NATIONAL DIALOGUE ON CLIMATE ACTION (NDCA)

BIOGAS ROLE IN CLIMATE ACTION

PRESENTER: MOHAMED SAID MOHAMED

Agenda

PART I: Intro

~ 20 min

- What is sustainable development?
- 3 Pillars of sustainable development
- History, timeline
- 17 sustainable development goals
- What is COP
- 3R strategy
- What is climate change?
- Greenhouse gases
- Climate change: Causes and effect
- Climate change: Facts

PART II: Biogas

~ 60 – 80 min

- What is biomass?
- What is biogas?
- Anaerobic condition
- Type and amount of biomass
- Biogas potential
- Add value
- Type of digestors
- Uses
- Slurry (nutrients)
- Pros vs. cons

What is sustainable development?

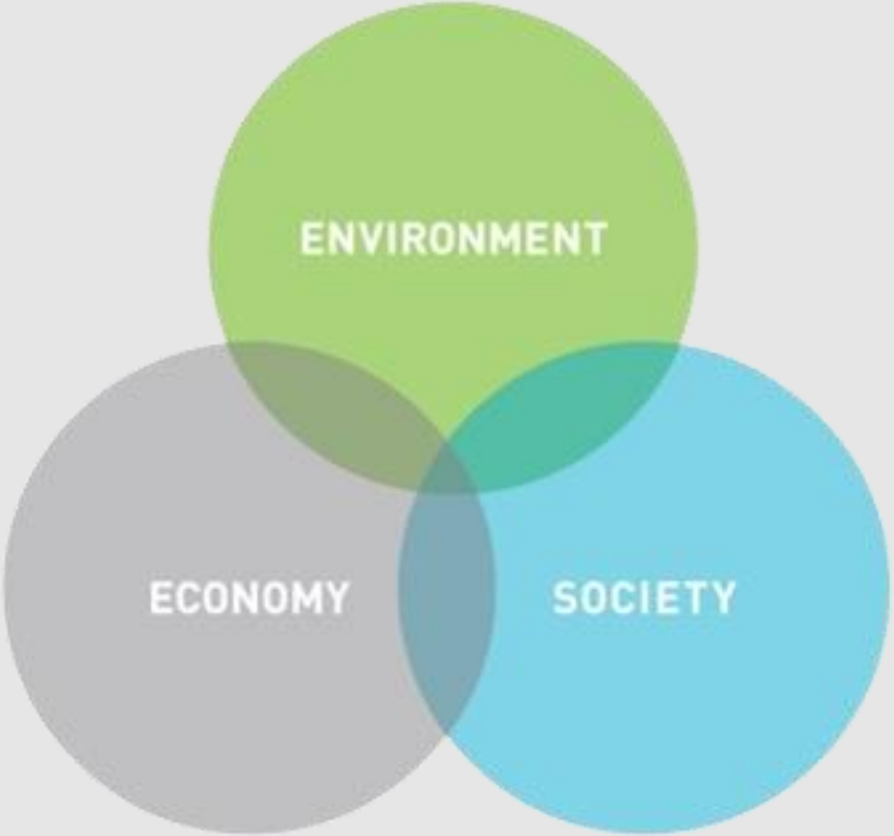
Gro Harlem Brundtland, former Prime Minister of Norway, defines it as: "**development that meets the needs of the present without compromising the ability of future generations to meet their own needs**" - Our Common Future (Report World Commission on the Environment and Development report, 1987).

3 Pillars of sustainable development

Economic sustainability: which aims to reduce extreme poverty and guarantee fair paid employment for all.

Environmental sustainability: which aims to protect the natural balance of the planet, while limiting the impact of human activities on the environment.

Society sustainability: which aims to guarantee access to basic resources and services for all. The sustainable development definition is, therefore, a development that is economically efficient, ecologically sustainable and socially equitable.



History, timeline

1972 — Stockholm
The first world conference to make the environment a major issue

12 – 23 FEB 1979 — Geneva
Scientific conference on climate change

1987 — Brundtland Report
By the United Nations through the Oxford University

03 – 14 JUNE 1992 — RIO, Earth Summit
UN Conference on Environment and Development (adopted by more than 178 Governments)
Agenda 21

1997
A five-year review of progress on Agenda 21

1998
A two-year international information campaign which began in 1998 preceded the Millennium Summit of 2000

History, timeline (cont.,)

2000
NEW YORK, Millennium Summit, adopted by 189 member in which the eight millennium development goals

2002
Johannesburg, World Summit on sustainable development
Kyoto Protocol

14 – 16 SEP 2005
NY, World Summit
Pledging an additional $50 billion per year to fight poverty

25 SEP 2008
New York, High-level meeting on the MDG

25 SEP 2015
Rio+20 conference
The Sustainable Development Goals (SDGs) came to life

12 DEC 2015
The Paris Agreement


1 NO POVERTY
2 ZERO HUNGER
3 GOOD HEALTH AND WELL-BEING
4 QUALITY EDUCATION
5 GENDER EQUALITY
17 PARTNERSHIPS FOR THE GOALS
6 CLEAN WATER AND SANITATION
13 CLIMATE ACTION
16 PEACE, JUSTICE AND STRONG INSTITUTIONS
7 AFFORDABLE AND CLEAN ENERGY
15 LIFE ON LAND
8 DECENT WORK AND ECONOMIC GROWTH
14 LIFE BELOW WATER
9 INDUSTRIES, INNOVATION AND INFRASTRUCTURE
10 REDUCED INEQUALITIES
11 SUSTAINABLE CITIES AND COMMUNITIES
12 RESPONSIBLE CONSUMPTION AND PRODUCTION

What is COP

Conference of the Parties (COP)

The COP is the supreme decision-making body of the Convention. All States that are Parties to the Convention are represented at the COP, at which they review the implementation of the Convention and any other legal instruments that the COP adopts and take decisions necessary to promote the effective implementation of the Convention, including institutional and administrative arrangements.

The COP meets every year, unless the Parties decide otherwise.

The first COP meeting was held in Berlin, Germany in March, 1995.

3R Strategy

European Week for Waste Reduction (**EWWR**) is an annual initiative to raise awareness about sustainable resource management and waste reduction through awareness actions.
The actions implemented during the week are based on the 3R strategy:

1. Reduce waste
2. Reuse the products
3. Recycle materials

Climate change

Climate change refers to **long-term shifts in temperatures and weather patterns**. These shifts may be natural, but since the 1800s, **human activities** have been the main driver of climate change, primarily due to the burning of fossil fuels (like coal, oil and gas), which produces heat-trapping gases.

As greenhouse gas emissions blanket the Earth, they trap the sun’s heat. This leads to global warming and climate change. The world is now warming faster than at any point in recorded history.

GHGs

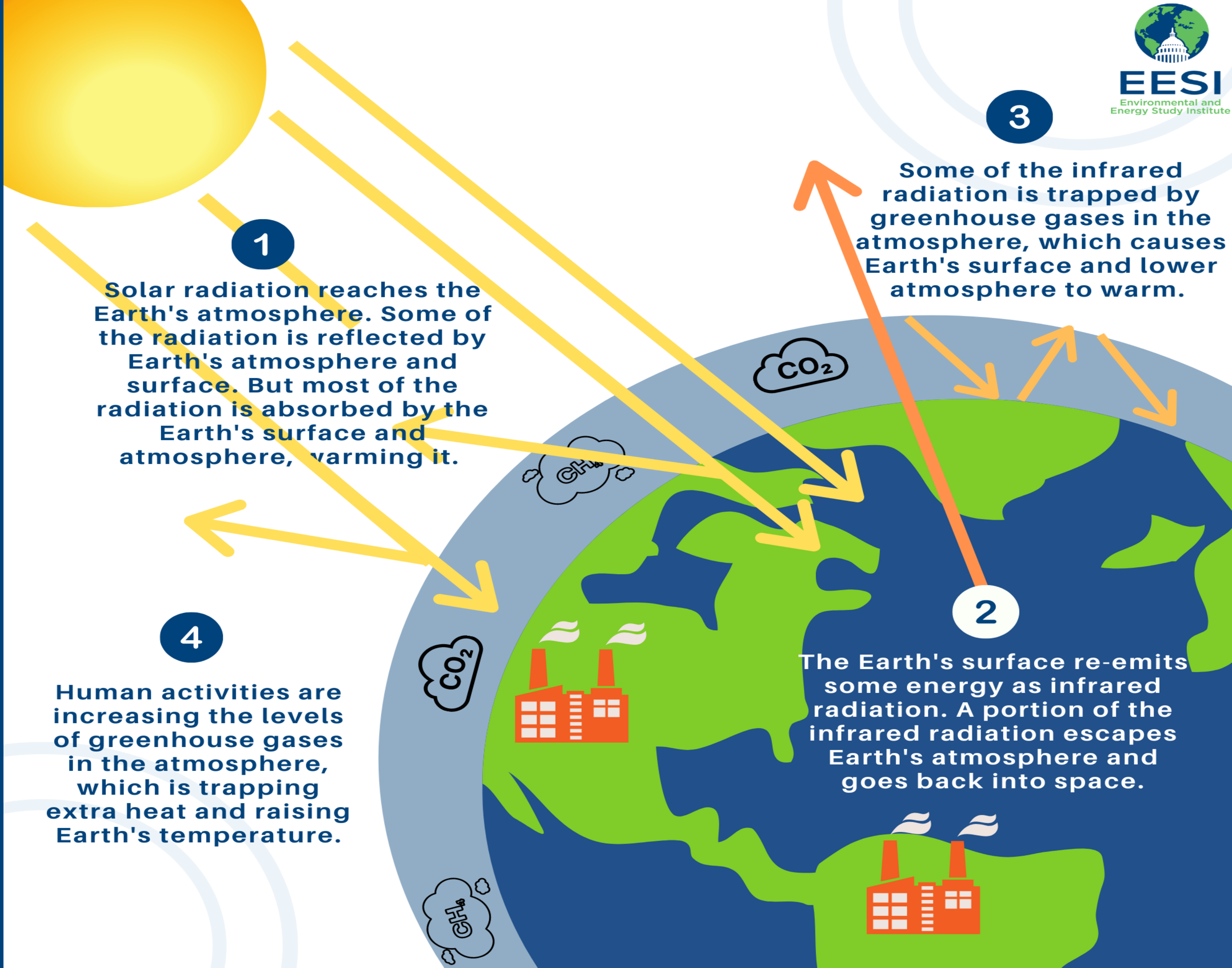
The greenhouse effect is a process that occurs when energy from a planet's host star goes through its atmosphere and warms the planet's surface, but the atmosphere prevents the heat from returning directly to space, resulting in a warmer planet. Light arriving from our Sun passes through Earth's atmosphere and warms its surface. The warmed surface then radiates heat, which is absorbed by greenhouse gases such as carbon dioxide. Without the natural greenhouse effect, Earth's average temperature would be well below freezing. Current human-caused increases in greenhouse gases trap greater amounts of heat, causing the Earth to grow warmer over time.

GUIDE TO THE GREENHOUSE EFFECT

The greenhouse effect is a natural process in which atmospheric gases trap the sun's heat and warm the Earth's surface and lower atmosphere. This makes Earth hospitable for life.

Human activities, such as burning fossil fuels for transportation and electricity generation, are increasing the concentration of greenhouse gases in the atmosphere. This enhances the greenhouse effect, trapping extra heat in the Earth's atmosphere and slowly warming the planet.

Graphic By: Sydney O'Shaughnessy



The Greenhouse Effect

Carbon dioxide

CO_2

CO_2 is naturally occurring but is also a by-product of burning fossil fuels, of burning biomass, of land-use changes and of industrial processes.

Methane

CH_4

CH_4 is the major component of natural gas and it is associated with all hydrocarbon fuels. Significant emissions also occur as a result of animal husbandry, waste management and agriculture.

Nitrous oxide

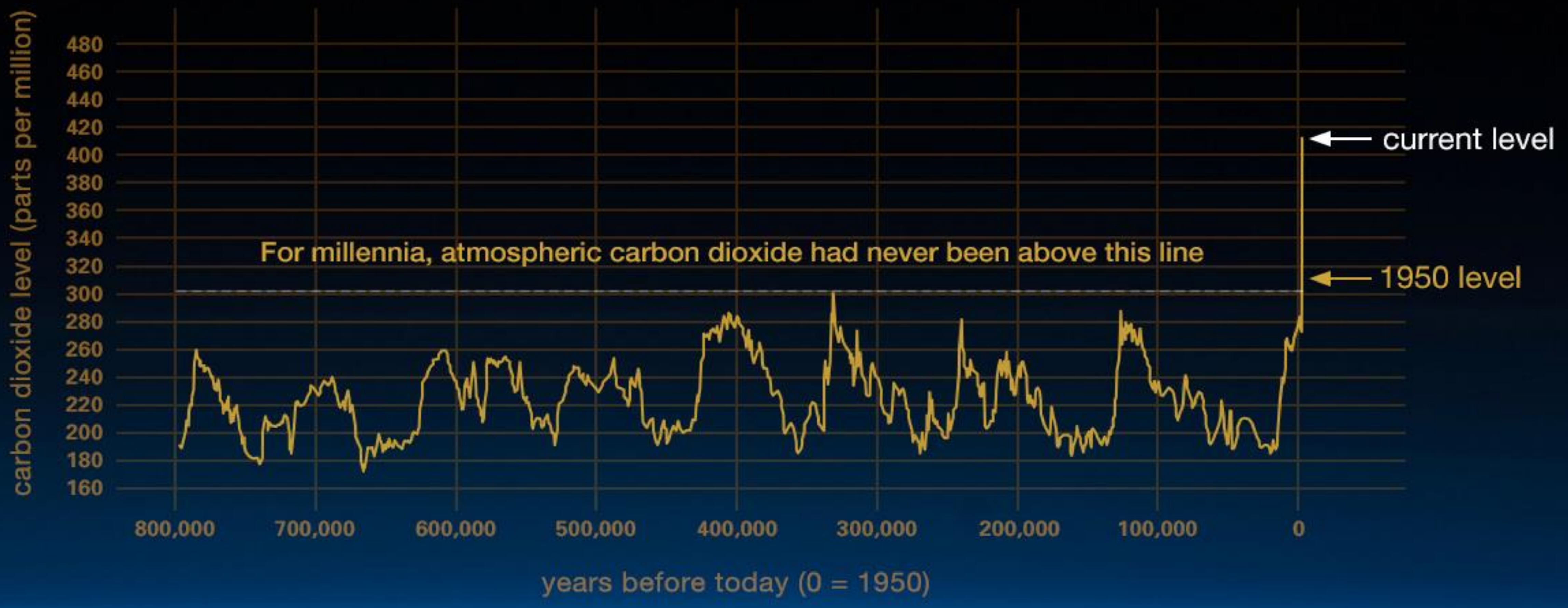
N_2O

The main anthropogenic source of N_2O is agriculture, in addition to sewage treatment, fossil fuel combustion, and chemical industrial processes. N_2O is also produced naturally e.g. through microbial action in wet tropical forests.

Fluorinated gases

F-gases

F-gases include sulphur hexafluoride (man-made chemical primarily used in electrical transmission and distribution systems, and in electronics), hydrofluorocarbons and perfluorocarbons (alternatives to ozone depleting substances, these by-products of industrial processes are powerful GHGs).


carbon dioxide level (parts per million)
480
460
440
420
400
380
360
340
320
300
280
260
240
220
200
180
160
For millennia, atmospheric carbon dioxide had never been above this line
current level
1950 level
800,000
700,000
600,000
500,000
400,000
300,000
200,000
100,000
0
years before today (0 = 1950)

Causes and Effects of Climate Change

Causes

- Rapid industrialization
- Energy use
- Agricultural practices
- Deforestation
- Consumer practices
- Livestock
- Transport
- Resource extraction
- Pollution

Effects

- Rising temperatures
- Rising sea levels
- Unpredictable weather patterns
- Increase in extreme weather events
- Land degradation
- Loss of wildlife and biodiversity

What are the social impacts of climate change?

Displaced people. Poverty. Loss of livelihood. Hunger. Malnutrition. Increased risk of diseases. Global food and water shortages.

What is Global Warming?

Understanding the causes to global warming and climate change

Global warming takes place when carbon dioxide, greenhouse gases, and air pollutants collect in the atmosphere. Then, they absorb sunlight and solar radiation that is bounced off the earth's surface, warming the plane. There are both natural and human causes of global warming. But, human activity contributes the most to global warming.

The Greenhouse Effect

The greenhouse effect refers to the situation when the Earth's atmosphere becomes thick due to gases and substances that trap the sun's radiation, making the Earth warmer. For Earth's temperature to remain stable, the amount of incoming solar radiation should be roughly equal to the amount of IR leaving the atmosphere. This is something that can, on some level, occur naturally.

Travel & Transportation

Most automobiles are powered via fossil fuels, including gasoline. They release carbon and other pollutants into the air, but affect both water and air quality. In fact, emissions due to transportation is known as one of the biggest causes behind rising temperatures.

Industrialization

The economic transition of the world from primarily farming-based to primarily industrial is another major cause of global warming. While the changes coincide with the start of the industrial revolution, in the mid-19th century with the emergence of the global economy.

Deforestation

A massive amount of forests are cleared every year to meet demands for wood and pulp. Forests release a lot of oxygen, consume carbon, and purify our air, thus maintaining the planet's temperature. As we lose millions of acres of trees and greenery, the planet's ability to absorb the carbon we produce drops dramatically. *In 2017, we lost about **39 million acres** of tropical forests.*

Electricity Overuse

Electricity for fossil fuels is another biggest greenhouse gas contributor. It accounts for about 28 percent of the total global warming effect. In the USA, 68% of electricity is still generated through the use of fossil fuels - mostly natural gas and coal.

Factory Farming

The industrialization of agriculture amplifies the potential negative effects of livestock production. Organic farming has a positive impact on global warming by reducing carbon through the growth of crops.
A **67% increase** is projected in antibiotics used in animal production, by 2030.

CLIMATE CHANGE

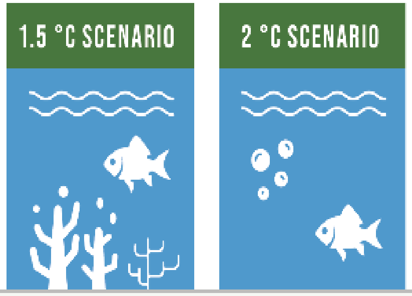
IS HUMANITY'S "CODE RED" WARNING

OUR WINDOW TO AVOID CLIMATE CATASTROPHE IS CLOSING RAPIDLY

DIFFERENT TEMPERATURE SCENARIOS FOR CORAL REEFS

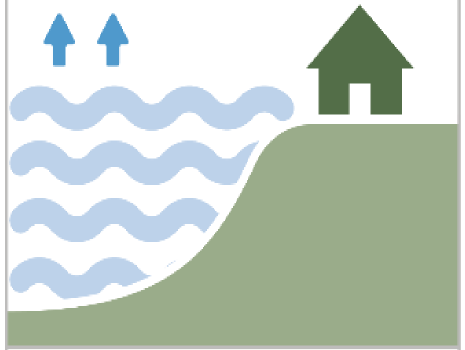
70%-90% GONE

DIE OFF COMPLETELY



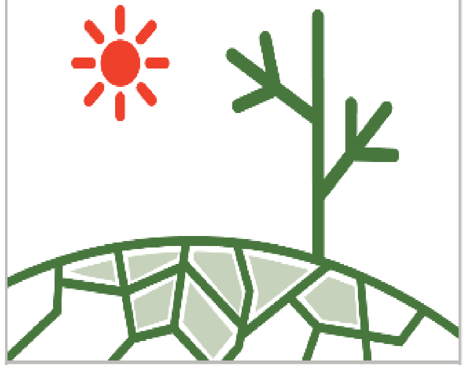
CORAL REEFS

SEA LEVEL WILL RISE 30-60 CM BY 2100



SEA LEVEL RISE

DROUGHT ESTIMATED TO DISPLACE 700 MILLION PEOPLE BY 2030



DROUGHTS

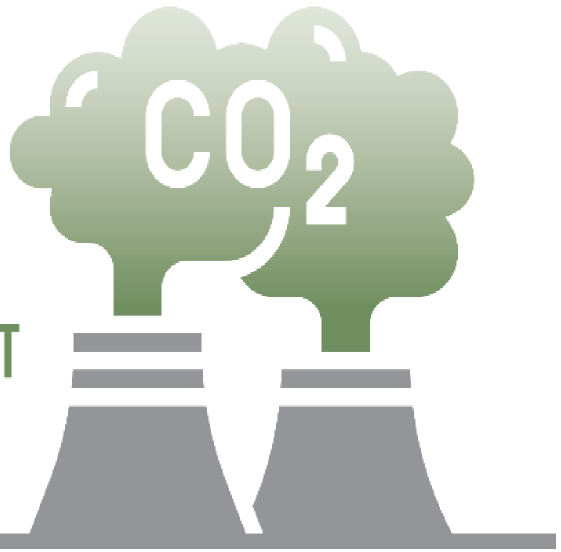
MEDIUM- TO LARGE-SCALE DISASTERS WILL INCREASE 40% FROM 2015 TO 2030

DISASTERS

ENERGY-RELATED CO_2 EMISSIONS INCREASED

6% IN 2021

REACHING HIGHEST LEVEL EVER

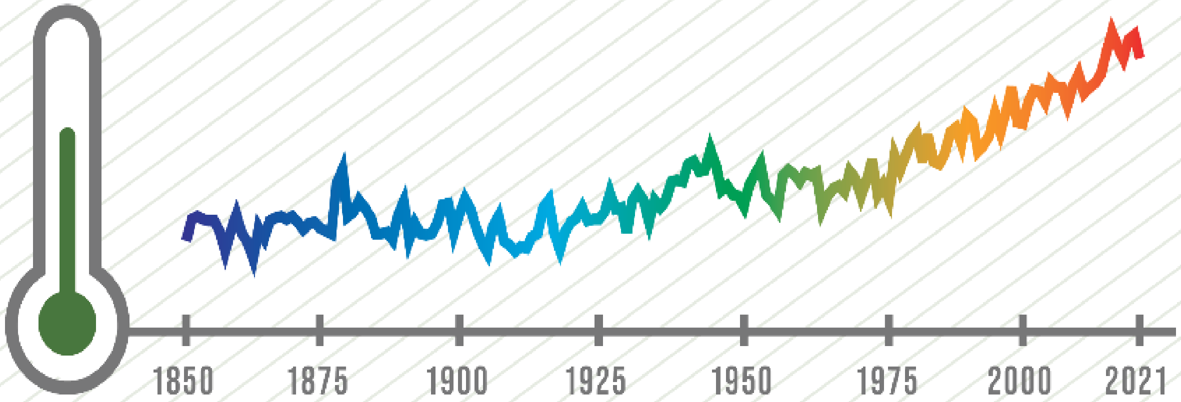


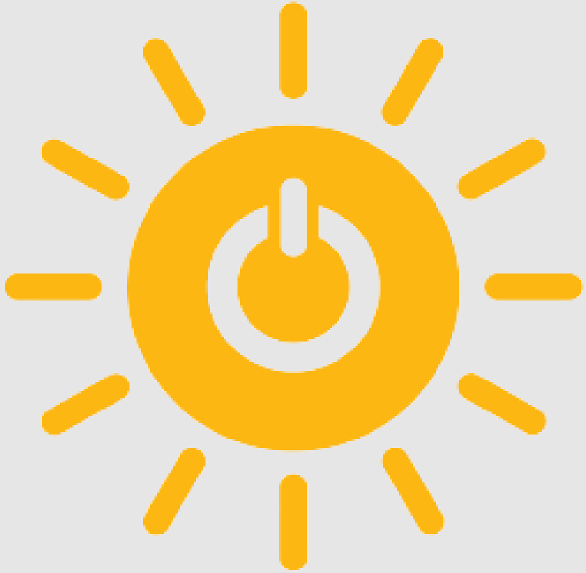
CLIMATE FINANCE

FALLS SHORT OF $100 BILLION YEARLY COMMITMENT

DEVELOPED COUNTRIES PROVIDED $79.6 BILLION IN CLIMATE FINANCE IN 2019

RISING GLOBAL TEMPERATURES CONTINUE UNABATED, LEADING TO MORE EXTREME WEATHER





What is biomass?

Organic material is something that was living and can decay. Wasted or spoiled food, plant clippings, animal manure, meat trimmings and sewage are common types of organic material used with anaerobic digestion. In contrast, inorganic material includes things like rocks, dirt, plastic, metal and glass.

Traditionally, biomass had been utilized through direct combustion. Cow dung cake is one of the most important and widely used biomass for the production of daily
energy needs.

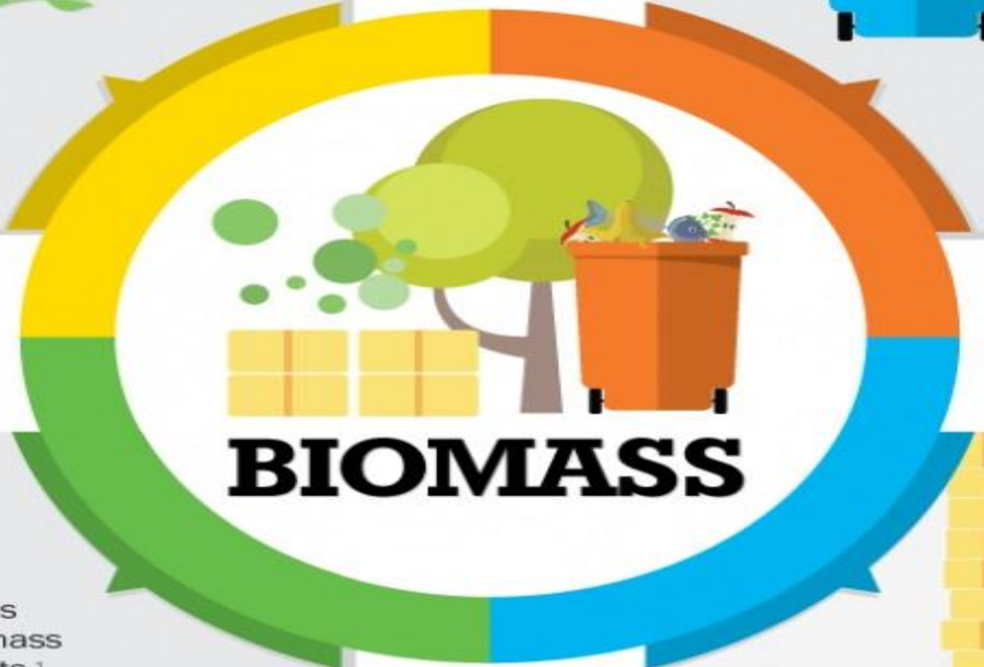
4 Fast Facts About BIOMASS

1 Versatility

Biomass can be used to produce renewable fuels, power, and everyday products like plastic.

2 Value for Wastes

There is significant potential to turn wastes such as plant material left over after harvest, sewage sludge, and the organic portion of garbage into bioenergy. Diverting these resources to produce energy and products provides value for otherwise problematic waste streams.



3 Economic Impact

Biobased activities have already generated more than $48 billion in revenue and 285,000 jobs. Estimates show that continuing to develop biomass resources could expand these impacts.[1]

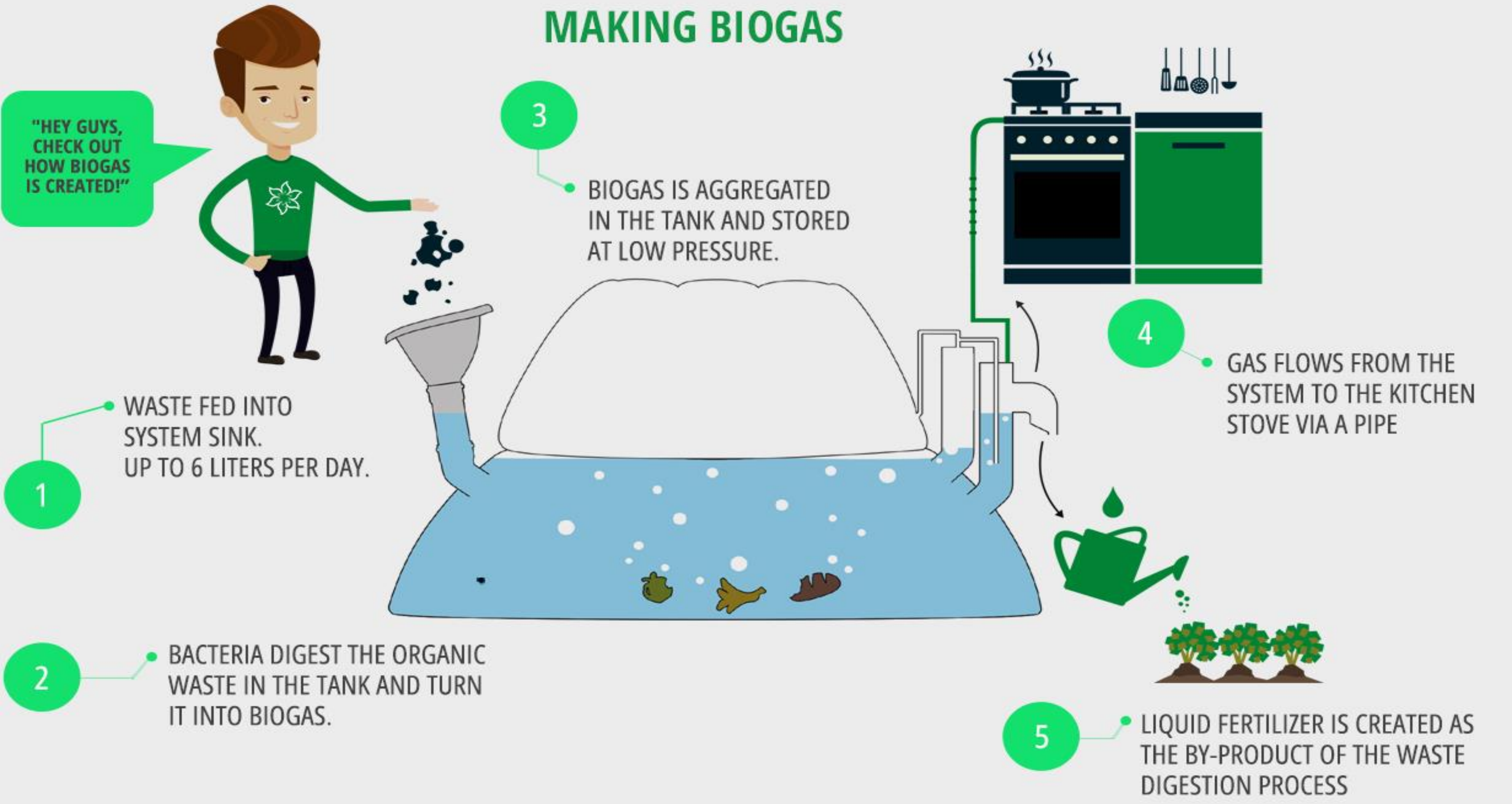
- Generate up to **50 billion gallons** of biofuels
- Produce **50 billion pounds** of biobased chemicals & products
- Add **1.1 million jobs** across a variety of key sectors (e.g., agriculture and manufacturing)
- Contribute **$260 billion** to the U.S. economy

4 Abundant

By 2030, the U.S. has the potential to sustainably produce 1 billion tons of biomass annually—that's enough to fill a 16-foot flatbed truck stacked roughly up to the moon![2]

What is biogas?

Biogas is a combustible gaseous fuel that is collected from the microbial degradation of organic matter in anaerobic conditions. Biogas is principally a mixture of methane (Ch_4) and carbon dioxide (Co_2) along with other trace gases. Biogas can be collected from landfills, covered lagoons, or enclosed tanks called anaerobic digesters. The biogas typically has 60% methane and 35% carbon dioxide. There is also some percentage of hydrogen, nitrogen, oxygen, ammonia, moisture etc.



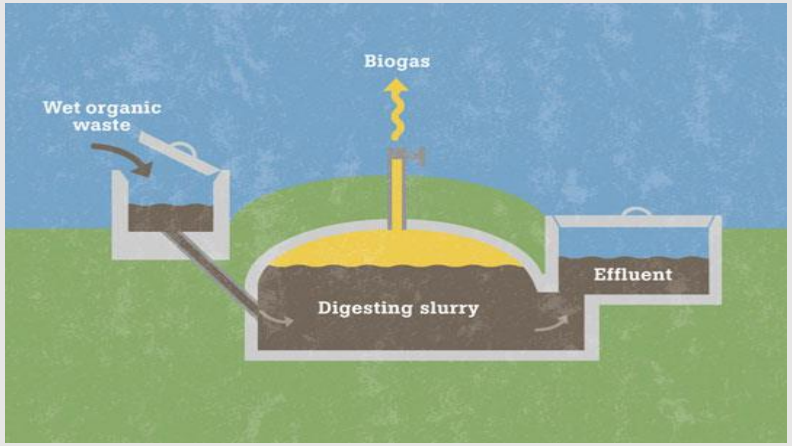
MAKING BIOGAS
"HEY GUYS, CHECK OUT HOW BIOGAS IS CREATED!"
1
WASTE FED INTO SYSTEM SINK.
UP TO 6 LITERS PER DAY.
2
BACTERIA DIGEST THE ORGANIC WASTE IN THE TANK AND TURN IT INTO BIOGAS.
3
BIOGAS IS AGGREGATED IN THE TANK AND STORED AT LOW PRESSURE.
4
GAS FLOWS FROM THE SYSTEM TO THE KITCHEN STOVE VIA A PIPE
5
LIQUID FERTILIZER IS CREATED AS THE BY-PRODUCT OF THE WASTE DIGESTION PROCESS

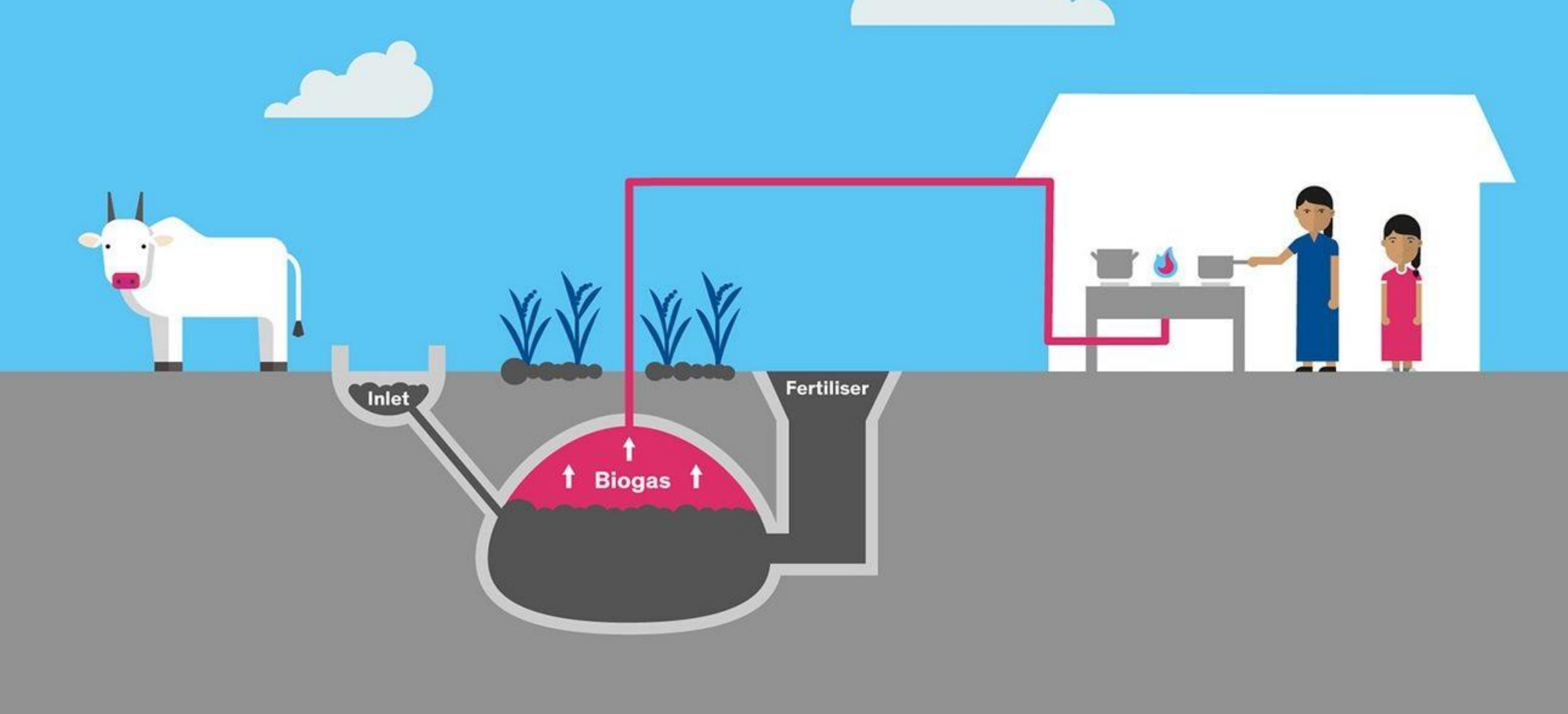
Biodigester

The biodigester is a physical structure, commonly known as the biogas plant.

Since various chemical and microbiological reactions take place in the biodigester, it is also known as bioreactor or anaerobic reactor.

The main function of this structure is to provide an anaerobic condition within it. As a chamber, it should be air and water tight. It can be made of various construction materials and in different shapes and sizes. Construction of this structure forms a major part of the investment costs for a biogas plant.




Inlet
Biogas
Fertiliser

Biogas composition

This is the mixture of gas produced by methanogenic bacteria while acting upon biodegradable materials in an anaerobic condition.

Biogas is mainly composed of 50 to 70 percent methane (CH_4), 30 to 40 percent carbon dioxide (CO_2) and low amounts of other gases.

Methane	CH_4	50 - 70
Carbon Dioxide	CO_2	30 - 40
Hydrogen	H_2	5 - 10
Nitrogen	N_2	1 - 2
Water vapor	H_2O	0.3
Hydrogen Sulphide	H_2S	Traces

Biogas characteristics

Biogas is about 20 percent lighter than air and has an ignition temperature in the range of 650° to 750° C.

It is an odourless after burning and colourless gas that burns with clear blue flame similar to that of LPG gas.

The calorific value of biogas is about 6 kWh/m3 (20 mega joule) - this corresponds to about half a litre of diesel oil.

The net calorific value depends on the efficiency of the burners or other user appliances; a conventional biogas stove has an efficiency of 50-60 %. Methane is the valuable component under the aspect of using biogas as a fuel.

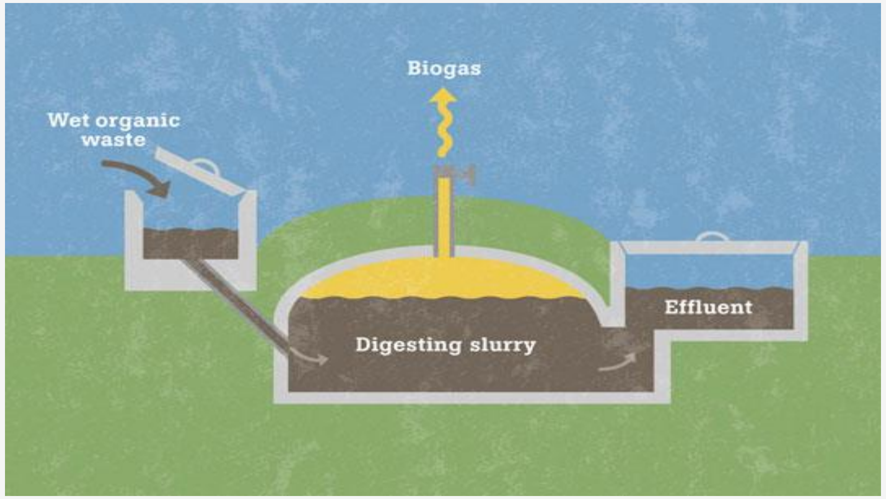
Methanogenic bacteria

These are the bacteria that act upon organic materials and produce methane and other gases in the process in an anaerobic environment.

As living organisms, they tend to prefer certain conditions and are sensitive to the micro-climate within the digester.

Biodigester

- The biodigester is a physical structure, commonly known as the biogas plant.
- Since various chemical and microbiological reactions take place in the biodigester, it is also known as bioreactor or anaerobic reactor.
- The main function of this structure is to provide an anaerobic condition within it.
- As a chamber, it should be air and water tight.
- It can be made of various construction materials and in different shapes and sizes. Construction of this structure forms a major part of the investment costs for a biogas plant.



Biodigester types

- Fixed dome
- Floating drum
- Separeated gas holder

Fixed dome / Chinese

The fixed dome also known as Chinese model biogas plant was developed and built in China as early as 1936.

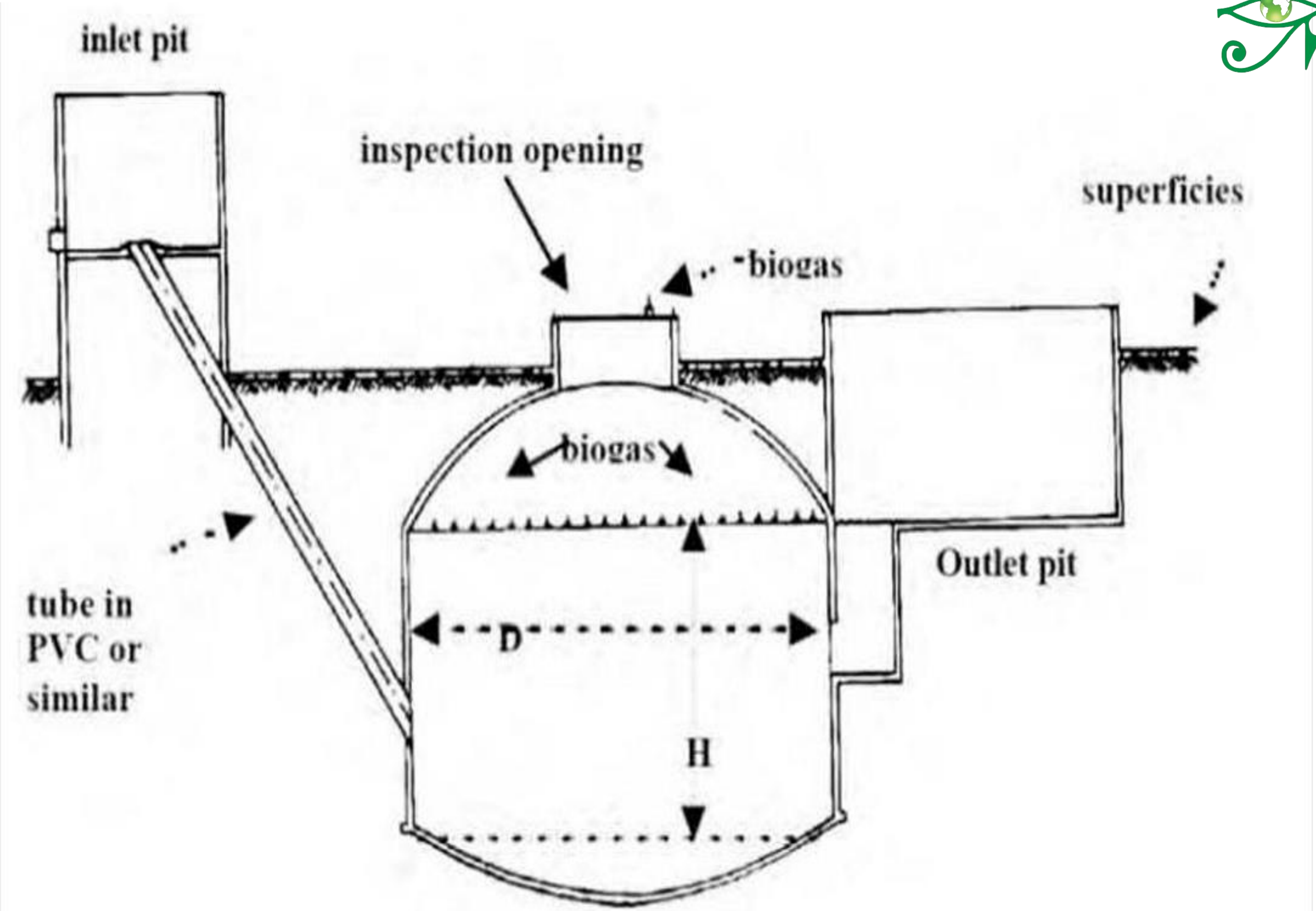
It consists of an underground brick masonry compartment (fermentation chamber) with a dome on the top for gas storage.

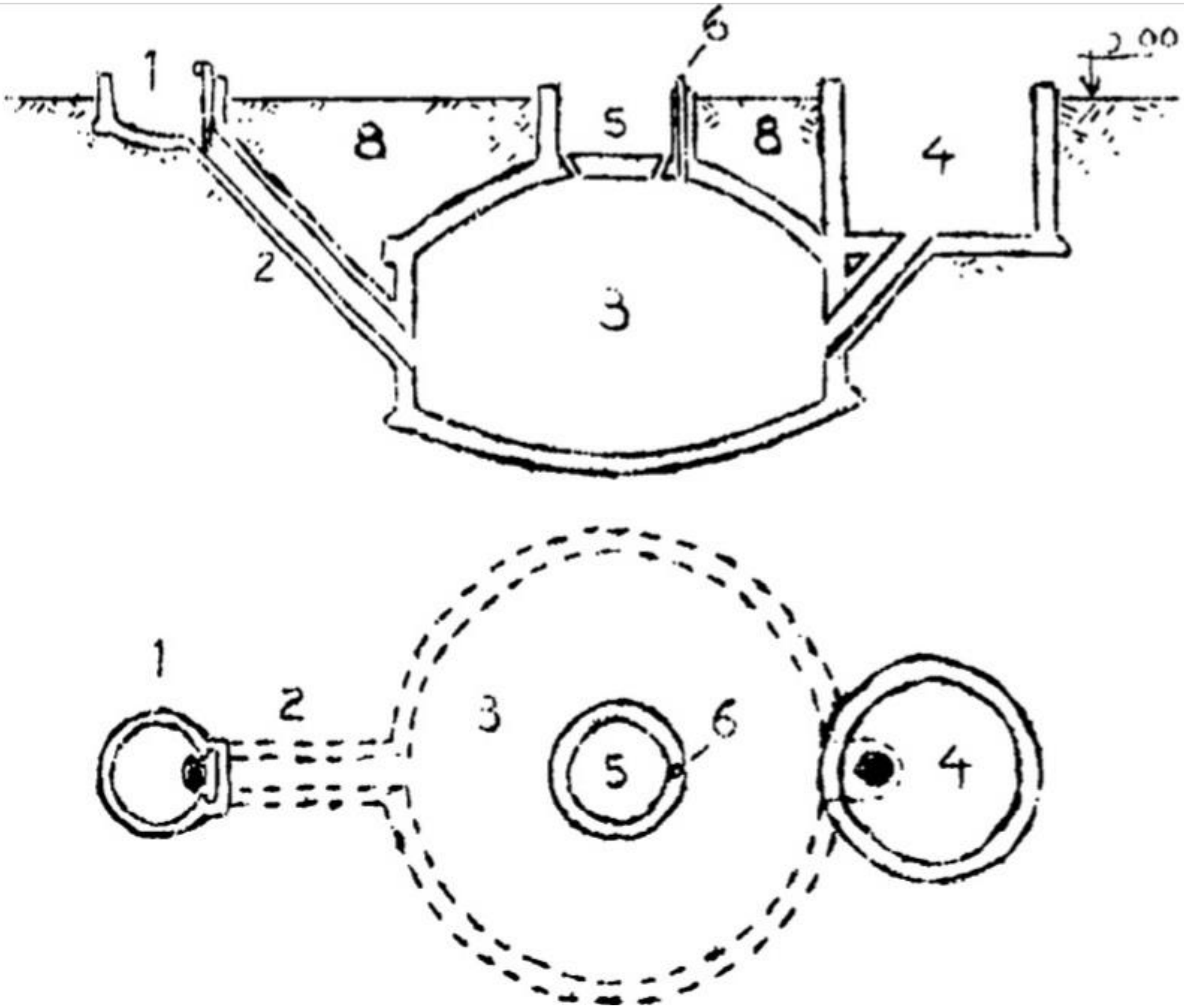
Fixed dome / Chinese cont.

In this design, the fermentation chamber and gas holder are combined as one unit.

This design eliminates the use of costlier mild steel gas holder which is susceptible to corrosion.

The life of fixed dome type plant is longer (over 25 years) compared to the floating drum design.


inlet pit
inspection opening
superficies
biogas
biogas
tube in
PVC or
similar
D
H
Outlet pit


1
2
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1
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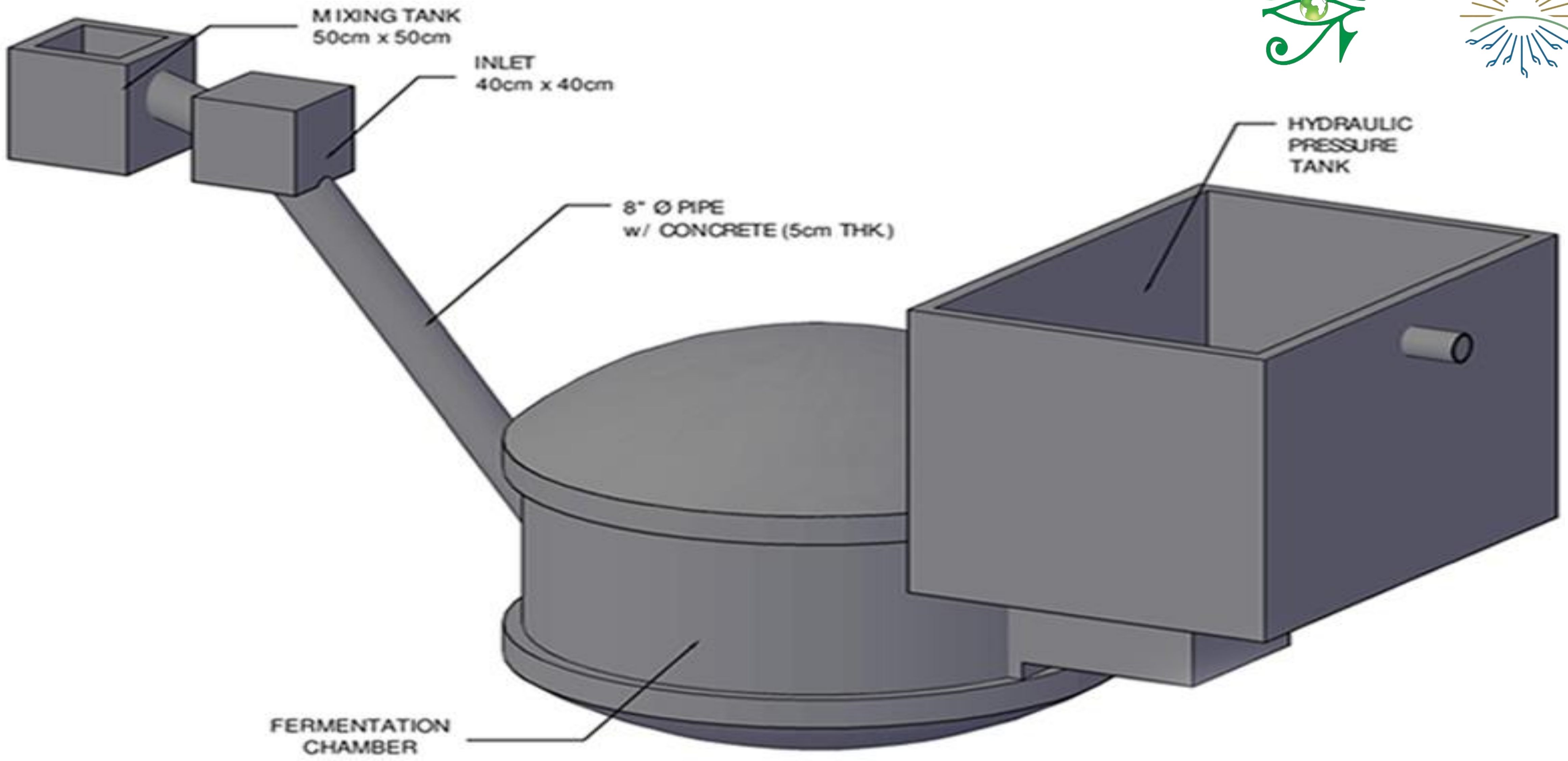

MIXING TANK
50cm x 50cm
INLET
40cm x 40cm
8" Ø PIPE
w/ CONCRETE (5cm THK.)
HYDRAULIC
PRESSURE
TANK
FERMENTATION
CHAMBER

Fixed dome / DEENBANDHU

In an effort to further bring down the investment cost, the Deenbandhu model was put forth in 1984 by the Action for Food Production (AFPRO), New Delhi, India.

This model proved to be some percent cheaper than other fixed dome designs used at that time in India.

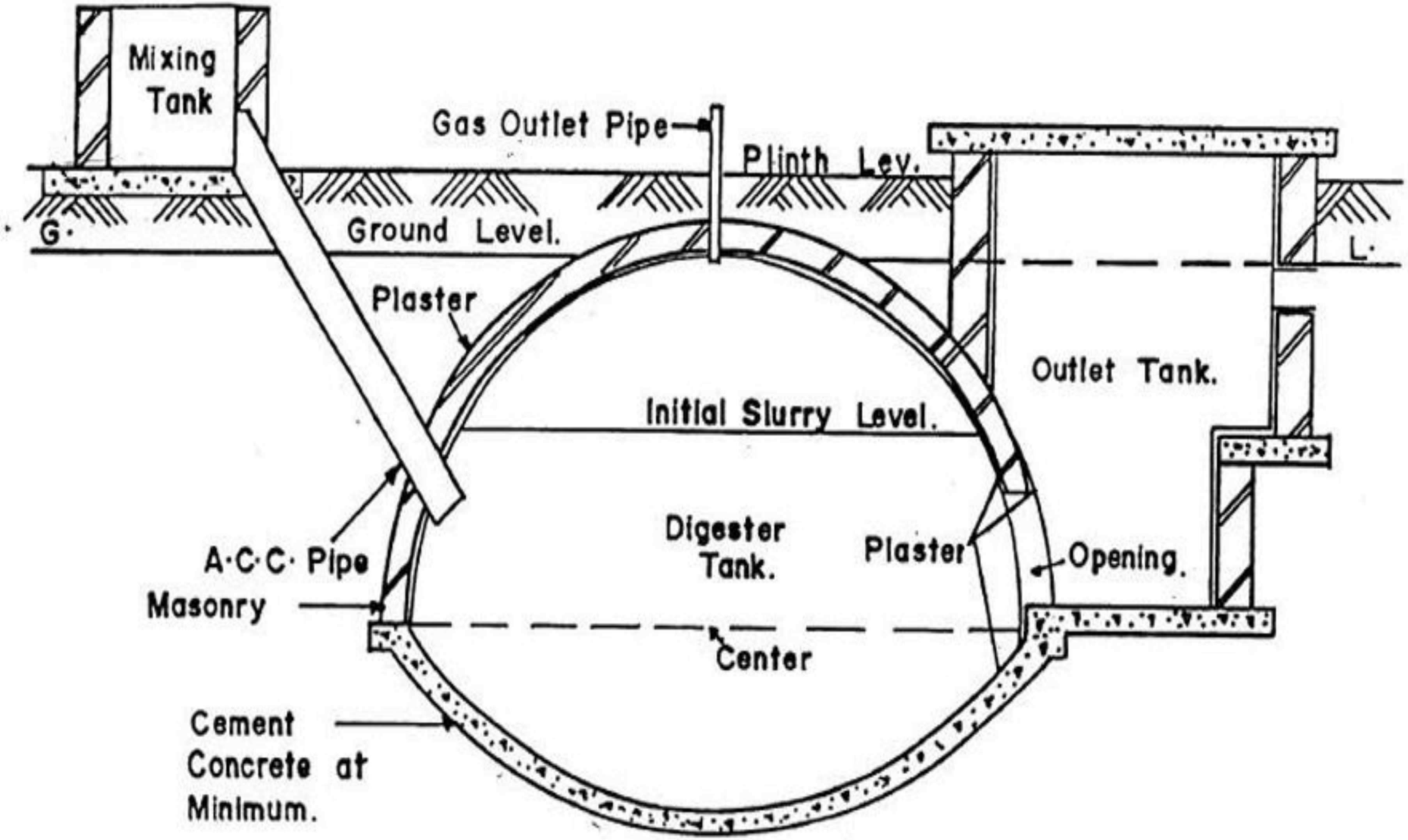
It also proved to be about 45 percent cheaper than a floating drum plant of comparable size.

Fixed dome / DEENBANDHU cont.

Deenbandhu plants are made entirely of brick masonry work with a spherical shaped gas holder at the top and a concave bottom.

A typical design of Deenbandhu plant is shown in Figure 1.3 (Singh. Myles and Dhussa, 1987).

The Deenbandhu model is now the most commonly used plant in India with more than 3 million plants constructed.


Mixing Tank
Gas Outlet Pipe
Plinth Lev.
G.
Ground Level.
L.
Plaster
Outlet Tank.
Initial Slurry Level.
Digester Tank.
Plaster
A.C.C. Pipe
Opening.
Masonry
Center
Cement Concrete at Minimum.

Fixed dome / BAG DIGESTER

The most commonly used low cost plant is the Plastic Bag Digester
The plastic bag digester consists of a trench (trench length has to be considerably greater than the width and depth) lined with a plastic tube.

Because of the low investment cost this type of digester has been popular in south-east Asia, notably the south of Vietnam.

Fixed dome / BAG DIGESTER cont.

The great weakness of this plant is its vulnerability, it is easily damaged by cattle and playing children.

Also the UV rays in sunlight make that the plastic gets brittle. Another disadvantage is the large ground surface which is needed for the plant which, unlike for the dome design, cannot be used for other purposes after the construction.

An advantage is that this type of plant is easy to construct in areas with high water tables.

Fixed dome / others

Fixed model doesn't have any moving parts.

May be constructed using steel mould.

Floating drum

In 1956 the floating drum biogas plant, popularly known as Gobar Gas plant, was introduced.

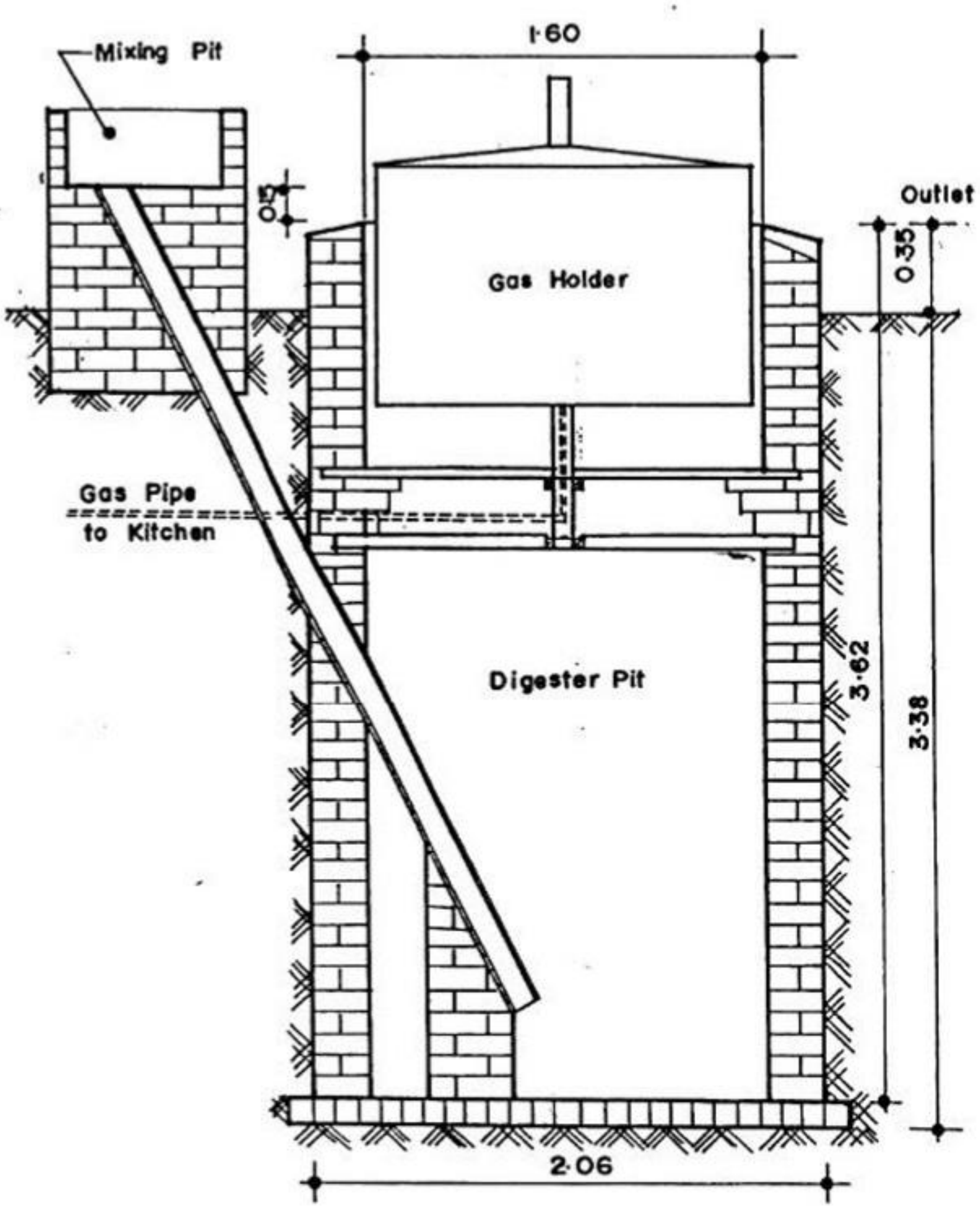
In 1962, this design was approved by the Khadi and Village Industries Commission (KVIC) of India and this design soon became popular in India.

Floating drum cont.

A mild steel drum is placed on top of the digester to collect the biogas produced from the digester.

Thus, there are two separate structures for gas production and collection.

With the introduction of fixed dome Chinese model plant, the floating drum plants became obsolete because of comparatively high investment and maintenance cost.


Mixing Pit
1·60
0·15
Outlet
0·35
Gas Holder
Gas Pipe
to Kitchen
Digester Pit
3·62
3·38
2·06

Inputs

Any biodegradable organic material can be used as substrate for processing inside the biodigester.

However, for economic and technical reasons, some materials are more preferable as input than others.

If the inputs have to be purchased or transported over a large distance, the economic benefits of outputs, gas and slurry, will be affected adversely.

Biogas potential

Type of Dung	Gas Production per Kg Dung (m3)
Cattle (cows and buffaloes)	0.023 - 0.040
Pig	0.040 - 0.05
Poultry (Chickens)	0.065 - 0.116
Humans	0.030 – 0.050

Factors affecting biogas production

C/N ratio

Diluation

Temperature

HRT

Toxicity

pH

C/n ratio

The relationship between the amount of carbon and nitrogen present in organic materials is expressed in terms of the Carbon/Nitrogen (C/N) ratio.

C/N ratio ranging from 20 to 30 is considered optimum for anaerobic digestion.

If the C/N ratio is very high, the nitrogen will be consumed rapidly by methanogens for meeting their protein requirements and will no longer react on the left over carbon content of the material.

C/n ratio cont.

As a result, gas production will be low.

On the other hand, if the C/N ratio is very low, nitrogen will be liberated and accumulated in the form of ammonia (NH4), NH4 will increase the pH value of the content in the digester.

A pH higher than 8.5 will start showing a toxic effect on methanogen population.

S.N.	Raw Materials	C/N Ratio
1.	Duck dung	8
2.	Human excreta	8
3.	Chicken dung	10
4.	Goat dung	12
5.	Pig dung	18
6.	Sheep dung	19
7.	Cow dung/ Buffalo dung	24
8.	Water hyacinth	25
9.	Elephant dung	43
10.	Straw (maize)	60
11.	Straw (rice)	70
12.	Straw (wheat)	90
13.	Saw dust	above 200

C/n ratio cont.

Materials with high C/N ratio could be mixed with those of low C/N ratio to bring the average ratio of the composite input to a desirable level.

As a means to balance C/N ratio, it is customary to load straw at the bottom of the digester upon which latrine waste will be discharged.

Dilution

Before feeding the digester, the excreta, especially fresh cattle dung, has to be mixed with water at the ratio of 1:1 on a unit volume basis (i.e. same volume of water for a given volume of dung).

However, if the dung is in dry form, the quantity of water has to be increased accordingly to arrive at the desired consistency of the substrate (e.g. ratio could vary from 1:1.25 to even 1:2).

The dilution should be made to maintain a total solid content from 7 to 10 percent.

Dilution cont.

If the dung is too diluted, the solid particles will settle down into the digester and if it is too thick, the particles impede the flow of gas formed at the lower part of digester.

There is also higher risk of scum formation at the top of the slurry layer. In both cases, gas production will be less than optimal.

Furthermore, most biogas plants are designed for a total solids content of about 8%. A change of this ratio will have an impact on the HRT and the hydraulic functioning of the plant.

Temperature

The methanogens are inactive in extreme high and low temperatures.

The optimum temperature is 35 degrees C.

HRT

HRT is high

The material remains more time in the digester The degree of digestion is more Energy saved from material is more.

HRT is low

The material comes out of the digester before it is fully digested. The energy saved from feed material is less Possibility that bacteria may get washed out even before they fully multiply

Toxicity

Mineral ions, heavy metals and the detergents are some of the toxic materials that inhibit the normal growth of microbes in the digester.

One of the most poisonous chemicals for anaerobic digestion is chlorine. Any cleaning material that contains chlorine will prevent the plant from working.

STEPS Three

A biogas plant uses anaerobic digestion, which uses a population of many different microbes that work together.

They are symbiotic, which means that they depend on one another.

The complex processes can be simplified to three basic stages.

The important stages in digestion are:

a. Hydrolysis
b. Acidification
c. Methanization

Hydrolysis

Large molecular complex substances are broken down into simpler ones, which are soluble in water, with the help of extracellular enzymes released by microbes.

This stage is also known as polymer breakdown stage.

For example, the cellulose, which consists of polymerized glucose is broken down to dimeric sugars, and then to monomeric sugar molecules (glucose and other simple sugars) by cellulolytic microbes.

ACIDIFICATION

The soluble chemicals, such as glucose, are fermented under anaerobic condition into volatile fatty acids (VFAs) with the help of enzymes produced by the acid forming microbes.

At this stage, the acid-forming bacteria break down molecules of six atoms of carbon (glucose) into molecules with less atoms of carbon (acids), which are in a more reduced state than glucose.

ACIDIFICATION cont.

The principal VFAs produced in this process include: acetic acid, propionic acid, and butyric acid.

These VFAs have strong odours which cause rotting foods to smell obnoxious. Other chemicals are also formed, such as ethanol.

Methane generation .

The VFAs produced in Stage 2 are processed by methanogenic microbes to produce methane and carbon dioxide.

The reaction that takes place in the process of methane production is called Methanization and is expressed by the following equations

Methane generation cont.

$CH_3COOH \rightarrow CH_4 + CO_2$

Acetic acid → Methane + Carbondioxide

$2\ CH_3CH_2OH + CO_2 \rightarrow CH_4 + 2\ CH_3COOH$

Ethanol + carbon dioxide → Methane + Acetic acid

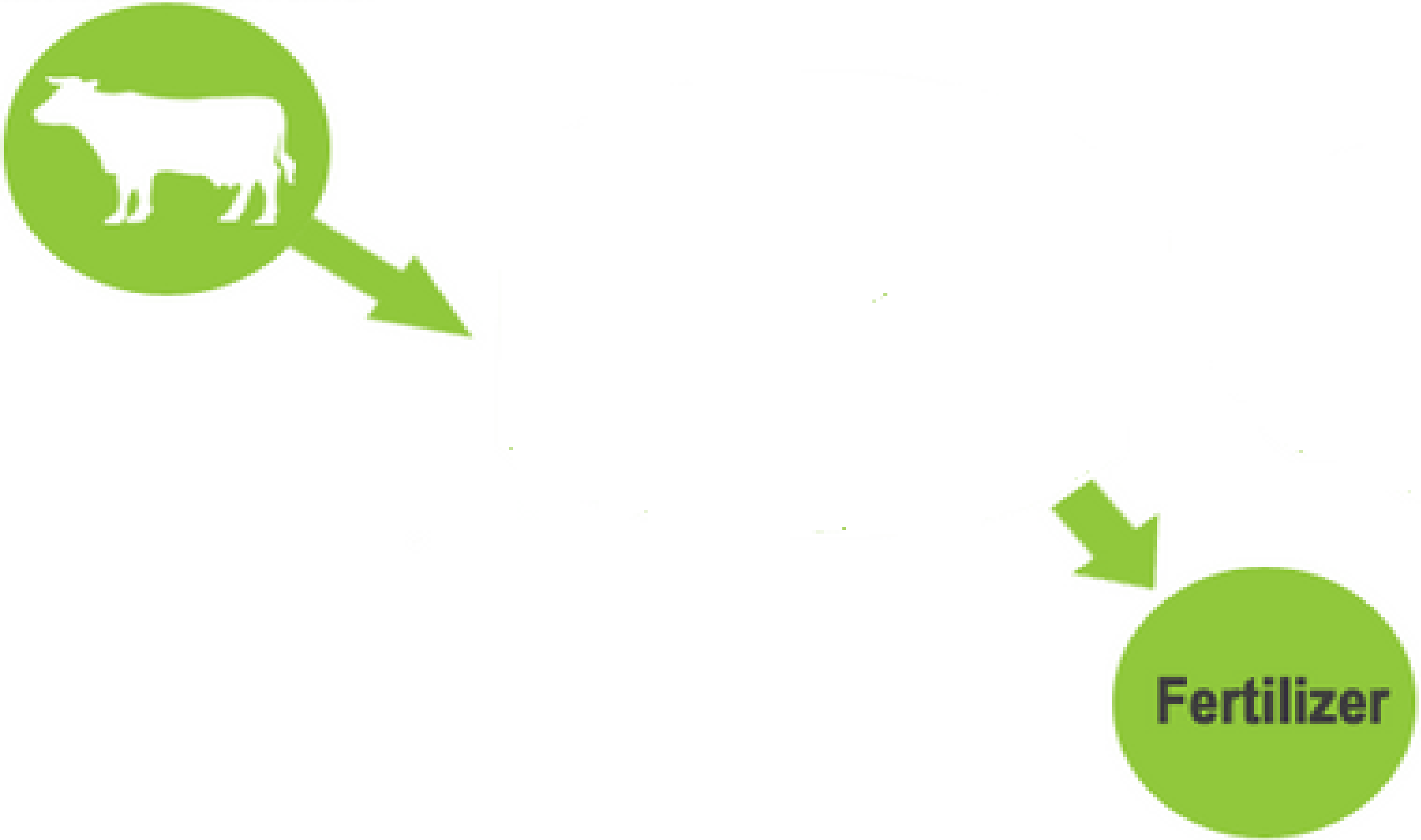
Hydrogen is also produced in the process, but only as an intermediate product:

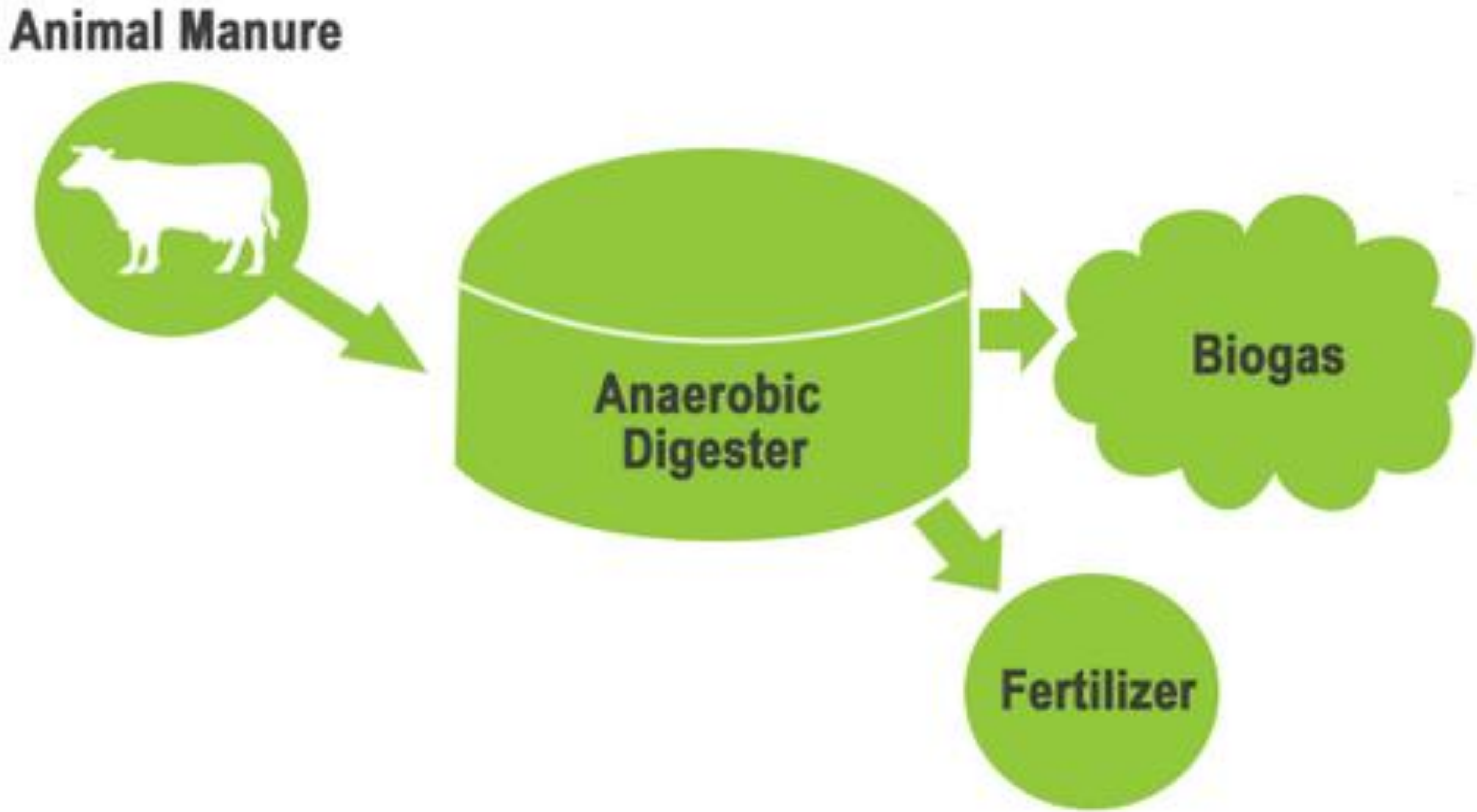
$CO_2 + 4H_2 \rightarrow CH_4 + 2\ H_2O$

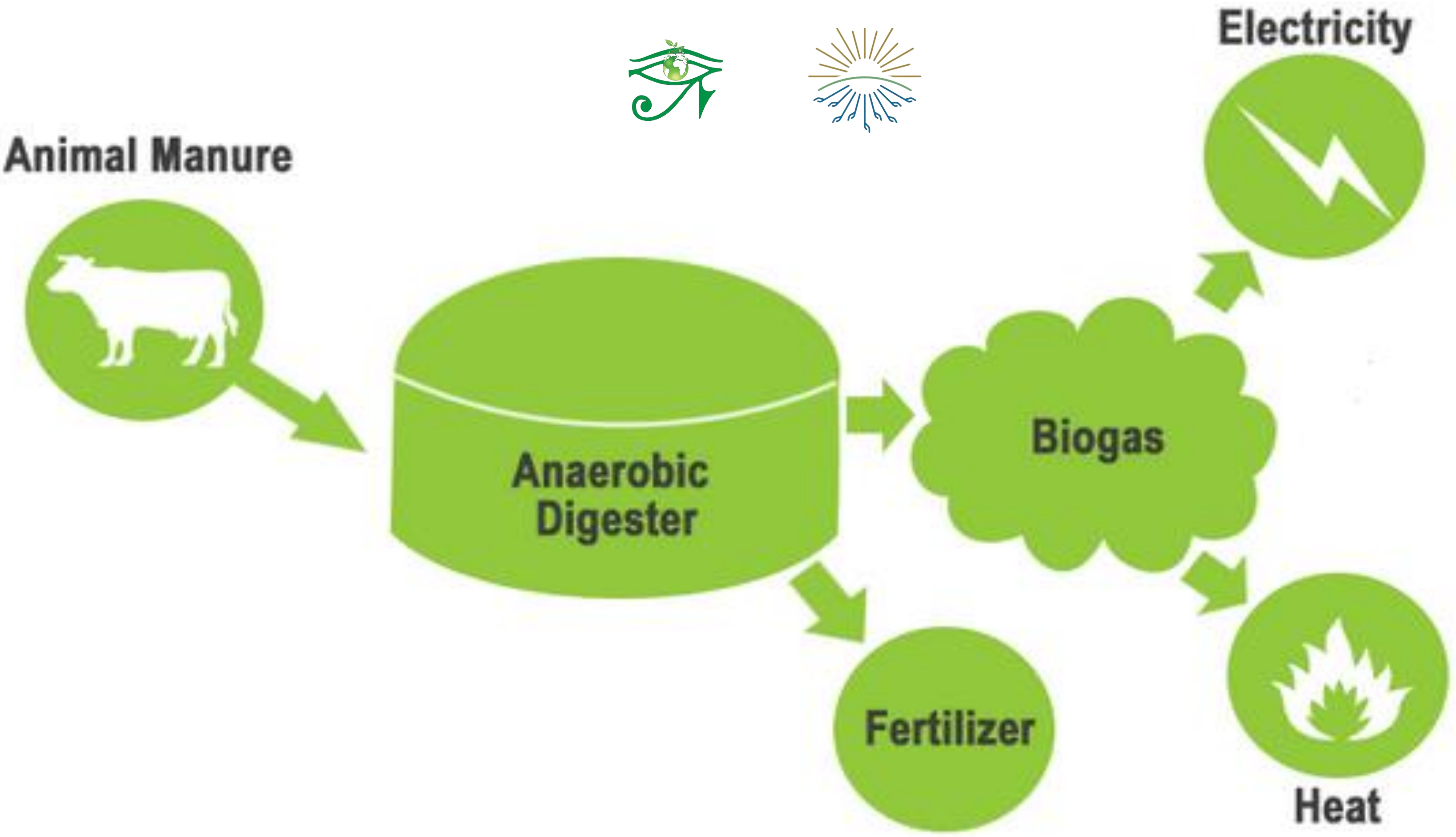
Add value

Instead of normal treatment of animal waste (aerobic treatment) which lead to loss a product in air and the other product in poor fertilizer.

Animal Manure




Animal Manure
Anaerobic Digester
Biogas
Fertilizer


Animal Manure
Anaerobic Digester
Biogas
Electricity
Heat
Fertilizer

Biogas uses

Cooking

Lighting

Heating

Electricity generation

CHP

Introduction to Bioslurry

Bioslurry definition
Bioslurry is the liquid discharged at the biodigester outlet after gas has been tapped for energy. It is superior organic fertilizer; a co-product of the biodigester. It is composed of 93% water and 7% of Dry Matter. It contains Nitrogen, Phosphorous, Potassium, Zinc, iron, manganese and copper among others. Wet slurry is alkaline (8.12PH), odourless and pathogen free.

Quality of Bioslurry depends on:-

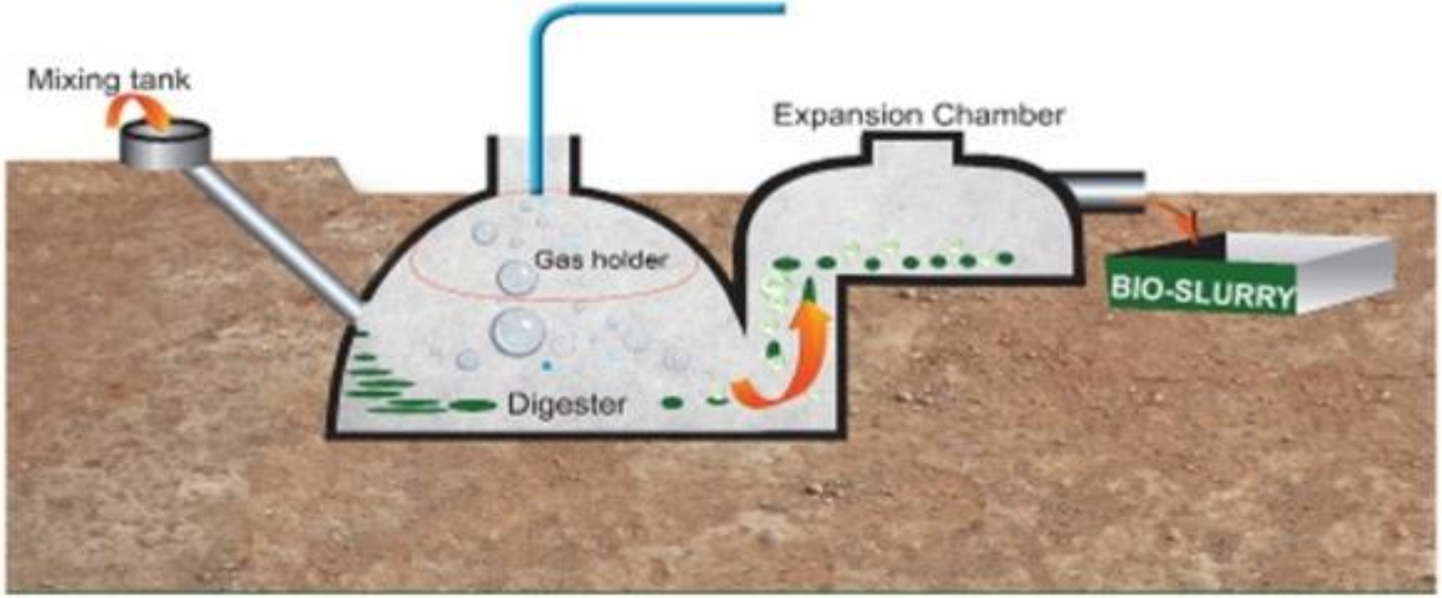
1. Species and Age of the animal from which the dung is drawn
2. Quality of Water used in mixing the dung
3. Types of animal feed and feeding rate.
4. Use of urine along with dung
5. Storage, treatment and application of the slurry

Modes of Application/Utilization
1. Liquid
   - Direct Feeding –In rows, Around the crops –Cover with soil after application.
   - Foliar (Liquid Manure) – See Page 5 of the Handbook
   - Irrigated- Through pipes
2. Solid-Compost Making –See Page 6 of the Handbook
3. Pellets and seed coating
4. Animal Feeding –Fish, chicken, Pigs

Direct Application: Pumping directly to the farm

Dry/Solid application after Compositing

Bioslurry production process



Biogas Plant (Fixed dome-model)

Benefits of Bioslurry

- An excellent soil conditioner, adds humus
- Enhances the soil's capacity to retain water.
- Safe to handle
- Highly nutritious and contains trace elements
- Is pathogen-free. The fermentation of dung in the reactor kills organisms causing plant disease including weeds
- It repels termites and pests that are attracted to raw dung.
- Effective for a period of over 3 years in soil while chemical fertilizers serve only one cropping season
- Savings on chemical fertilizer and pesticides (Cash)

Slurry vs. Chemical fertilizer

Source

Composition

Soil fertility

Ground water pollution

Micro organisms

Manufacturing

Air pollution

Human health

Cost

Yield

Sizing

Fixed dome plant (Deenbandhu design)

The Deenbandhu design combines a hemisphere with a curved base. Based on the specifications of a number of different sizes of Deenbandhu digesters given in Kudaravelli (2013), the depth of the curved base of this design (k) is usually about 40% of the radius (r) of the digester.

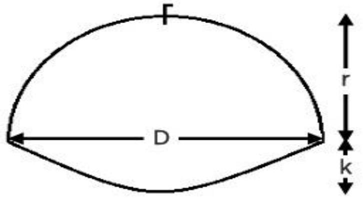


Figure 5: Fixed dome plant (Deenbandhu)

Measurement: To calculate the volume of a Deenbandhu digester, it is also only necessary to measure the maximum diameter (D) of the digester and this can be done in the same way as described for the hemisphere design.

Volume calculation: For data processing, it is necessary to calculate the radius (r) of the digester ($r = D/2$) and the depth of the curved base ($k = 0.4r$). The total plant volume (V_p) can then be calculated as the volume of a hemisphere and sphere segment:

$$V_p = \frac{2}{3}\pi r^3 + \frac{1}{6}\pi k(3r^2 + k^2)$$

The digester volume (V_d) and gas storage volume (V_g) can be calculated as before (by multiplying the total plant volume by 0.65 and 0.35 respectively) and a lookup table for these volumes across a range of diameters is given in Table 11 in Appendix 1.

Fixed dome plant (Chinese design)

The Chinese design of a fixed dome plant consists of a hemisphere on top of a cylinder with a curved or flat bottom. This type of digester is common in China and may also be found in other countries that have received assistance and training from the Biogas Institute of the Ministry of Agriculture in China (BIOMA).

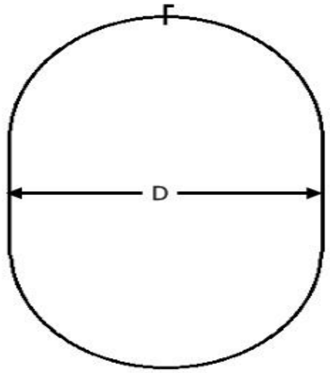


Figure 6: Fixed dome plant (Chinese design)

Measurement: A standard plant design has been developed by the Biogas Training Centre in Sichuan, China (LGED, 2002) and the volume of plants built following that specification can be calculated from the diameter of the plant (which can be measured as described previously).

Volume calculation: the total plant volume (V_p) following this design can be calculated from the measured diameter (D) as follows:

$$V_p = \frac{D^3}{2.2368}$$

COW MANURE TO BIOGAS

25 KG WASTE

YIELD ONE CUBIC METER

ONE CUBIC METER

60 – 65 % METHANE

30 CUBIC METER

ONE CUBIC METER BIOGAS PER DAY EQUAL TO 1 LPG PER MONTH

ONE CUBIC METER

CONTAIN 6 KWH, DUE TO LOSSES IS CONVERTED TO NEARLY **2 KWH**

Nutrient of different fertilizer

BIOGAS SLURRY 1.4 %

FARM YARD MANURE 0.5%

COMPOST 1.5 %

BIOGAS SLURRY 1.0 %

FARM YARD MANURE 0.2 %

COMPOST 1.0 %

BIOGAS SLURRY 0.8 %

FARM YARD MANURE 0.5 %

COMPOST 1.5 %

ADVANTAGES

- *Renewable source of energy.*
- *Organic fertilizer (odorless sludge).*
- *Sustainable development.*
- *Low maintenance.*
- *Simple installation, silent operation.*

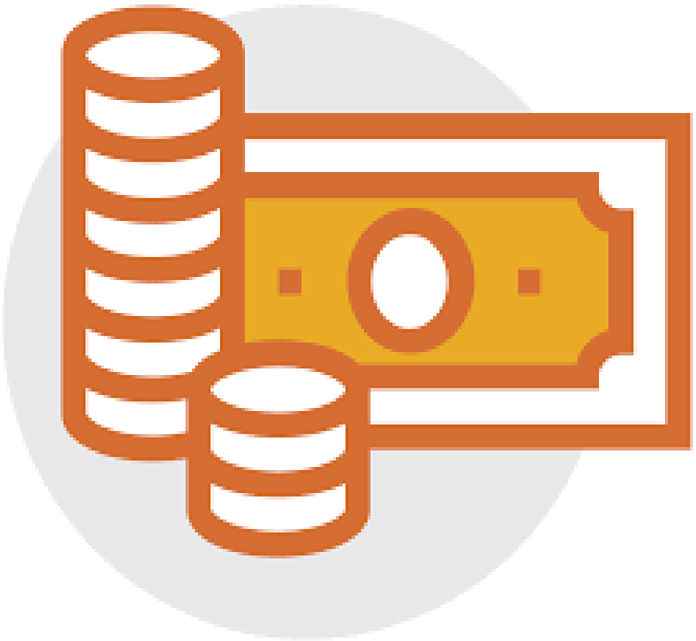
DISADVANTAGES

- *High capital cost (One–time cost)*
- *Need proper conditions.*
- *Some Usage of fuel requires removal of h_2s and co_2.*

Finicial ANALYSIS Example

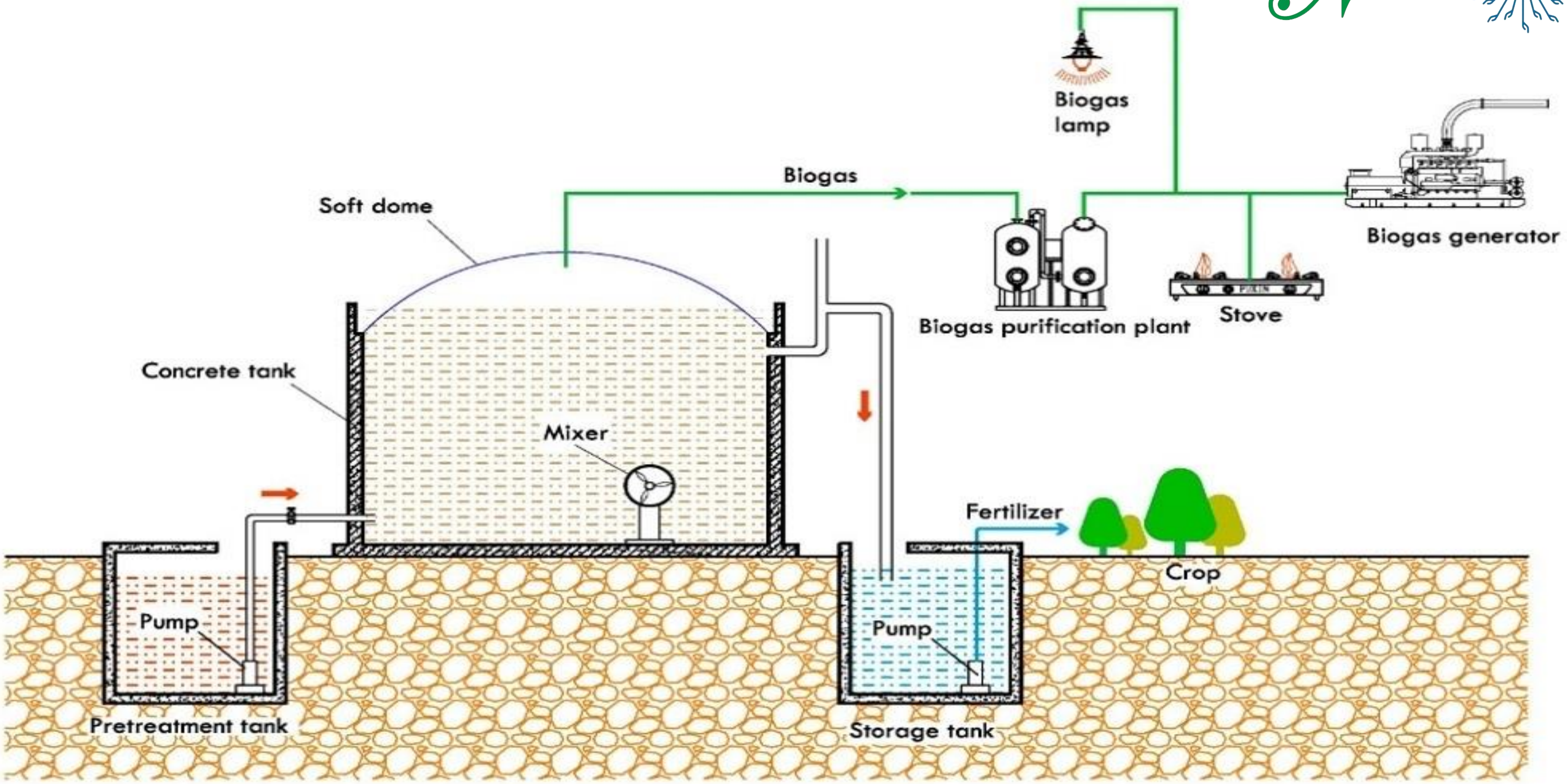
A family consists of 4 persons, have 5 cows, consume 2 liquefied petroleum gas cylinder per month.

Calculate ROI if construct household biogas plant.



FINICIAL ANALYSIS

Design.
Selection Model.
Earth Work.
Construction Materials
Connection Materials.
Equipment.
End Use.
Operation.
Maintenance.
ROI



Biogas
lamp
Biogas
Soft dome
Biogas generator
Biogas purification plant
Stove
Concrete tank
Mixer
Fertilizer
Crop
Pump
Pump
Pretreatment tank
Storage tank