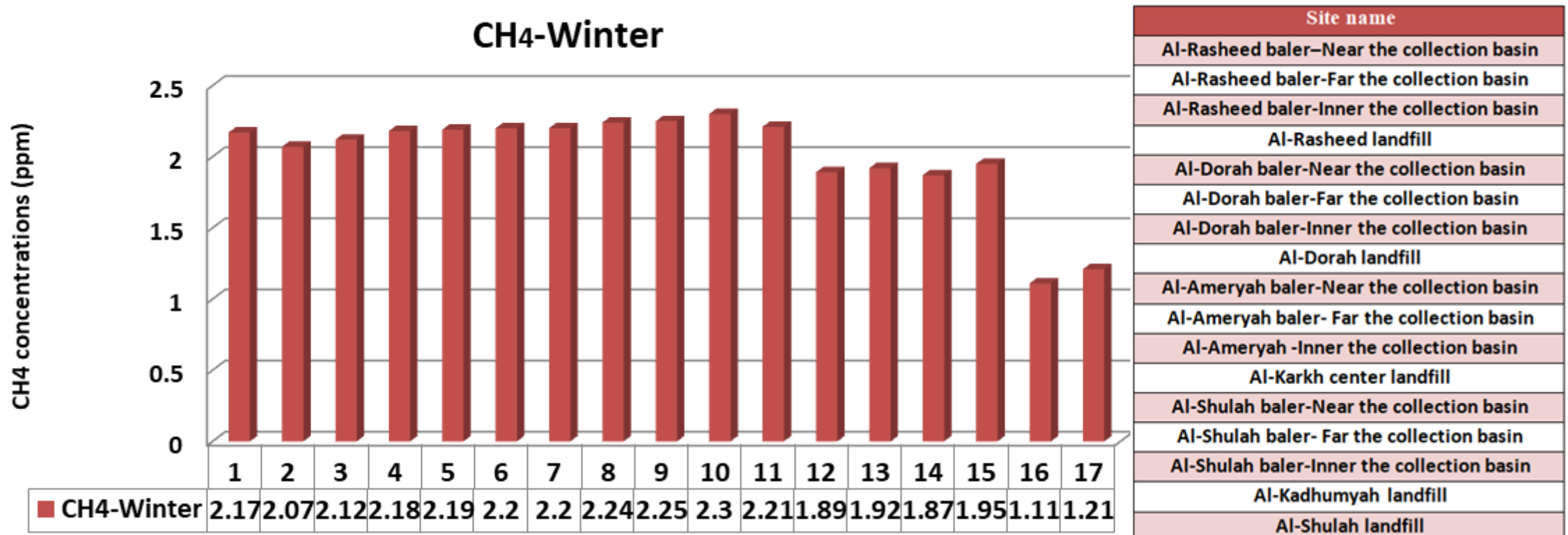
Impact	Type	Amount of waste/tons/day
Al-Shulah baler (typical)	Household and commercial waste	300 tons per day
Al-Mansour baler (typical)	Household and commercial waste	350 tons per day
Al-Rasheed baler (typical)	Household and commercial waste	400 tons per day
Al-Doura baler (typical)	Household and commercial waste	270 tons per day
Al-Karkh center landfill	Household waste and commercial	300 tons per day
Al-Kadhumyah landfill	Household and commercial waste	360 tons per day
Al-Shulah landfill	household and commercialwaste	350tons per day
Al-Rasheed landfill	Household and commercial waste	300 tons per day
Al-Doura landfill	Household and commercial waste	350 tons per day

Currently, there are two landfills in Baghdad; unfortunately, there is no landfill that meets the criteria of environment landfill. Instead, all of the waste is dumped into random holes. Landfills occupy 45.5 km² of Baghdad land, and this area is expected to increase to 60 km² by 2025. The required number of landfill in Baghdad is six based on the future 2027 population and the landfill volume is estimated about 138 million m³.



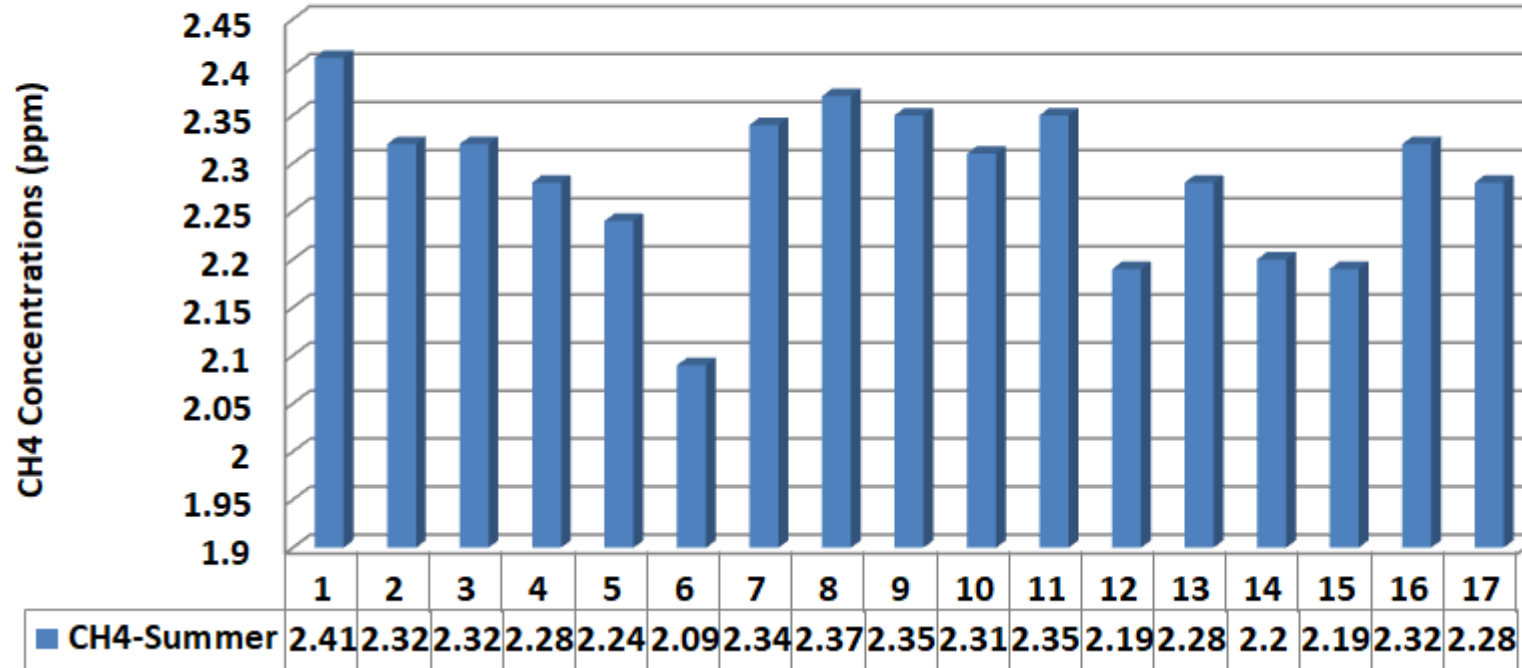
Measurements and Results

□ The concentrations measurements of the Methan gas (CH₄) into the waste balers and landfill in study areas,



Measurements and Results

CH4-Summer



Site name
Al-Rasheed baler-Near the collection basin
Al-Rasheed baler-Far the collection basin
Al-Rasheed baler-Inner the collection basin
Al-Rasheed landfill
Al-Dorah baler-Near the collection basin
Al-Dorah baler-Far the collection basin
Al-Dorah baler-Inner the collection basin
Al-Dorah landfill
Al-Ameryah baler-Near the collection basin
Al-Ameryah baler- Far the collection basin
Al-Ameryah -Inner the collection basin
Al-Karkh center landfill
Al-Shulah baler-Near the collection basin
Al-Shulah baler- Far the collection basin
Al-Shulah baler-Inner the collection basin
Al-Kadhumyah landfill
Al-Shulah landfill

□ For the purpose of calculating the annual emission rate of this gas (tons of CH₄) from the annually municipal waste generated amount (tons of MSW), it needs to the percentage of methane generation and can be derivation by applying this equation (tons of methane/ton MSW), however, this study needed to the annual data for the average CH₄ concentrations, as well as for the waste generated during the study period, in order to be able to calculate the percentage of annually gas generated. Despite that, this generated gas from household solid waste can be invested in study area, since most of the organic waste comes from residential areas, and therefore biogas can be produced through waste fermentation and gas extraction from it in order to use it, for example, in the production of electric power, and using the remaining waste in the production of fertilizer that increases soil fertility, as experiments have proven that fertilizer generated from organic matter is the best among the fertilizers types.



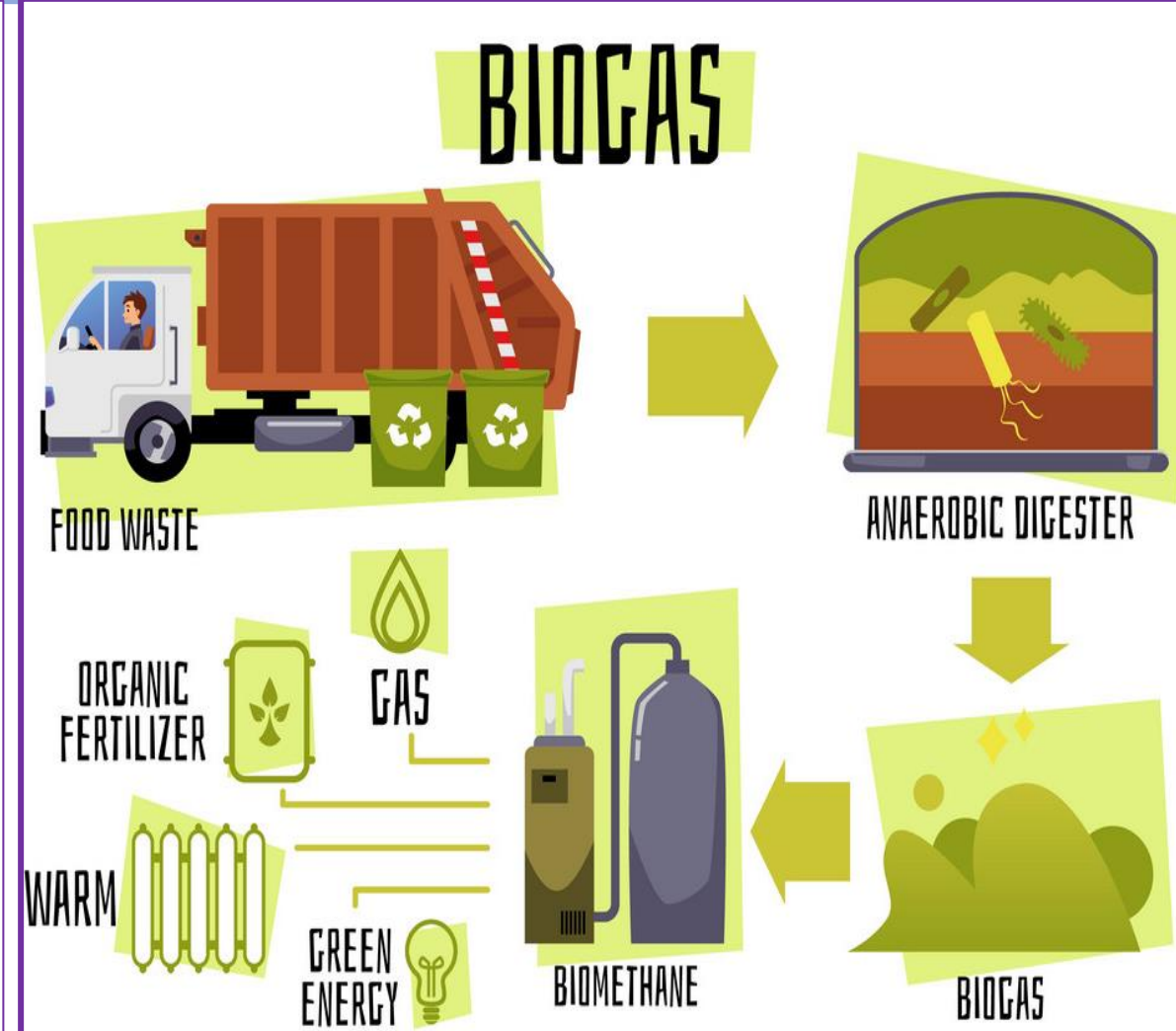
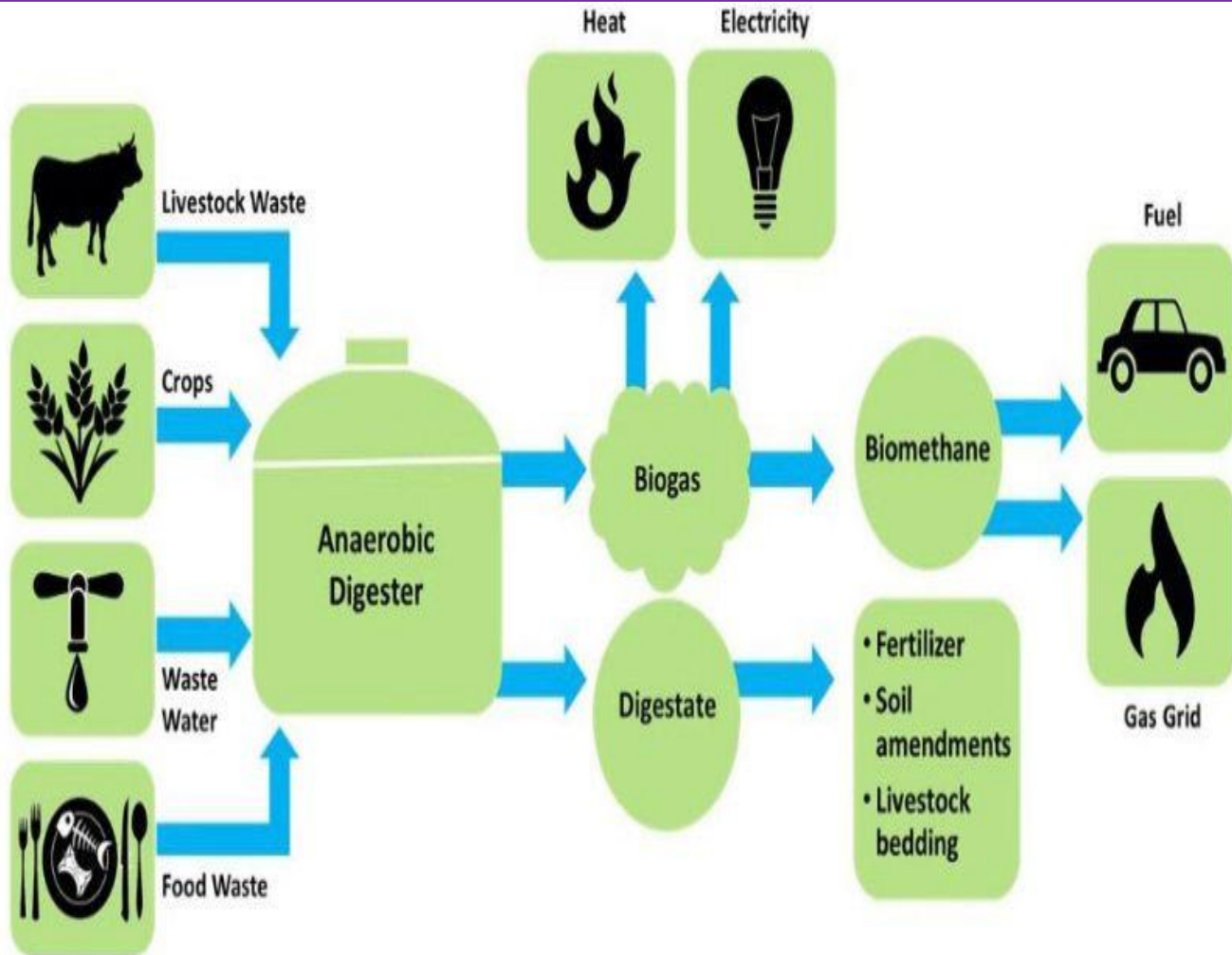
- ❑ **The waste will be exploited in a very safe way on the environment; generating electric power, fertilizer, and liquid fuel in addition to the economic consideration.**
- ❑ **The waste balers and landfills in the study area receive large quantities of organic waste from different sources, which are good sources of CH₄ gas, and through the microbial decomposition process of organic carbon, the organic compounds decompose into methane (CH₄) and carbon dioxide (CO₂), which are the two main components of landfill gas.**
- ❑ **Therefore, the waste balers and landfills in the city of Baghdad will increase methane emissions due to the increase in urbanization in the city, as well as the large population growth, high-income rates for the citizen, and the trend towards making all landfills subject to environmental and health control.**
- ❑ **Also, the gas emission rate shows a slight difference due to the climate conditions, because the climate of the city of Baghdad (the study area) in particular and Iraq in general, is hot and warm for long periods of the year, it is considered one of the suitable conditions for the decomposition of organic carbon and generation of methane.**
- ❑ **This process needs more knowledge about how landfill operators determine and report the required emission value and create a spatial database of gas emissions from the decomposition of municipal organic waste. In addition, before calculating the ratios of gas generation, the data of waste disposal quantities are verified in one year. Landfills report the Methane Generation Rate values that are used in the estimation of landfill gas generation.**

Investment Methods of the Waste in the Study Area

For waste conversion to energy, there are a lot of ways to extract energy from solid waste in addition to the possibility of using it as high Fertilizer quality, these methods are:

- ❖ **Incineration (Energy Recovery):** is intended for the organic material burn to restore energy from the incineration process, and used in electricity production. Burning waste to recover energy is one of the most common methods and is done through special furnaces, but it requires the application of strict standards to control gas emissions.
- ❖ **Energy production from biogas:** This method is one of the biological means to obtain organic gas. The biogas technology depends on the anaerobic fermentation of solid and liquid waste, plant and animal farm waste, and sewage waste in an environmentally safe manner, as well as protecting the environment from pollution through the use of Methane gas as a new and renewable energy source, in addition to protecting the environment from pollution.
- ❖ **Three products can be obtained from this method:** biogas, bio-liquid, and organic fertilizer. Biogas is used in power and heat-generating plants, while bio-liquid and organic fertilizers are used in Agricultural production, this process is considered one of the most stable processes for treating waste and generating renewable energy in the form of electricity, heat, and fertilizer.
- ❖ **One of its advantages is to avoid odors and emissions in the air and not to throw liquid waste so as not to cause pollution and low treatment cost.**

Biogas production method



Conclusions

Possibility of renewable and environmentally friendly energy production from the waste of the study area, and to reduce the amount of gaseous emissions significantly, because the results of this study indicated to:

- ❑ Most of the waste are consist of organic material, and concentrations of methane gas (CH₄) could be invested in biogas production measured, although its concentrations do not exceed global determinants (WHO).**
- ❑ In this study, the energy can be produced in two ways, either by burning waste with special incinerators with environmental monitoring or by increasing the decomposition of trash in order to extract biogas.**
- ❑ These methods of producing energy from waste are one of the best methods to protect the environment in addition to its significant economic return and the possibility of extracting energy at a low economic cost, and waste disposal, at the same time compared with other disposal methods.**
- ❑ Additional profit value for the farmer by producing higher quality fertilizers.**
- ❑ Treating solid waste and producing biofuels will reduce the amount of gas emissions and mitigate the global warming phenomenon and the occurrence of climate changes, as well as reduce their health, environmental and other effects.**
- ❑ It requires more research on techniques for extracting energy from the waste as a renewable resource, establishing sorting, collection, and biogas production units, where a disposed of the large part of the waste will benefit it, and production of electrical energy, also the possibility of producing of organic fertilizer, will reduce the levels of pollution caused by solid waste.**



Any ?

**Thank you for
your listen**