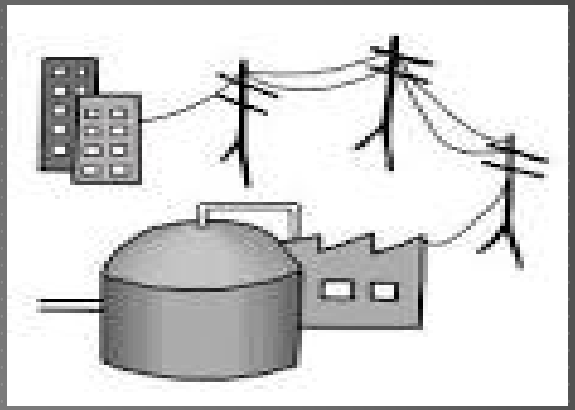
EWACC 2012:

Economic Viability of Utilizing Biogas Technology in Contained Communities in Rural Areas in Egypt

Mohamed El Zayat

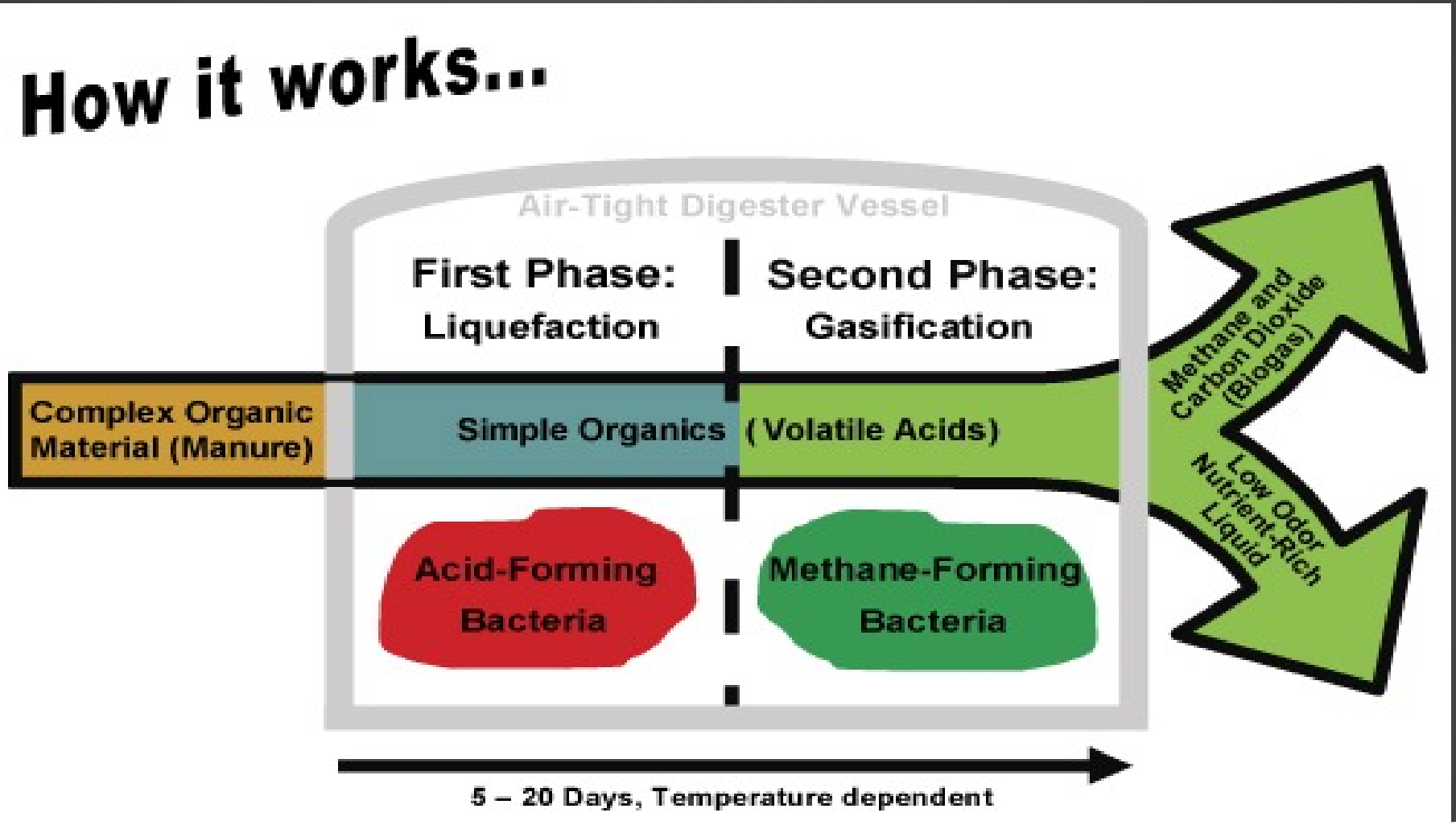


OUTLINE

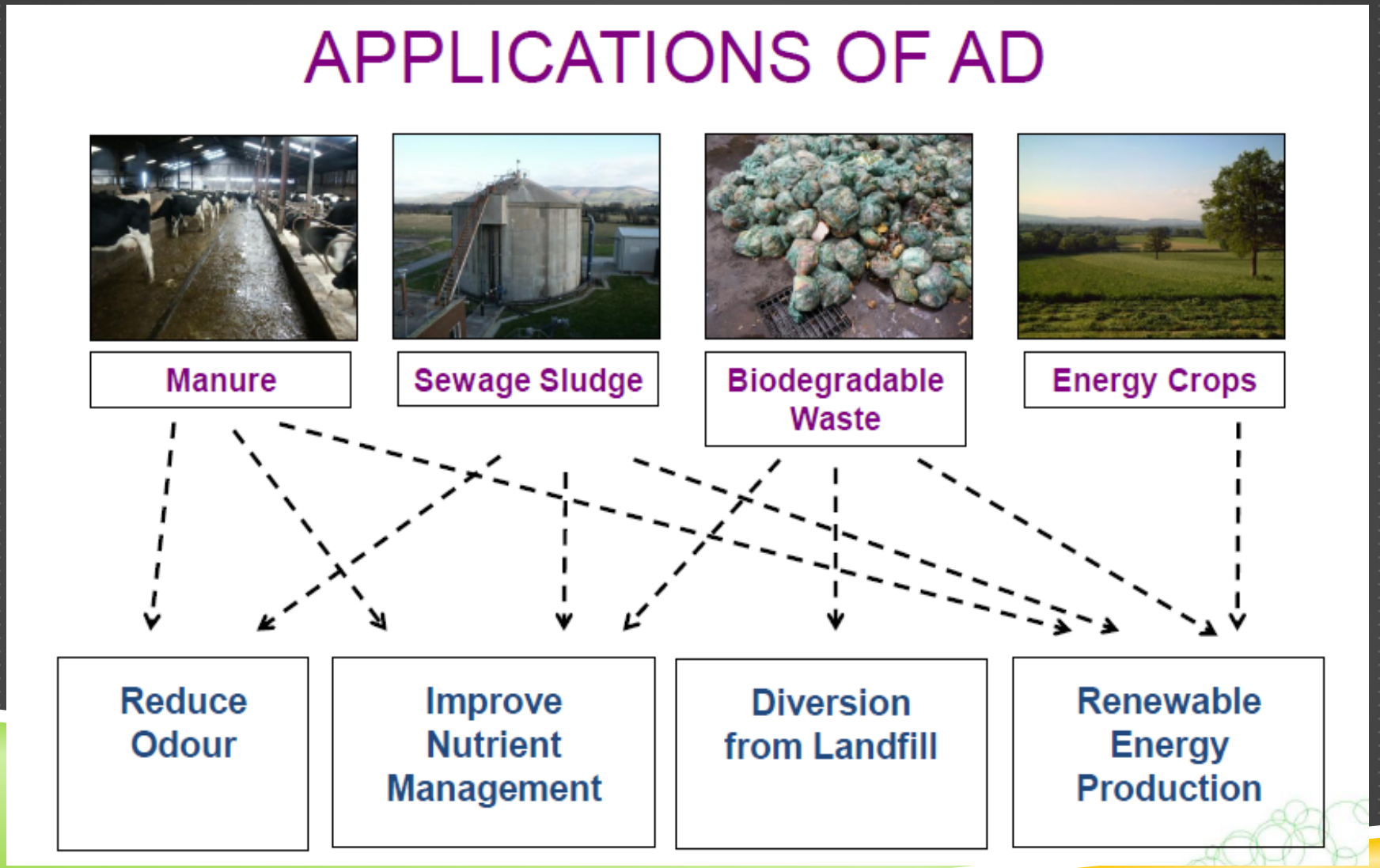
- Introduction
  - Background
  - Research Motivation
  - Objectives
- Methodology
  - Biogas Formation
  - Experimental Design
  - Economic Analysis
  - Carbon Finance
- Results and Discussions
  - Biogas Production
  - Economic Indicators
  - Revenues from Carbon Finance
  - Indirect Effects
- Conclusions and Recommendations
- Q&A

INTRODUCTION

BACKGROUND INFORMATION



RESEARCH MOTIVATION

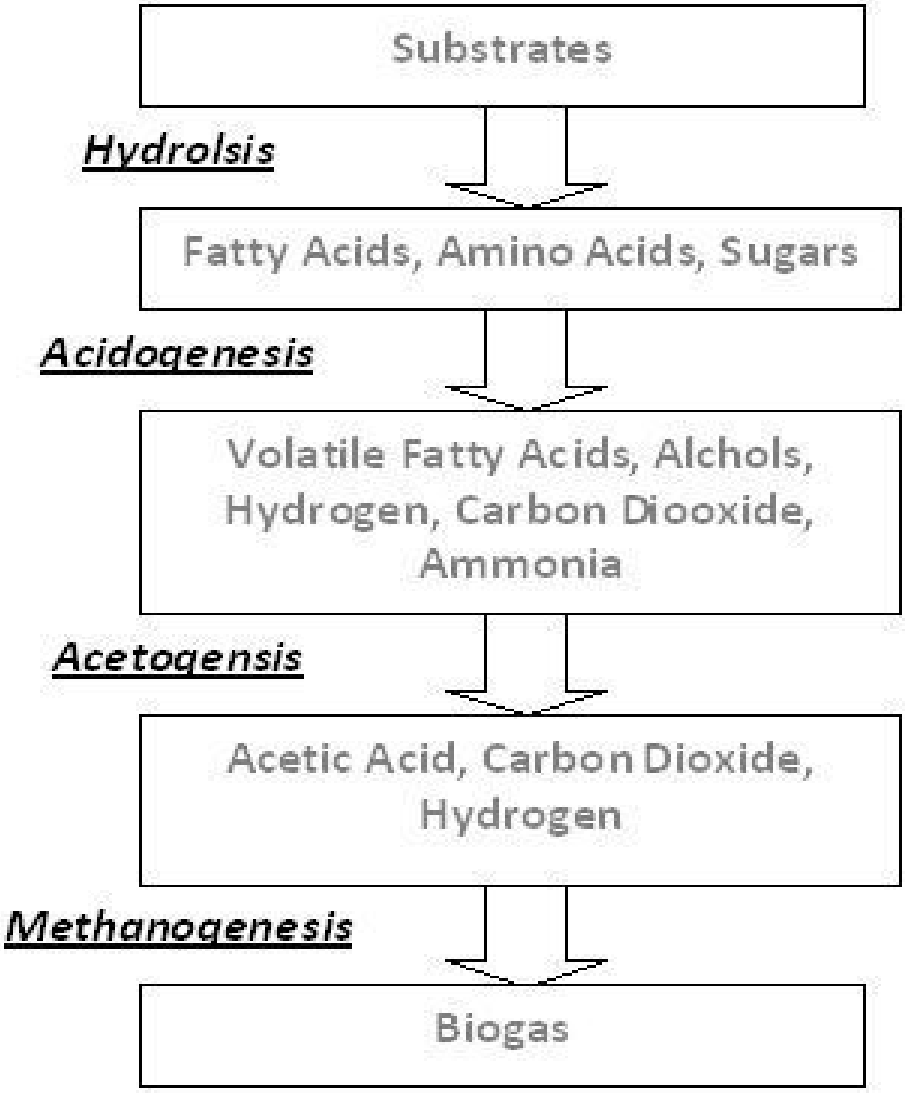


OBJECTIVES

- To conduct the physical experiments under the Egyptian environmental conditions to improve the reliability of the economic evaluation
- To ascertain the economic viability in developing a small scale Biogas system which would be built in contained rural areas in Egypt.
- To assess the socio-economic impacts on households in rural areas
- The anaerobic digester would:
  - Treat all organic food
  - Produce eco-friendly energy
  - Produce green fertilizers

METHODOLOGY

BIOGAS FORMATION



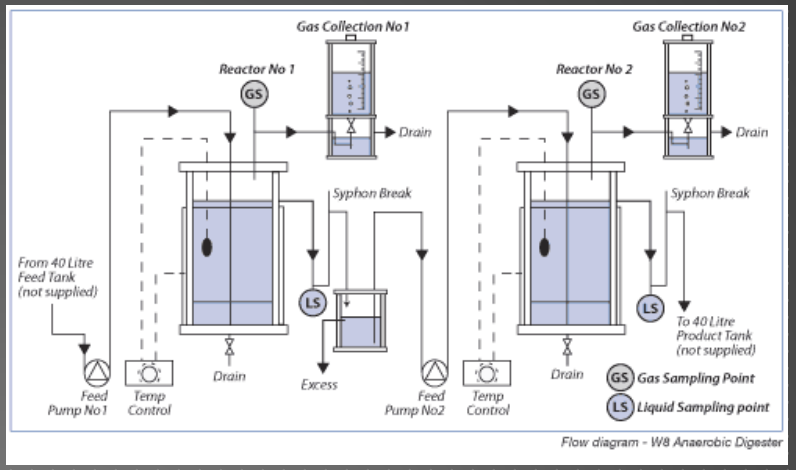
BIOGAS FORMATION (CONT'D)

- Methanogenic bacteria prefers pH conditions of 6.8-7.5
- Biogas formation occurs between 4 and 75°C.
  - Psycophillic (4-20°C),
  - Mesophillic (20-42°C),
  - Thermophilic (42-75°C)

EXPERIMENTAL DESIGN

- Reactor Technology
  - Fixed Dome (FD) digester
  - Up-flow Anaerobic Sludge Blanket (UASB) digester

EXPERIMENTAL DESIGN (CONT'D)



- Bench Scale AD
  - UASB anaerobic digester equipment used is an Armfield Ltd ANAEROBIC DIGESTER (W8) ® system.

ECONOMIC ANALYSIS

- Economic Viability Entails:
  - Analyzing the data using shadow prices
  - Analyzing the indirect costs and benefits of the project,
  - Looking at the overall effect of the project on the economy

- ERR is compared with the SDR not WACC

REVENUES FROM CARBON FINANCE

- "Under the Clean Development Mechanism, emission-reduction projects in developing countries can earn certified emission reduction credits, each equivalent tonne CO_2" – Kyoto Protocol
- The main premise behind the Kyoto Protocol is to limit or reduce greenhouse gas emissions in developed countries
- Allowing the selling of CERS has caused emission reductions to have an economic value
- Amount of CERs depends on AD size and baseline emissions
- Biogas CDM projects varies from 1.76 to 7.0 tCO2/ household/year

United Nations
Framework Convention on Climate Change

RESULTS AND DISCUSSIONS

BIOGAS PRODUCTION (CONT'D)

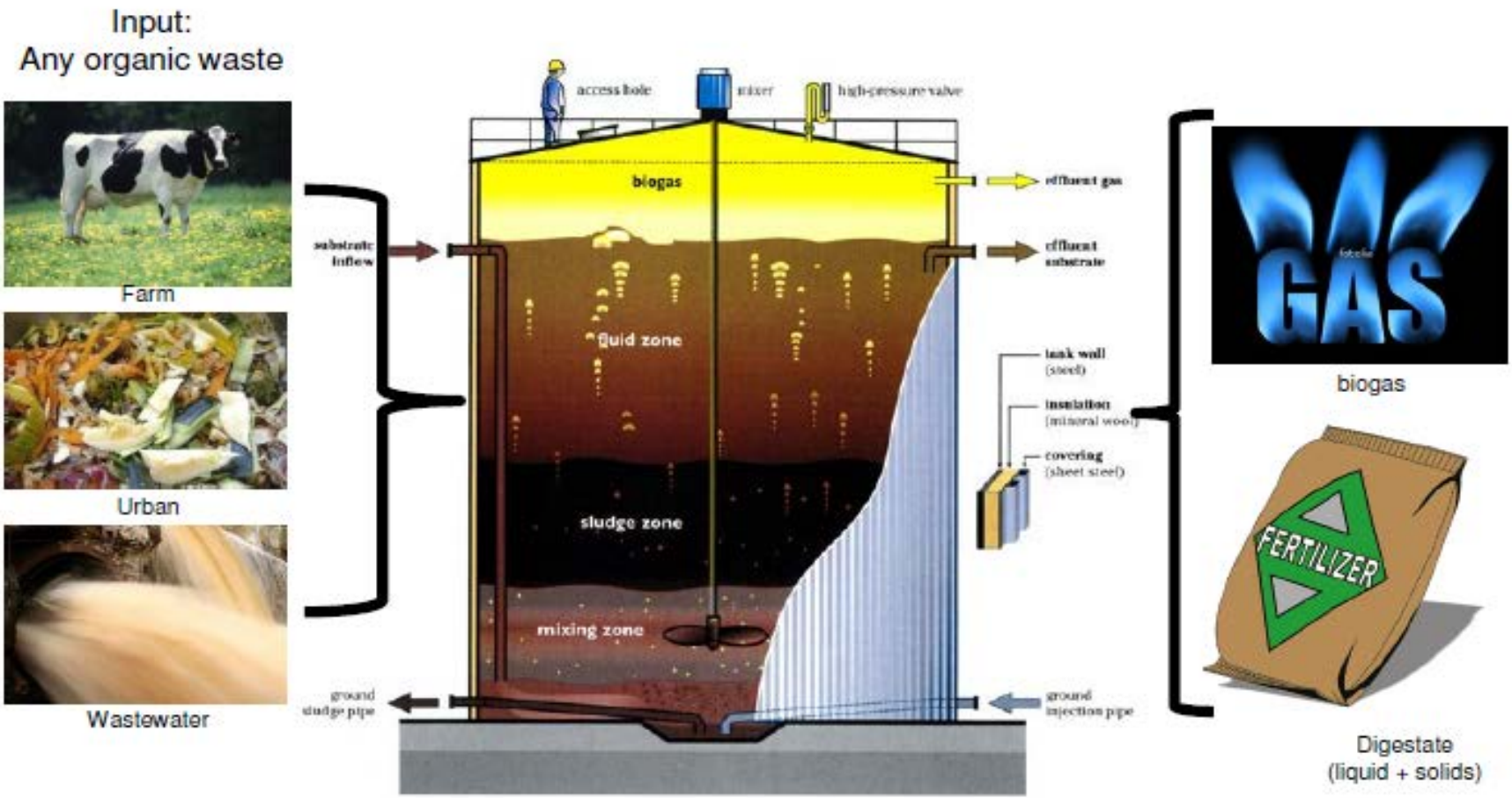
Volumetric Flow Rate	1.70±0.05	L/day (Retention Time–6 days)
pH	6.8~7.5	**-**
Influent COD	7700	mg/L
Effluent COD	900	mg/L
Biogas Production Rate	**0.0053**	Nm^3/day
COD Influent Loading Rate	13.2	g/day
COD Effluent Unloading Rate	1.6	g/day
COD Removal	**88**	%

BIOGAS PRODUCTION (CONT'D)

- 0.01 m3 UASB reactor running at 35° C and the conditions imposed by the feed is capable of producing 0.0053 Nm3 of Biogas per day.
- Scaling up to 1 m3; Biogas yield 0.53 Nm3 per day.
- 0.53 Nm3 is a conservative estimation of a full scale reactor performance.
- 0.89 Nm3 can be used for an average reactor performance scenario.
- Thus, Economic Analysis was performed for these two scenarios.

ECONOMIC ANALYSIS

Digester



www.americanbiogascouncil.org

ECONOMIC ANALYSIS (CONT'D)

Item	**Amount**	**Scenario 1 Conservative Yields (Nm^3/year)**	**Scenario 2 Average Yields (Nm^3/year)**
Animal Manure	350 m^3/year	185.5	311.5
OFMSW	70 tones/year	17,500	29,050
Total Biogas yield		**17,685.5**	**29,361.5**
Methane Fraction	65%	11,500	19,000
Carbon Dioxide	34%	5,950	9,877
Impurities	1%	175	290
Green Fertilizer	**2 -3%**	**36**	**54**

ECONOMIC ANALYSIS (CONT'D)

Economic feasibility study was completed in U.S. Dollars

- SER from 2007 to 2016 using the supply and demand approach and annual devaluation value of 3%. varies from **6.7 up to 8.2 EGP**
- The electricity tariff depends on the amount of monthly consumption per household (**0.05 EGP/ kwh**)
- ADB report "Reforming Energy Subsidies in Egypt", the subsidy is **44%**
- Methane will be used as a household fuel instead of natural gas, the price of methane will be equivalent to the FOB price of natural gas **4.5 USD/MBTU (0.16 USD/Nm3)**
- Avg. price of green fertilizer = **99 EGP/m3 (14 USD/ m3)**

ECONOMIC ANALYSIS (CONT'D)

Initial Capital Cost	**USD**
Reactor, Pumps, Piping	6,620
Accessories, Buffer Tank, Mixing Unit	1,556
Scrubbing/ Drying Equipment	390
Gas storage	260
Sum	**8,827**
O&M	**883**

CARBON FINANCE

- 1.7 tCO2/household /year was used in the conservative approach
- 4.35 tCO2/hpusehold/year was utilized in the second scenario.
- Number of households = 80
- CERs = 140 tCO2/year and 384 tCO2/year
- CERs price = 6.5 USD

It is worth mentioning that the transaction costs are reduced in CPA since it counts for other individual activities in multiple sites at the same time.

ECONOMIC INDICATORS

		Scenario 1 *Conservative Approach*	**Scenario 2** *Average Approach*
Outcome(USD/year)			
Initial Capital Cost		8,568	8,568
Operation and Maintenance Cost		857	857
Income(USD/year)			
Electricity		82	135
Natural Gas		920	1520
Green Fertilizers		504	756
CERs		910	2262
Economic Indicators			
W/O CDM	Pay Back Period (years)	13.20	5.5
	ERR	**Negative**	**12.61%**
	NEPV (USD)	-4, 214	1,861
With CDM	Pay Back Period (years)	5.5	2.04
	ERR (%)	**12.68%**	**43.32%**
	NEPV (USD)	1,892	17,039

INDIRECT EFFECTS

- In addition to the economic indicators, economic contribution or indirect effects of the biogas facilities will be measured in terms of:
  - Value added
  - Employment effect
  - Foreign exchange earnings.

CONCLUSIONS AND RECOMMENDATIONS

CONCLUSIONS AND RECOMMENDATIONS

- Biogas can be utilized:
  - Green energy source,
  - To reduce greenhouse gas emissions and enhance the air quality
  - To generate green fertilizers
- The project showcases an innovative way to use biogas from animal manure and solid waste for energy generation in Egypt.
- Implementing new technology will lead to tech and knowledge transfer.

CONCLUSIONS AND RECOMMENDATIONS

- The project will help contribute to the sustainable development of Egypt through its contribution to the environmental, economic, and social pillars.
- The project will :
  - Have positive value added
  - Create job opportunities
  - Earn foreign exchange as a CDM project
- Thus, it would be in the best interests of the economy as a whole for projects like this are implemented on a greater scale due it is positive impact on the society.

Thank You