

JORDAN



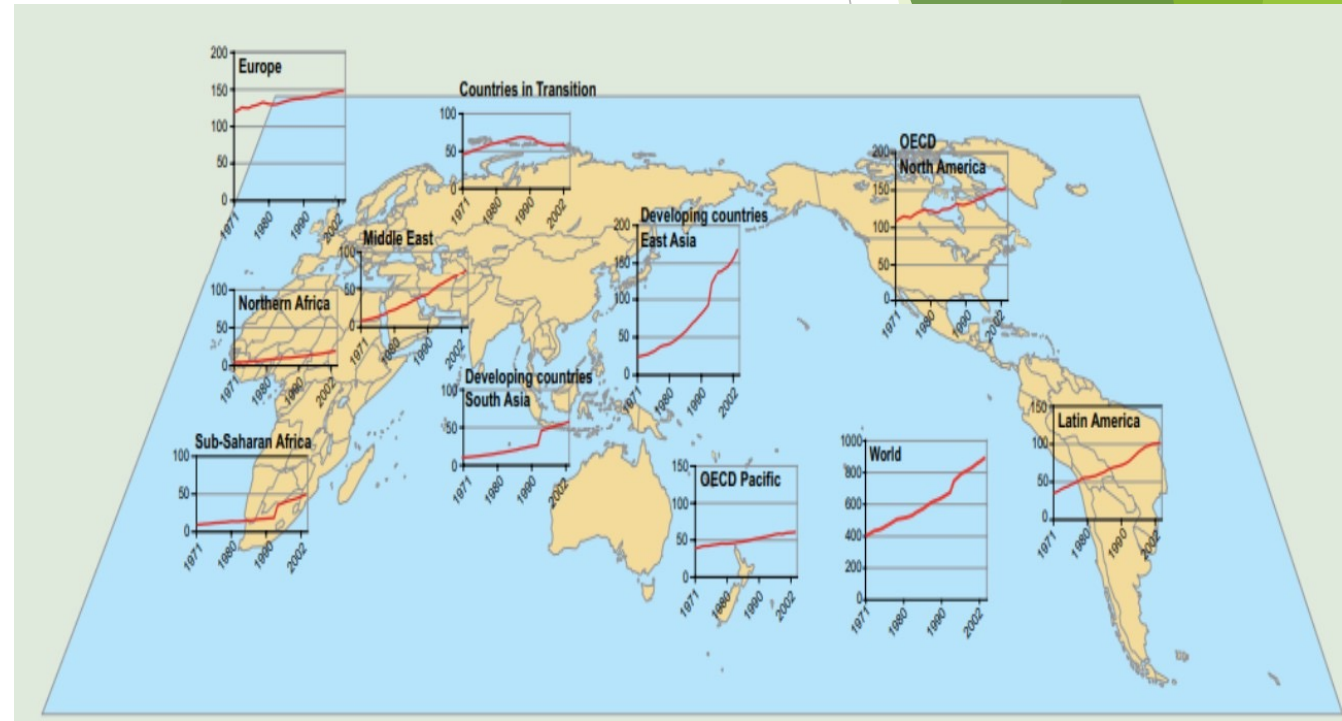
# Potential of Waste to Energy: Current & Future Prospects

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Global WtERT Congress 2023- Hangzhou - China

# Introduction & Background

- ▶ According to The World Bank in 2050 the world will generate an annual amount of 3.5 billion tons of Municipal Solid Waste (MSW).
- ▶ 40% of waste generated worldwide is not managed properly which may cause environmental and public health problems.



IPCC, 2007

# BACKGROUND: JORDAN

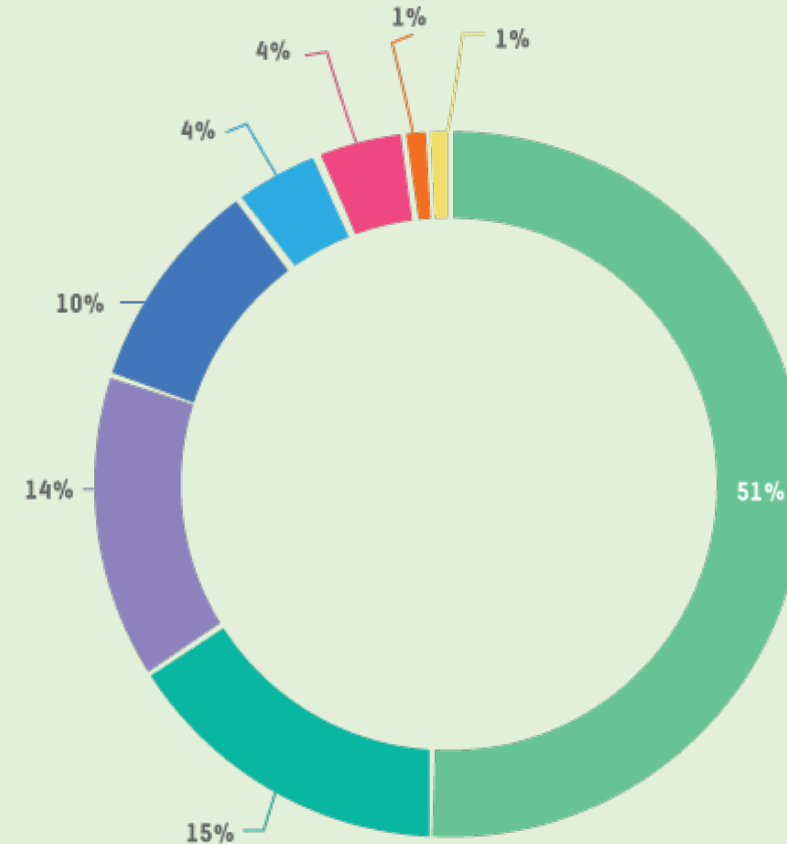
- Jordan is a Middle Eastern country.
- With middle-income, and a territory of 89,34 km<sup>2</sup>.
- Has 11.5 million inhabitants.
- Annually generates 3.3 million tons of MSW
- More than 90% disposed into landfills
- Suffers from scarcity of natural resources (e.g., water and energy resources).
- lacks domestic fossil fuel sources and depends on fuel import.
- In 2020 the country imported 91% of its demanded energy.
  - Oil & Gas import accounts for 19% of the total national budget → **Challenge**



- **Waste-to-energy an attractive option:**
  - contribute to decreasing the dependency of the country on imported oil.
  - reduce the amount of emissions by adopting clean energy technologies.

**Jordan generates an annual amount of 3.3 million tons of solid waste**

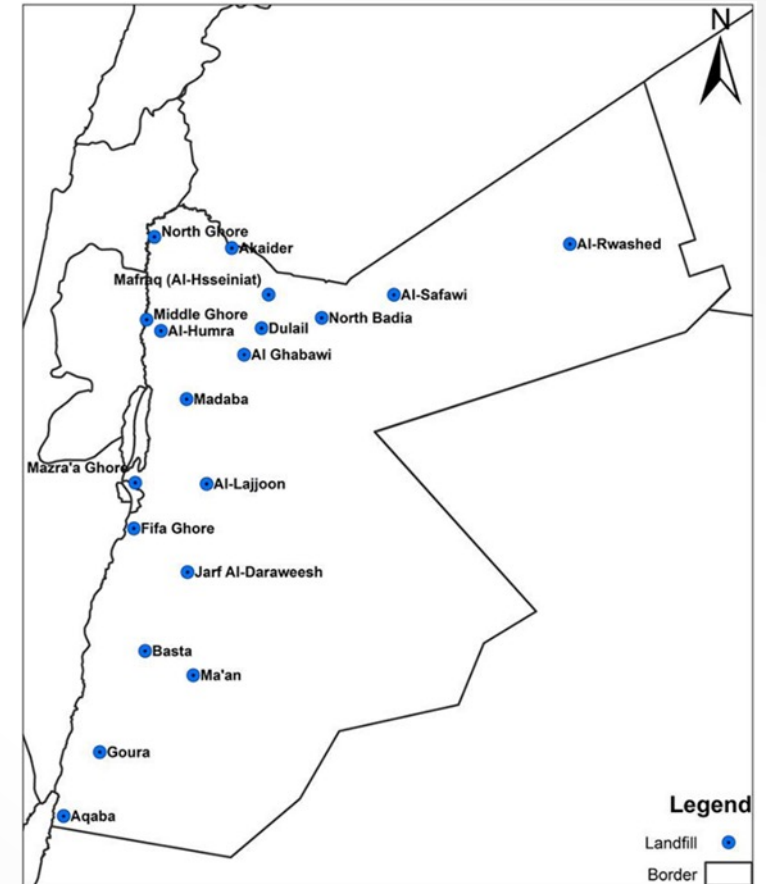
**MSW COMPOSITION IN JORDAN**



● BIOWASTE (ORGANIC) ● PLASTICS ● PAPER / CARDBOARD ● OTHER ● METALS ● GLASS ● TEXTILE ● WOOD AND GARDEN

# SOLID WASTE MANAGEMENT IN JORDAN

- Traditional options in waste management are predominant.
- 19 official disposal sites in different governorates of the country
  - One sanitary engineered landfill (Al Ghabawil landfill) serving the governorates of Amman and Zarqa,
  - The second largest landfill in the country is being rehabilitated to become a sanitary one.
  - All the remaining disposal sites are classified as unsanitary landfills (dump sites).
- Estimated annual disposed amount is 2,8 million tons/year, With an annual increase of 3%, while refugees increased this amount to 10%.



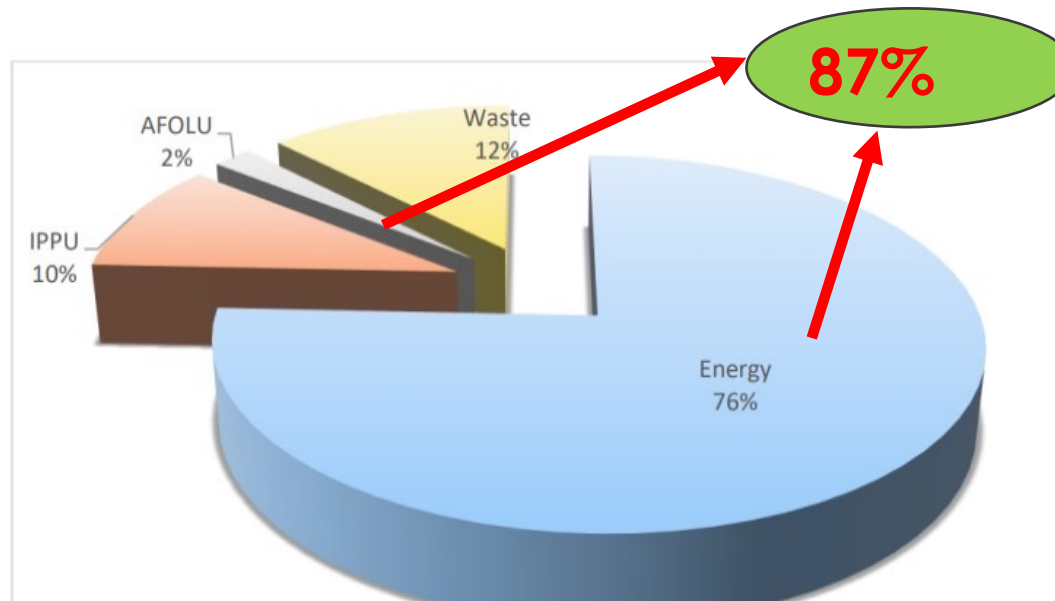
# RENEWABLE ENERGY IN JORDAN



- The installed capacity of renewable energy in 2019 was 1423 MW (Minister of EMR, 2019).
- The National Energy Strategy (2015-2025) calls for increasing the share of renewable energy in the total energy mix of the country TO 20% BY 2025.
- The strategy states that the main renewable energy share in electricity generation came from solar and wind energy with a share of 6%.

# JORDAN'S GREENHOUSE GASES EMISSIONS

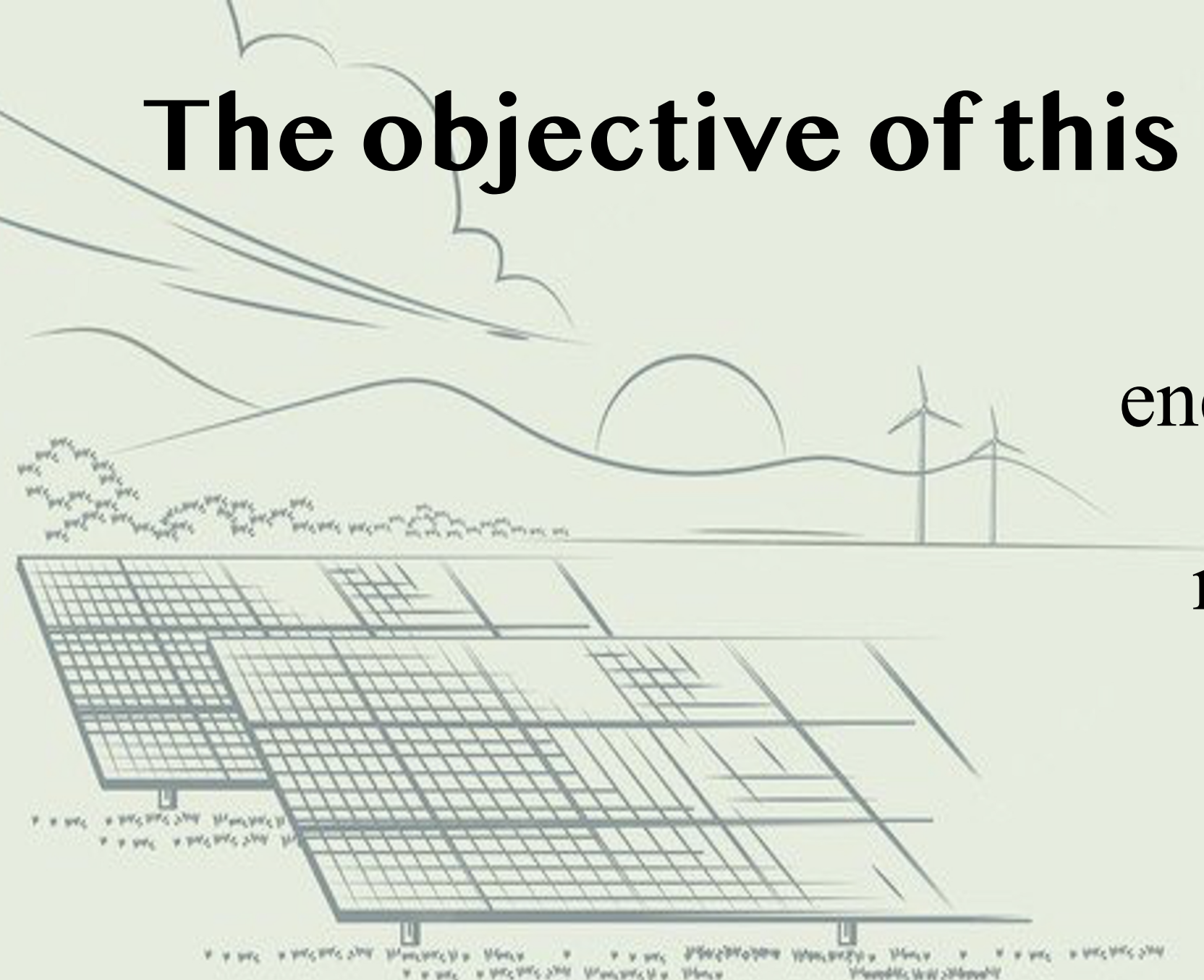
Categories	Emissions CO <sub>2</sub> Equivalent (Gg)	Percentage of the overall
<b>Total National Emissions and Removals</b>	<b>32646.79</b>	<b>100%</b>
<b>Energy</b>	24701.38	75.66%
<b>Industrial Processes and Product Use</b>	3247.38	9.95%
<b>Agriculture, Forestry, and Other Land Use</b>	651.67	2.00%
<b>Waste</b>	4046.37	12.39%



Jordan 4<sup>th</sup> NC UNFCCC

# The objective of this paper

To assess the energetic potential of waste to energy running projects as well as the future ones.

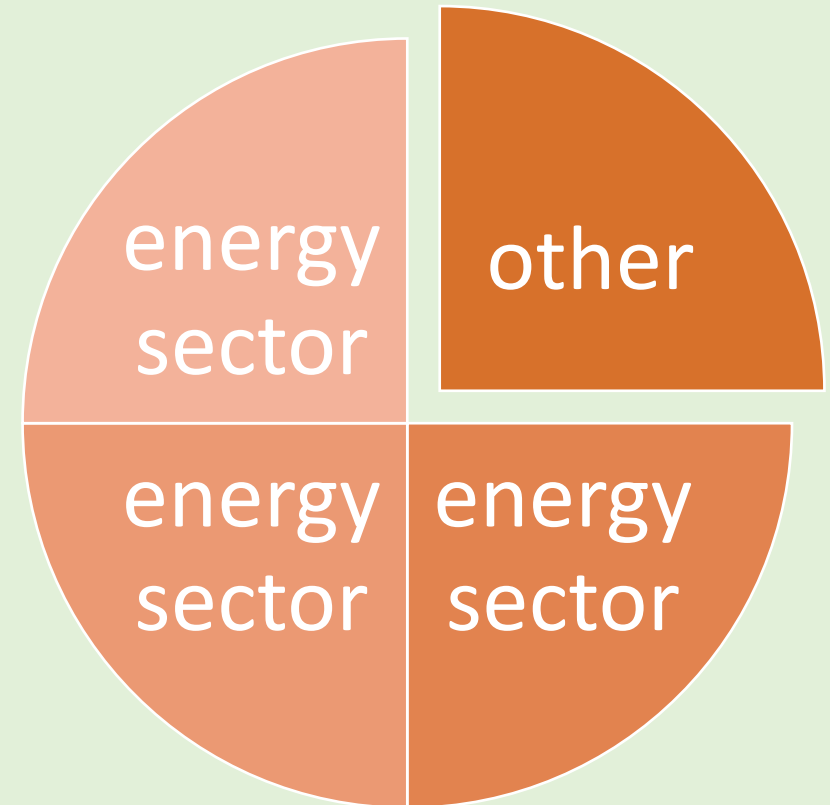




# Waste to energy potential in Jordan


## To date:

1. Jordan follows traditional options in waste management
2. 90% of the solid waste disposed into landfills and dump sites
3.  $\frac{3}{4}$  of the greenhouse gases (GHGs) in Jordan is coming from energy and waste sectors



# Waste to energy potential in Jordan


## Municipal solid waste



Calorific value  
= 2747 kcal/kg

- In case energy recovered from the generated waste it will contribute to 6% of oil consumption in the year 2000

# Waste to energy potential in Jordan



**Agriculture  
residues (5.83  
million tons)**

**42% of  
agriculture  
residues =**

- 313.14 million cubic meter of biological power
- 847.39 GWh of power potential

# National Strategies



## Jordan Vision 2025

Decrease the solid waste amount by 33%



## Jordan Energy Strategy 2020-2025

Increase the share of renewable energy to 20% by 2025



## National Solid Waste Management Strategy 2015

promoting waste-to-resources and waste-to-energy interventions

# LANDFILL BIOGAS

## Biogas from Landfills

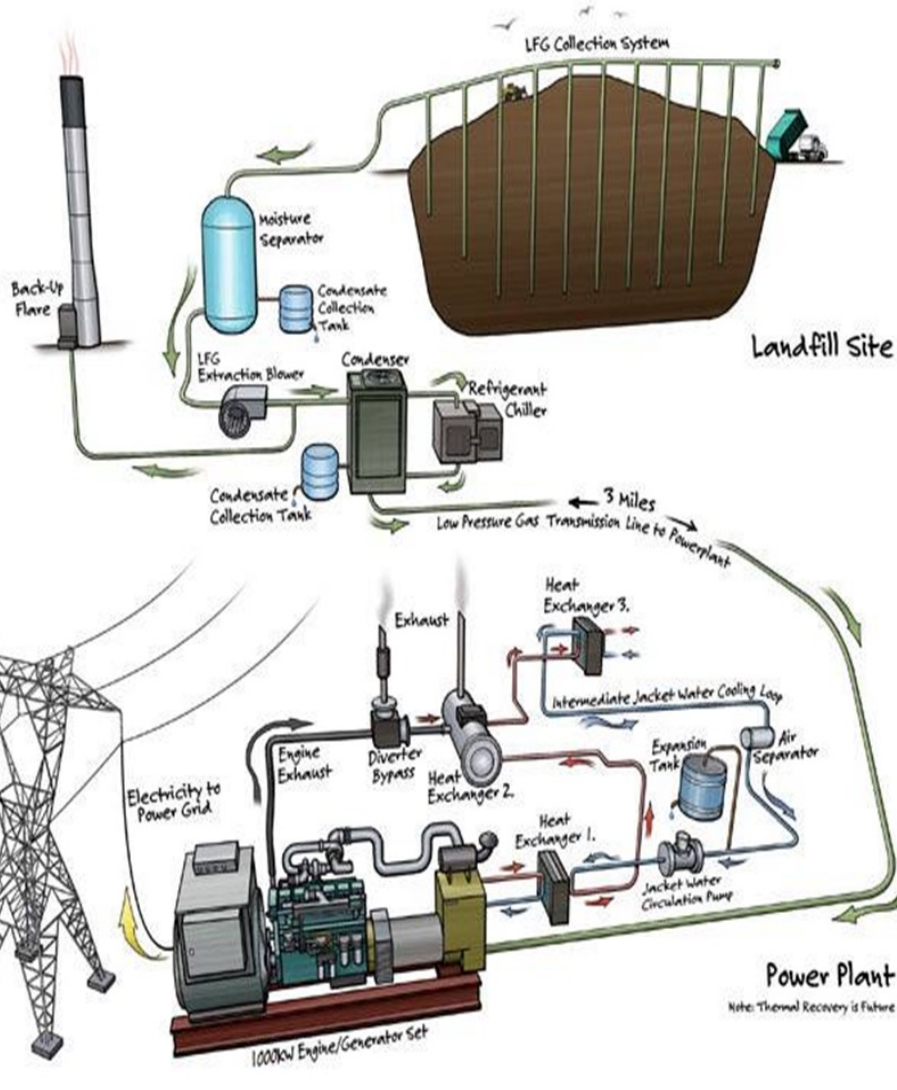
- Landfill biogas in Jordan began in 2000.

### 1. Al-Ghabawi Landfill

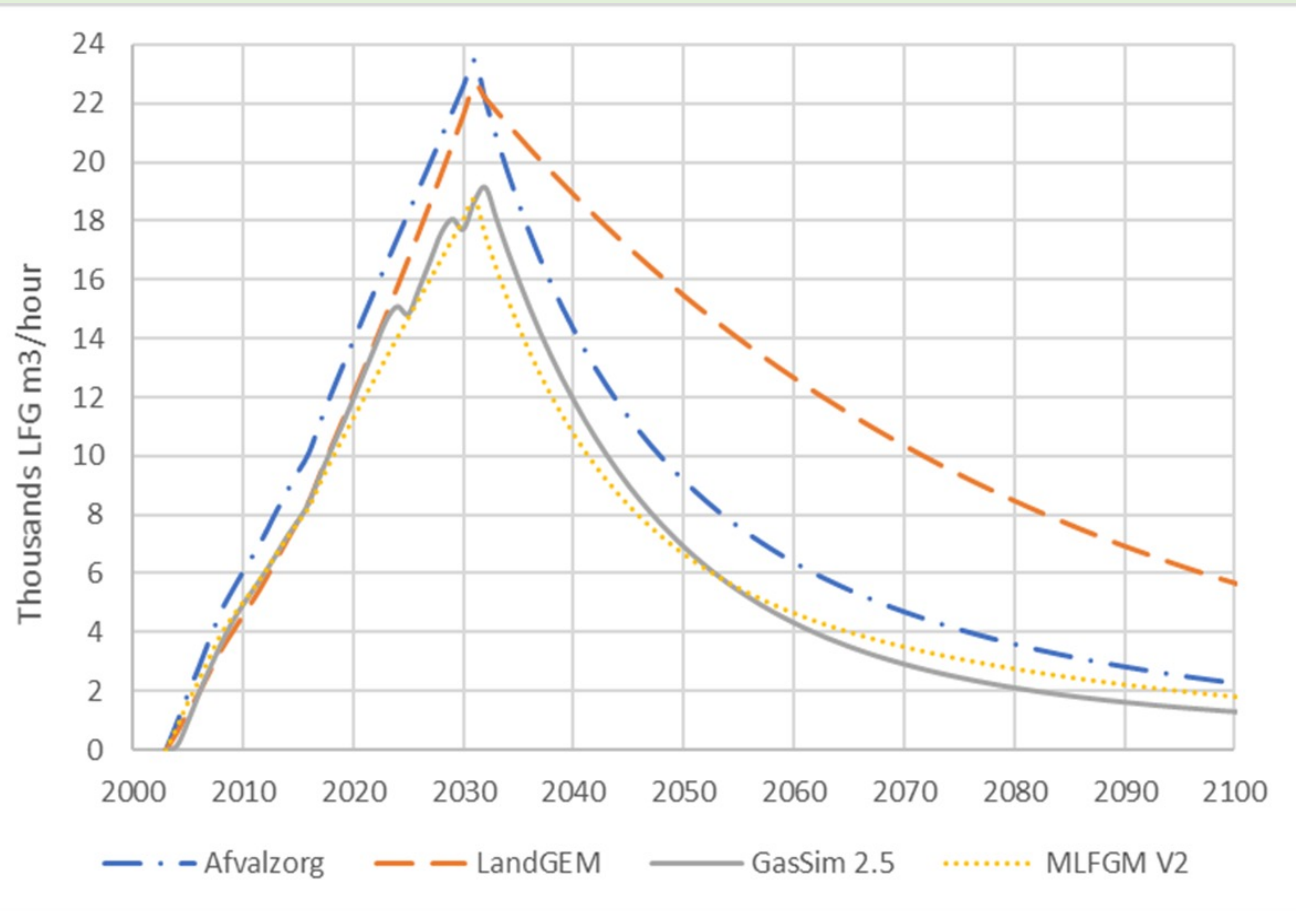
- The largest in Jordan, receives 50% of the country's solid waste.
- Currently operates a 4.8 MW biogas project (BOT) at the Ghabawi sanitary landfill.

### 2. Russaifah Landfill

- 4 MW from a closed landfill in Russaifah.
- 84 Biogas wells
- Production declined due to reduced biodegradation within the landfill.



# Energetic potential of the landfills in Jordan



A recent study estimates a potential of **34.8 MW from major landfills in Jordan** (Abu Qdais et al. (2023).

. This utilization could mitigate **18 million tons of CO<sub>2</sub>eq between 2020-2030**

Simulated landfill gas emissions data (Abu-Qdais et al., 2023)

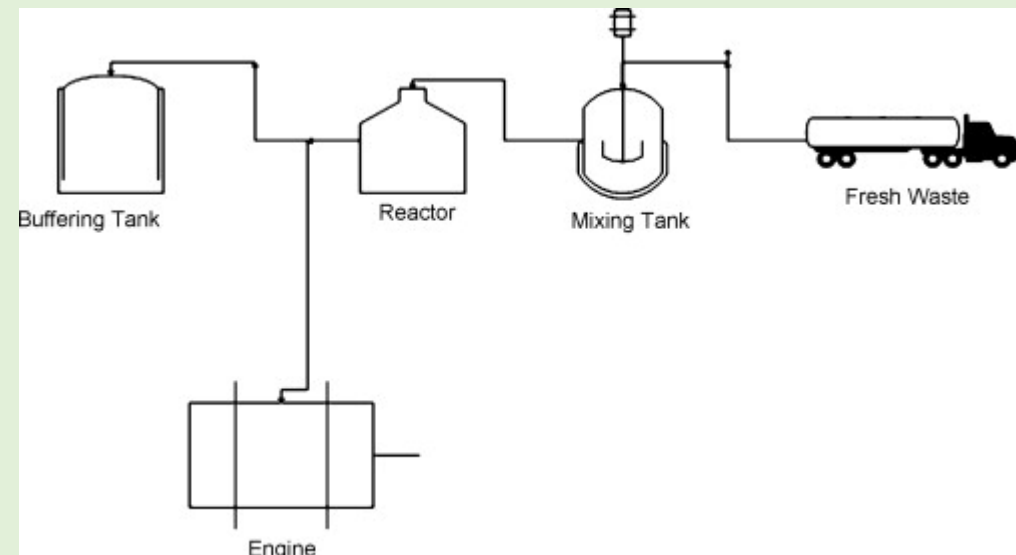
# Sewage Sludge Anaerobic Digestion

- All the recently constructed wastewater treatment plants in Jordan are equipped with digester systems
- Al-Samra plant generates 6.5 MW from sludge in a combined heat and power (CHP) system.
- Wadi Shallala plant produces 0.58 MW from sludge.

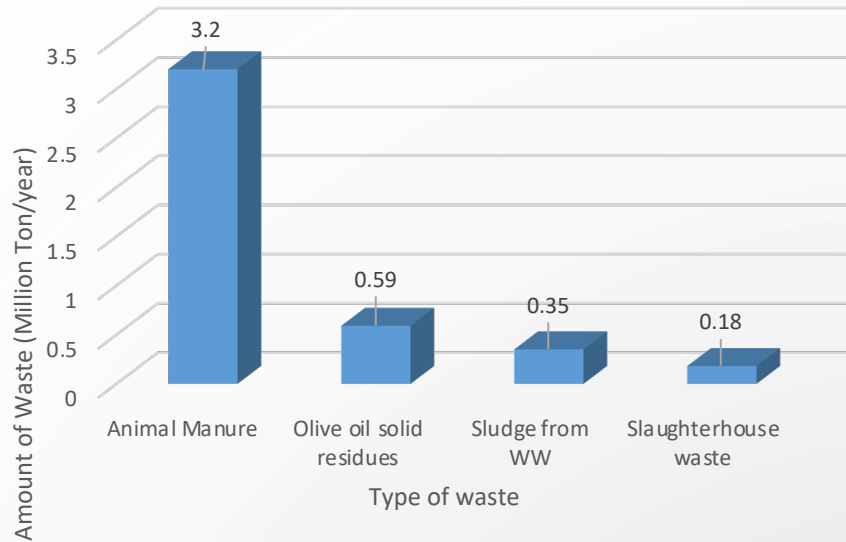


# Anaerobic Digestion

Electricity generation from waste digestion started taking place in Jordan in the year 2001. Anaerobic digestion demonstration plant with **1MW capacity** was built nearby the closed landfill in Russaifah. The plant capacity has been increased in **2008 to about 4 MW..**



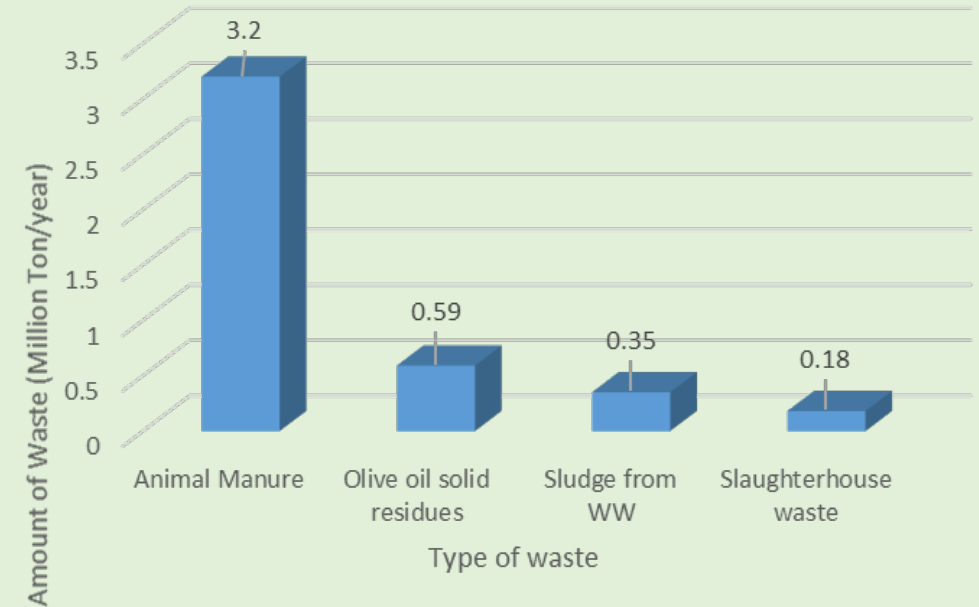
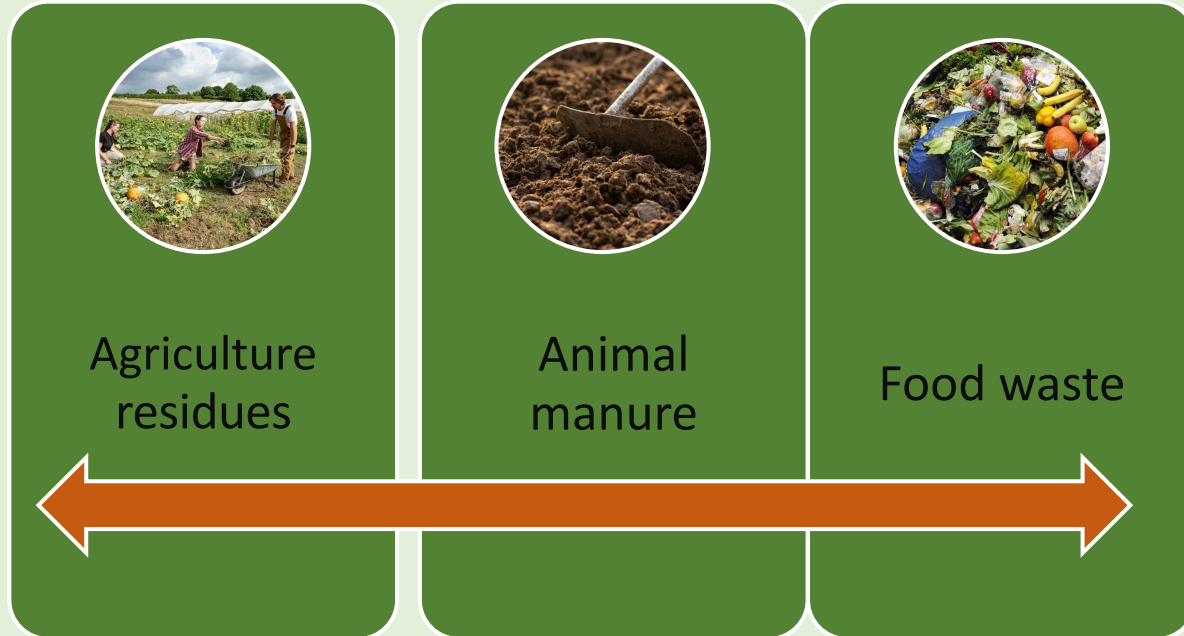




Amounts of different types of biowaste generated in Jordan in 2018  
(Adapted from Ababneh, 2018)

- The potential power and the amount of electrical energy that can be obtained from bio-gasification of animal waste, slaughtering, and sewage sludge is about 37.02 MW and 64452 Mwh/a, respectively.
- While considering the biodiesel production from olive waste residue will yield an annual amount of 28,253,184 liters/year. (Ababneh, 2019).

# Energy from Biowaste



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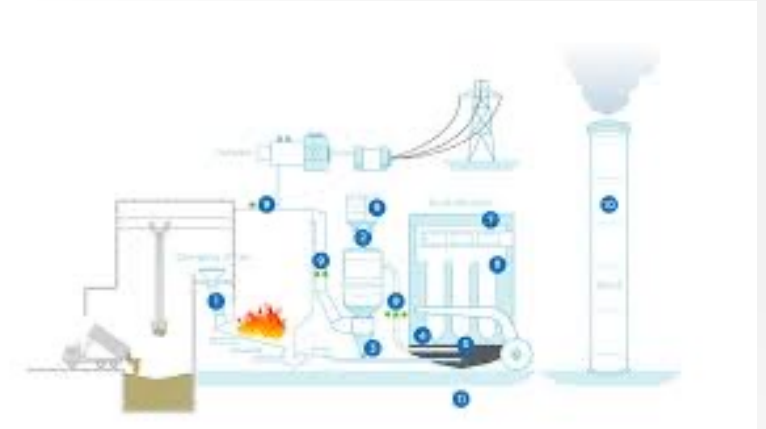
**157 000 tons (toe)**

# Incineration



Incineration of solid waste is not widely practiced in Jordan. There are small scale incinerators from 3-5 tons that incinerate medical waste without energy recovery

# INCINERATION IN JORDAN



- Incineration of solid waste is **limited** in Jordan.
- Mainly **small-scale** incinerators for medical waste with no energy recovery.
- **Potential for Energy Recovery:** 50% of solid waste in Jordan is **suitable** for energy recovery via incineration with an **estimated energy** of 340 kWh/ton (Al Jaradeen, 2016).
- **Innovative Modeling:** Thabit et al. (2020) developed a software model to simulate incineration using Jordan's waste characteristics.
- **Promising Results:** Modeling indicates that incinerating municipal solid waste could yield:
  - 23 MWe of power.
  - 8,500 m<sup>3</sup> /day of desalinated water.

# RESEARCH ACIVITIES WTE JORDAN



PERGAMON

Energy Conversion & Management 41 (2000) 983–991

**ENERGY  
CONVERSION &  
MANAGEMENT**

[www.elsevier.com/locate/enconman](http://www.elsevier.com/locate/enconman)

## Energy content of municipal solid waste in Jordan and its potential utilization

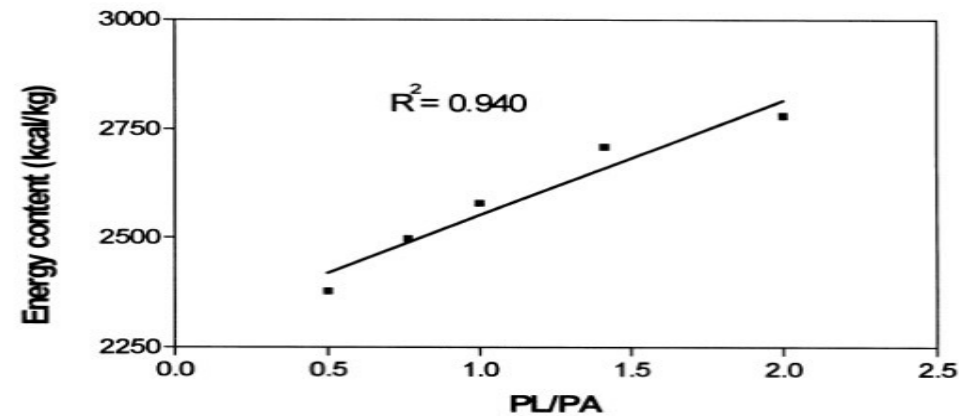
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*M. Abu-Qudais, H.A. Abu-Qdais / Energy Conversion & Management 41 (2000) 983–991*

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# RESEARCH ACIVITIES WTE JORDAN



Contents lists available at ScienceDirect

## Resources, Conservation and Recycling

journal homepage: [www.elsevier.com/locate/resconrec](http://www.elsevier.com/locate/resconrec)

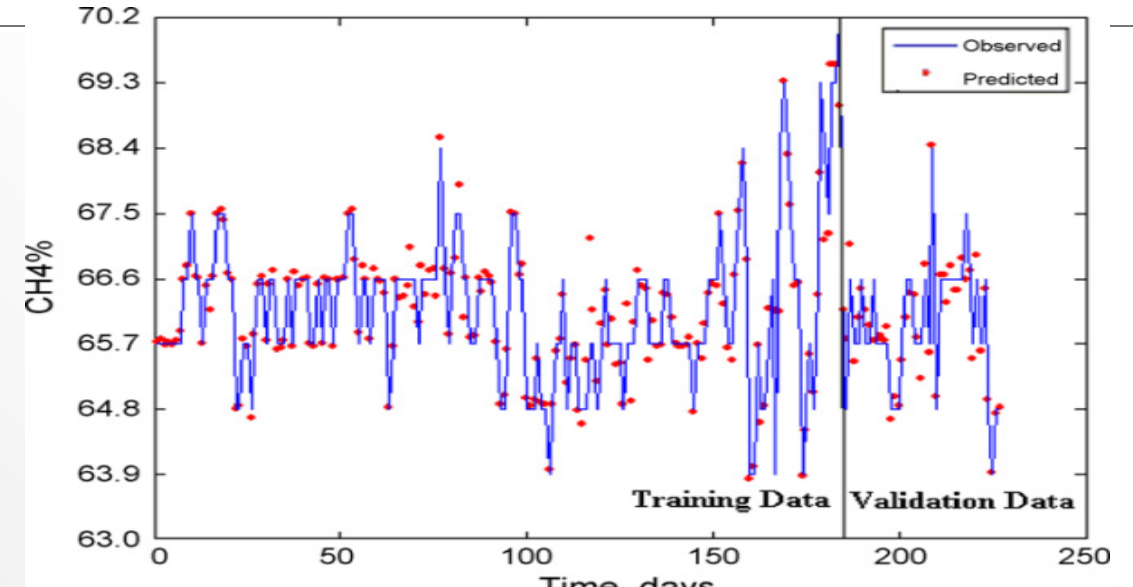
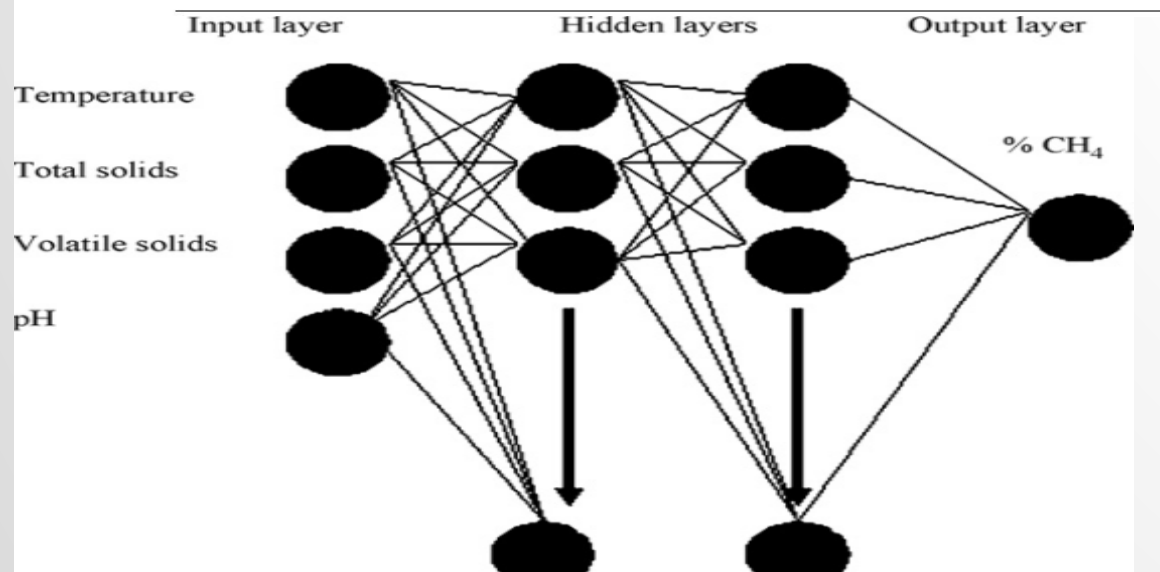


## Modeling and optimization of biogas production from a waste digester using artificial neural network and genetic algorithm

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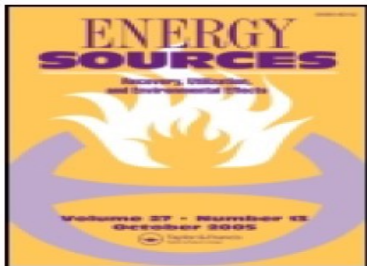
<sup>b</sup> Civil and Architecture Engineering Department, Qatar University, P.O. Box 2713, Doha, Qatar



# RESEARCH ACTIVITIES WTE JORDAN



## Pilot Landfill Biogas Plant



## Energy Sources, Part A: Recovery, Utilization, and Environmental Effects

ISSN: 1556-7036 (Print) 1556-7230 (Online) Journal homepage: <http://www.tandfonline.com/loi/ueso20>

Taylor & Francis  
Taylor & Francis Group

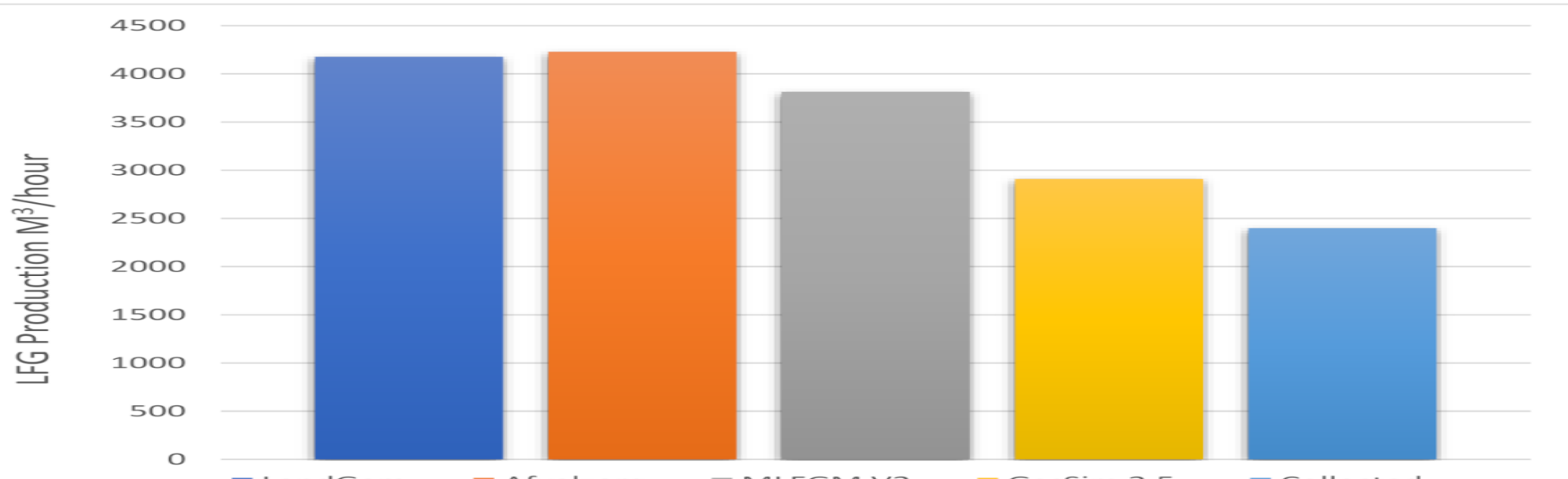
## Energetic and Methane Emission Reduction Potentials from an Unsanitary Landfill

H. A. Abu Qdais , A. M. Maqableh , L. M. Al Nawayseh & N. M. Al Jamal

Article

# Assessment of Greenhouse Gas Emissions and Energetic Potential from Solid Waste Landfills in Jordan: A Comparative Modelling Analysis

Hani A. Abu-Qdais \*, Ziad Al-Ghazawi and Abdallah Awawdeh





**Thank You**  
For Your Attention!

Any Questions

