This presentation premiered at WaterSmart Innovations

watersmartinnovations.com

watersmart
INNOVATIONS

WATER, ENERGY AND CLIMATE NEXUS: THE ROLE OF UNDERUTILIZED RENEWABLE ENERGY

JULIET OHEMENG-NTIAMOAH

Department of Civil and Environmental Engineering

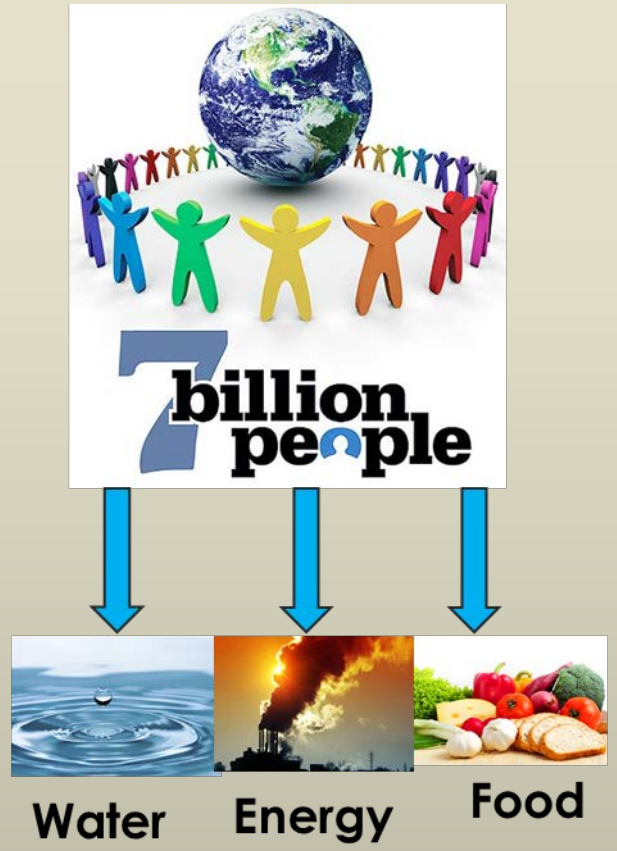
Tennessee Technological University

PRESENTATION OUTLINE

- INTRODUCTION
- WATER, ENERGY AND CLIMATE NEXUS
- WATER CONSERVATION STRATEGIES
- WASTEWATER AS A RESOURCE
- ENERGY RECOVERY FROM WASTEWATER
- ROLE OF ANAEROBIC DIGESTION
- FUTURISTIC APPROACH OF WATER RESOURCE RECOVERY (CASE STUDIES)

INTRODUCTION

- World population is increasing and consequently exerting stress on resources, particularly water, energy and food.
- Given the current global population growth rate (1.13% per year), there is the need to maximize resource conservation measures. [1]
- Water and energy conservation has received significant attention over the past decades.

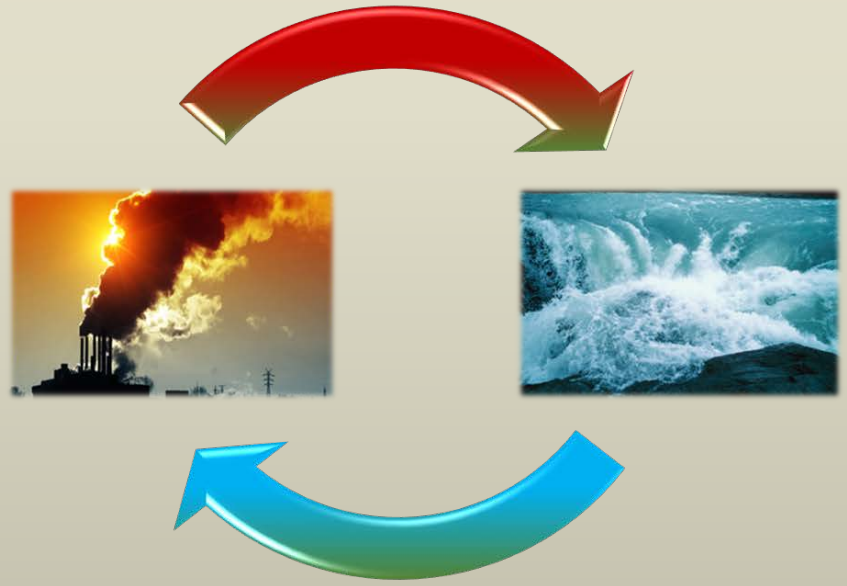


WATER,ENERGYAND CLIMATE NEXUS

In the US, About 56.6 billion kWh per year used in the water sector. [2]

USGS estimates total water use of 355,000 Mgal/day [3]

- **Energy for Water:**
  - Drinking water Treatment
  - Distribution of drinking water
  - Wastewater Treatment



- **Water for Energy:**
  - Hydropower
  - Thermoelectric cooling
  - Fuel production (biofuels/ethanol, Hydrogen)

Climate

- Most of the energy use is accompanied by green house emissions

WATER CONSERVATION STRATEGIES

- Improved faucets
  - Automated shutoff valves
  - Motion sensor-activated faucets

- Water efficient toilets
  - low flush models
  - Dual flush models

- Increased reclaimed water use

81% of power plants proposed for construction have one WWTP within a 10-mile radius, and those plants could provide a sufficient cooling water supply [4]

- But what happens to the other resources in wastewater?

WASTEWATER AS A RESOURCE

- Wastewater can be viewed as a resource not just for water but as **energy** and nutrient resource.

- **The energy potential of wastewater is10 times more than the energy used to treat it**. [5]
  - It takes about 15kWh to treat a gallon of wastewater.

- Hence, some WWTPs are aiming at becoming net zero or net positive treatment facilities.

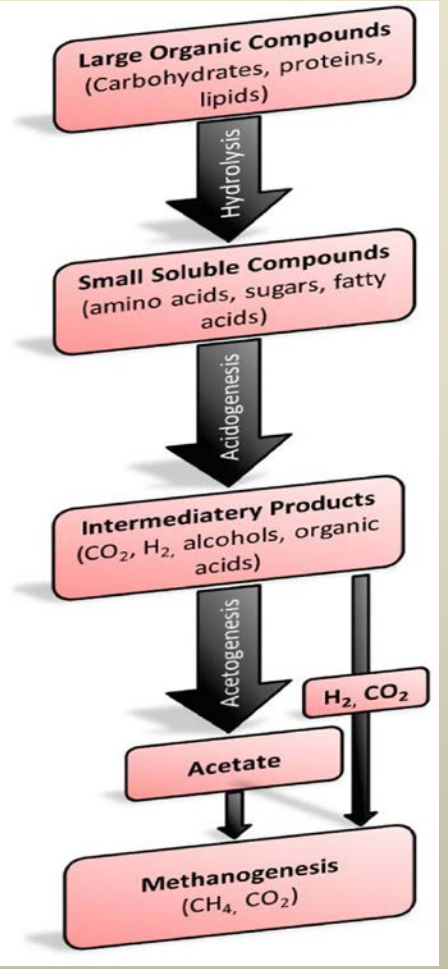
ENERGY RECOVERY IN WASTEWATER

The most conventional technologies for recovering energy in wastewater:

- Thermal processes such as incineration
- Microbial Fuel Cells (conversion of organic energy into electricity)
- Anaerobic digestion (by far, the most economic and well established process for energy recovery in wastewater)

ANAEROBIC DIGESTION

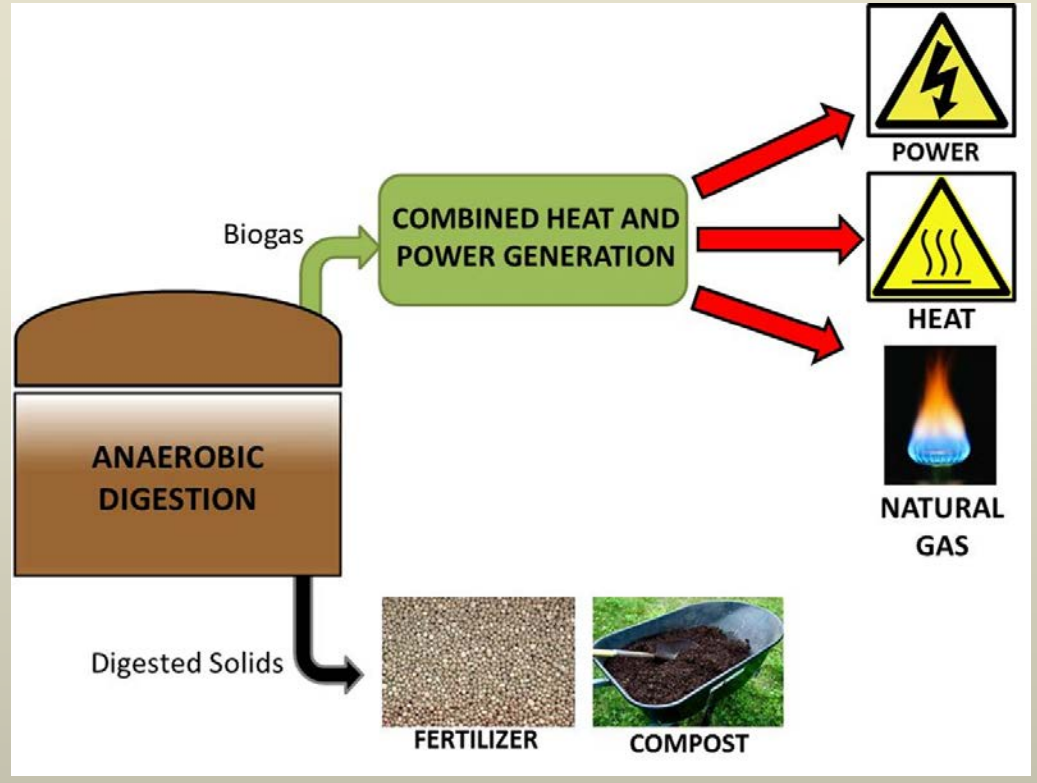
- Anaerobic digestion is the degradation or decomposition of complex organic matter into methane and CO_2 by microorganisms in the absence of oxygen.
- Anaerobic digestion occurs naturally in oxygen-free environments such as marshes, sediments, wetlands and digestive tracts of ruminants
- For several decades, anaerobic digestion has been applied in many industries, agricultural sector, and most particularly in wastewater treatment facilities



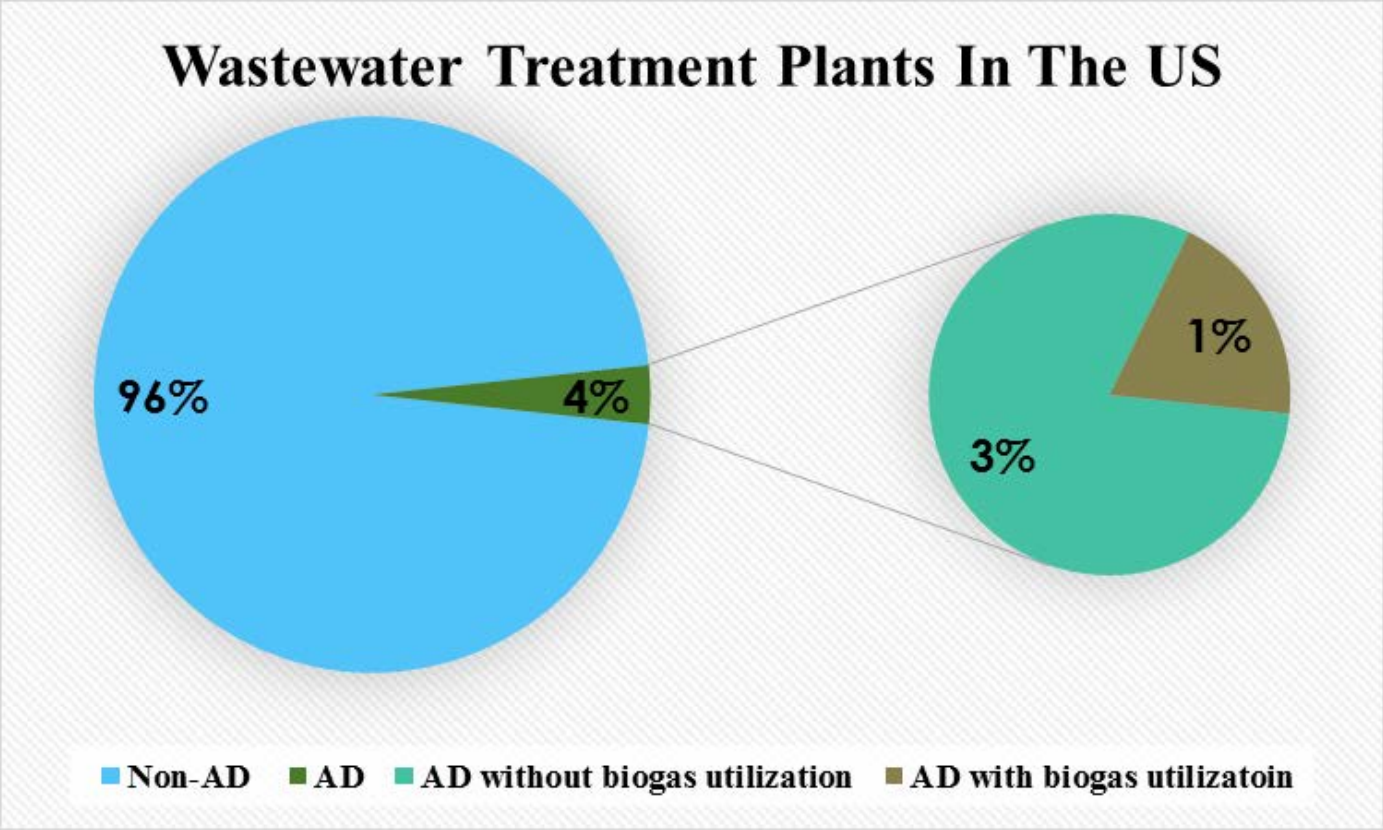
BENEFITS OF ANAEROBIC DIGESTION

- Biogas can be converted to **Heat, Electricity or injected in Natural Gas Pipelines**

- Digested Solids can be composted to be used as **soil amendments and fertilizers**



CLIMATE BENEFIT OF ANAEROBIC DIGESTION



- There are currently 16000 wastewater treatment plants in the US:
  - Only 544 employ anaerobic digestion and only 106 out of the 544 utilize the biogas that is produced.
  - EPA estimates that if all 544 were utilizing their biogas, that would be equivalent to removing emissions of 430,000 cars! (EPA, 2007)

ANAEROBIC CO-DIGESTION

- Co-digestion is the process of adding supplemental feedstocks to anaerobic digester with the aim of augmenting biogas yield.
- Most WWTPs have digesters of excess capacities which can be utilized by co-digesting the wastewater sludge with organic waste.
- Also, most states are banning landfilling of organic waste and co-digestion gives the opportunity of organic waste diversion which helps protect land and water from pollution.

FUTURISTIC APROACH

- It is estimated that wastewater treatment accounts for about 3% of the US electrical load.
- With increasing stringent regulatory standards, it is probable that the energy requirements of wastewater treatment plants would increase.
- It is therefore, imperative that wastewater treatment facilities become more sustaining by generating their own energy through enhanced (co-generation) anaerobic digestion systems.
- There are currently a few facilities that have already set the pace of being energy neutral.

CASE STUDY: **EBMUD**

- East Bay Municipal Utility District (EBMUD) in Oakland, California is wastewater treatment plant that employs anaerobic co-digestion.

- Co-digests sewage sludge, food scraps, waste streams from wineries and poultry farms and organic fraction of municipal solid waste.

- EBMUD is currently energy self-sufficient and sells excess biogas to the electrical grid.

Biogas production saves EBMUD approximately $3m yearly.

CASE STUDY: **BIOBUS**

- UK's BioBus, a 40-seat bus that runs on biogas generated from the treatment of sewage sludge and foodwaste.

- A total of 17 million m3 of biomethane, enough to power 8,300 homes, is generated annually at the plant through anaerobic digestion.

REFERENCES

- Copeland, Claudia. "Energy-water nexus: the water sector's energy use."*Congressional Research Service. January* 3 (2014).
- Maupin, M.A., Kenny, J.F., Hutson, S.S., Lovelace, J.K., Barber, N.L., and Linsey, K.S., 2014, Estimated use of water in the United States in 2010: U.S. Geological Survey Circular 1405, 56 p
- U.S. DOE Study, Reuse of Treated Internal or External Wastewaters in the Cooling Systems of Coal-Based Thermoelectric Power Plants
- EPA, CHP. *Opportunities for and benefits of combined heat and power at wastewater treatment facilities*. EPA-430-R-07-003, 6, 2007.
- Water Environment and Re-use Federation

QUESTIONS?

Juliet Ohemeng-Ntiamoah

Department of Civil and Environmental Engineering,

Tennessee Tech University.

Email: johemengn42@students.tntech.edu