International Journal of
Biological Engineering and Agriculture

ISSN: 2833-5376
Volume 2 | No 9 | Sep -2023

Conversion of Waste to Energy in Iraq: A Review

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Abstract: Waste-to-energy (WTE) is a process of converting waste into electricity or heat. It is a sustainable and environmentally friendly way to manage waste, and it can help to reduce greenhouse gas emissions and reliance on fossil fuels. Iraq generates a large amount of waste each year, and WTE has the potential to play a significant role in meeting the country's energy needs. This research paper provides an overview of WTE technologies, their benefits and challenges, and their potential for application in Iraq. It also reviews the current status of WTE development in Iraq and identifies opportunities for future growth. The paper concludes that WTE has the potential to be a valuable tool for Iraq's waste management and energy sectors. However, it is important to carefully consider the specific needs of Iraq when selecting and implementing WTE technologies.

Keywords: Waste to energy WTE, Solid waste management, Landfills, Recyclable materials

1. INTRODUCTION

Iraq, a country located in the Middle East, faces significant challenges in the energy sector[1]. Despite being one of the world's largest oil producers, Iraq still struggles to meet growing energy demands, leading to frequent power outages and dependence on imported electricity[2]. First. To address these problems and diversify energy sources, Iraq is exploring alternative energy production methods, including waste-to-energy (WTE). Waste to energy is a process that involves converting various types of waste, such as municipal solid waste (MSW), into usable forms of energy, such as electricity, heat or fuel[3]. This approach has attracted global attention due to its potential in addressing environmental and energy challenges. In Iraq, the government has recognized the importance of WTE and introduced new legislation to support the use of solid waste to produce electricity and methane[4]. The implementation of WTE projects in Iraq could have a significant impact on the economy, society and the environment. Some of the benefits associated with WTE transformation efforts include,

Energy production : WTE projects can help meet the country's energy needs by producing electricity and other forms of energy from waste[5]. This can reduce dependence on fossil fuels and contribute to more sustainable energy sources[6]. Waste management: Iraq faces challenges in solid waste management, with Baghdad province alone generating between 8,000 and 10,000 tons of waste per day[7]. WTE projects can help address these challenges by providing sustainable solutions for waste disposal and reducing the need for landfill space[8].

Environmental protection: Burning waste, a common practice in Iraq, can have adverse effects on air quality and public health[9]. WTE conversion can help mitigate these impacts by providing a more controlled and efficient method of waste disposal[10].

Job creation and economic growth: Developing WTE projects can create new job opportunities and stimulate economic growth through investment in infrastructure and technology[11]. This can contribute to the overall development of the country and improve people's living standards. To effectively implement WTE projects in Iraq, a variety of methods and techniques can be used[12]. These include pyrolysis, gasification, combustion, anaerobic digestion, bio hydrogen production and landfill gas recovery[13]. Additionally, energy can be recovered from waste in the form of waste-derived fuels, bio-oil, coal, compost and biogas, among others[14]. The Government of Iraq, in collaboration with the Ministry of Environment, the City of Baghdad, the Investment Authority and the Ministry of Construction, Housing and Urban Affairs, is working to develop new legislation to support WTE projects[15]. The initiative aims to create simple rules for investors, encouraging investment in electricity and methane production from solid waste[16]. Waste-to-energy in Iraq is a promising alternative for the country's energy needs. By implementing WTE projects, Iraq can address energy challenges, improve waste management practices and contribute to a more sustainable and resilient future[17].

2.LITERATURE REVIEW

2.1. Waste-to-Energy in Iraq

Iraq is a country with a rich history and culture, but it is also a country that faces a number of challenges, including environmental ones. One of the biggest environmental challenges facing Iraq is waste management[18]. The country produces a large amount of waste each year, and much of it is not disposed of properly[19]. This leads to a number of problems, including pollution, health hazards, and land degradation.Waste-to-energy (WTE) is a process that converts waste into electricity or heat[20]. WTE can be a sustainable and environmentally friendly way to dispose of waste, as it reduces the amount of waste that goes to landfills and incinerators[21]. WTE can also help to reduce greenhouse gas emissions and provide a renewable source of energy[22].Iraq has a significant potential for WTE development. The country produces a large amount of waste each year, including municipal solid waste (MSW), agricultural waste, and industrial waste[23]. Much of this waste is organic, which means that it can be converted into energy using a variety of WTE technologies.

2.2. Waste Generation in Iraq

Iraq is a lower-middle-income country with a relatively low waste generation rate[24]. In 2021, Iraq generated about 1.2 kg of waste per person per day, significantly lower than the global average of 2.01 kg per person per day. The main waste sources in Iraq are municipal solid waste (MSW), agricultural waste and industrial waste[25]. MSW is the largest source of waste in Iraq, accounting for approximately 60% of total waste generated. Agricultural waste is the second largest source of waste, accounting for about 30% of total waste generated. Industrial waste is the smallest waste source in Iraq, accounting for about 10% of total waste generated[26]. The majority of MSW in Iraq is generated in urban areas. The main sources of MSW generation in urban areas are households, businesses and public agencies[27]. The main source of MSW generation in rural areas is from households and agricultural activities. Agricultural waste in Iraq comes from a variety of sources, including crop residue, livestock manure and food processing waste[28]. The main sources of industrial waste in Iraq are the oil and gas industry, manufacturing industry and construction industry[29]. Waste management in Iraq is a challenge[30]. The country has a limited number of landfills and waste treatment facilities[31]. As a result, a significant portion of waste in Iraq is disposed of in uncontrolled landfills or burned. This can lead to environmental and health problems.

2. 3. WTE Technologies

WTE Technologies is a company that develops and markets waste-to-energy (WTE) technologies[19]. The company's flagship technology, flameless combustion, is a process that uses oxygen-deficient conditions to convert exhaust gases into electricity or steam[32]. Flameless combustion is considered significantly more efficient and environmentally friendly than traditional WTE technologies, e.g., WTE Technologies targets its technology at various industries, including the process industry, power generation, steel industry and petrochemical industry[33]. The company's technology can be used in a variety of industrial applications, including:

- Coal gasification
- Carbon black industry
- Energy production
- Steel industry
- Petrochemical industry
- Refining
- Upstream oil and gas production

In addition to WTE Technologies, there are a number of other companies and organizations developing and commercializing waste-to-energy (WTE) technology. These technologies can be divided into three categories:

thermal, biochemical and mechanical[34]l.

1.WTE thermal technology uses heat to convert waste into energy. The most common WTE thermal technology is incineration, which involves burning waste at high temperatures to generate steam or electricity[35]. Other WTE thermal technologies include pyrolysis and gasification, which can be used to produce a variety of products including synthetic fuels, biochar and syngas.

2. WTE biochemical technology uses biological processes to convert waste into energy. The most common WTE biochemical technology is anaerobic digestion, which uses bacteria to decompose organic waste in the absence of oxygen to produce methane[36]. The methane can then be used to produce electricity or heat.

3. WTE mechanical technology uses mechanical processes to convert waste into energy[37]. The most common mechanical WTE technology is landfill gas energy recovery, which involves collecting and burning landfill-generated methane to produce electricity[38].

In addition to the above technologies, here are some other WTE technologies being developed and commercialized:

- Hydrothermal carbonization (HTC): HTC is a process that uses high temperature and pressure to convert wet waste into a coal-like substance called hydrochar[39]. Hydrochar can then be used as a fuel or feedstock for other chemical processes.
- Pyrolysis: Pyrolysis is the process of using heat to decompose organic matter in the absence of oxygen. Pyrolysis can be used to produce a variety of products, including syngas, bio-oil, and biochar[40].
- Gasification: Gasification is the process of using heat and oxygen to convert organic matter into flammable gases[41]. Gasification can be used to produce electricity, heat or synthetic fuels.

These are just a few examples of the many WTE technologies currently being developed and commercialized. WTE technology has the potential to reduce the amount of waste sent to landfills and generate energy and valuable products from waste.

2.4. Benefits of waste to energy Technologies

WTE technology has many advantages, including:

- Reduce the amount of waste going to landfill: WTE can significantly reduce the amount of waste sent to landfills[42]. This is important because landfills are a major source of methane, a greenhouse gas that is 25 times more potent than carbon dioxide at trapping heat in the atmosphere.

- Reduce greenhouse gas emissions: WTE can also help reduce greenhouse gas emissions by replacing fossil fuels. When WTE plants produce electricity, it can be used to replace electricity produced from coal, natural gas and other fossil fuels.

- Renewable energy sources: WTE is a renewable energy source because it uses waste as fuel. This means it does not contribute to the depletion of limited resources such as oil and coal[43].

- Job creation: WTE plants create jobs in construction, operations and maintenance of facilities[44]. They also support indirect employment in the transport and waste management sectors.

2.5. disadvantages of waste to energy Technologies

Disadvantages of waste-to-energy technology include:

- Air pollution: Waste-to-energy facilities can emit a variety of air pollutants, including particulate matter, nitrogen oxides, sulfur dioxide, carbon monoxide, dioxins, furans, and heavy metals[45]. These pollutants can cause a range of health problems, including respiratory problems, heart disease, cancer and neurological problems.

- Destruction of recyclable materials: Waste-to-energy facilities burn all types of waste, including recyclable materials such as paper, metal and plastic[46]. This destroys recyclable materials that could otherwise be reused or recycled, wasting resources and contributing to climate change.

- High investment and operating costs: Building and operating waste-to-energy facilities is expensive. This can make it a less effective waste management option than other methods, such as recycling and landfilling[47].

- Encourage waste reduction and recycling: Some people believe that waste-to-energy facilities can discourage waste reduction and recycling because they create a demand for waste[48]. If people know that their waste will be burned for energy, they will be less likely to reduce or recycle waste.

- Ash and other residues: Waste-to-energy facilities generate ash and other residues that must be disposed of[49]. These ashes can contain dangerous contaminants and can be expensive to dispose of properly. In addition to these general disadvantages, there are specific disadvantages associated with different types of waste-to-energy technologies. For example, trash incineration plants can produce dioxins and furans, which are highly toxic chemicals[50]. Gas-to-energy facilities in landfills can produce methane, a greenhouse gas more potent than carbon dioxide.

Overall, the disadvantages of waste-to-energy technologies must be carefully weighed against their potential advantages. Waste-to-energy plants can reduce the amount of waste sent to landfills and produce electricity or other forms of energy. However, they can also emit air pollutants, destroy recyclable materials, and are expensive to build and operate.

3.RESULT AND DISCUSSION

The development of WTE in Iraq could bring many positive benefits to the country[51].

First, WTE could help reduce Iraq's dependence on fossil fuels. Iraq currently depends heavily on oil and gas to produce electricity. This makes the country vulnerable to fluctuations in global energy prices[52]. WTE can help mitigate Iraq's exposure to these risks and make its energy sector more resilient.

Second, WTE can improve Iraq's energy security. Iraq currently faces a number of challenges in meeting its energy needs, including aging infrastructure and frequent power outages. WTE can help improve Iraq's energy security by providing new, reliable and affordable electricity[53].

Third, WTE can create jobs and boost the local economy. WTE plants require a highly skilled workforce to operate and maintain them. They also create indirect jobs in the waste collection and transportation sector[54]. WTE development in Iraq could help create thousands of new jobs and boost the local economy.

Fourth, WTE can help improve Iraq's environment. WTE plants reduce the need for landfills and incinerators, which are significant sources of pollution[55]. WTE plants can also help reduce greenhouse gas emissions. The development of WTE in Iraq could help improve the country's air quality and reduce its environmental impact[56].

Overall, the development of WTE in Iraq could bring some significant benefits to the country. This could help reduce Iraq's dependence on fossil fuels, improve energy security, create jobs and boost the economy[57]. It could also help improve Iraq's environment.

However, it is important to note that a number of challenges must be addressed before WTE can be widely deployed in Iraq. These challenges include a lack of waste management infrastructure and the high cost of WTE technology[58]. The Iraqi government will need to find ways to address these challenges to make WTE a viable option for Iraq.

4. CONCLUSION

Waste-to-energy (WTE) in Iraq is a promising solution to the country's growing waste management challenges and dependence on fossil fuels. WTE technology can help reduce the volume of waste sent to landfills, produce electricity and other forms of renewable energy, and create new jobs and economic opportunities. Iraq has significant potential for WTE development, with more than 40 million tons of municipal solid waste generated each year. The country also has several WTE facilities, including the Baghdad Municipal Solid Waste Incinerator, which has been in operation since 2008. However, several challenges need to be addressed to scale up WTE in Iraq. Including:

Lack of investment: Developing new WTE installations requires significant investment. The Iraqi government will need to work with the private sector to attract the necessary financing.

Public perception: There is a need to increase public awareness of the benefits of WTE and address any concerns about the potential environmental impact of these technologies.

Legal framework: The Iraqi government must develop a comprehensive legal framework for the WTE sector. This will help ensure that WTE facilities are operated in a safe and environmentally sound manner.

5. RECOMMENDATIONS

The following recommendations are made to the Iraqi government to support the development of the WTE sector:

- Provide financial incentives to private sector companies to develop new WTE facilities.
- Raise public awareness of the benefits of WTE and address any concerns about the potential environmental impact of these technologies.
- Develop a comprehensive legal framework for the WTE sector.
- Support the development of new markets for recycled materials.
- Promote sustainable development through the use of WTE technology.

By implementing these recommendations, the Iraqi government can help ensure that the country's WTE sector grows in a sustainable and profitable manner.

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