An Efficient Biomethanation Technology - Organic Waste to Compressed Biogas (CBG)

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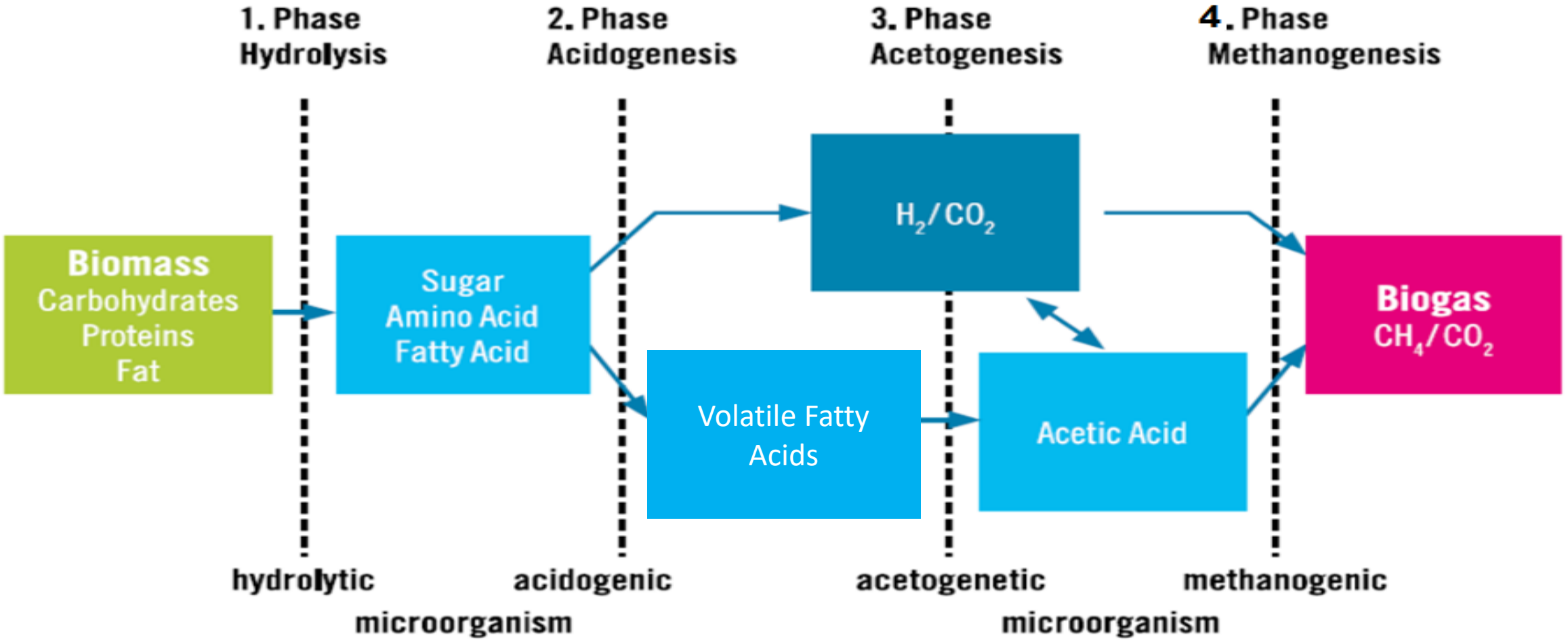
Introduction

- Increase in population, rapid urbanization and industrialization across the country led to massive increase in waste generation.
  - Organic waste is of bio-origin and biodegradable in nature
- Unscientific and Uncontrolled disposal of organic waste results in release of large quantities of GHGs

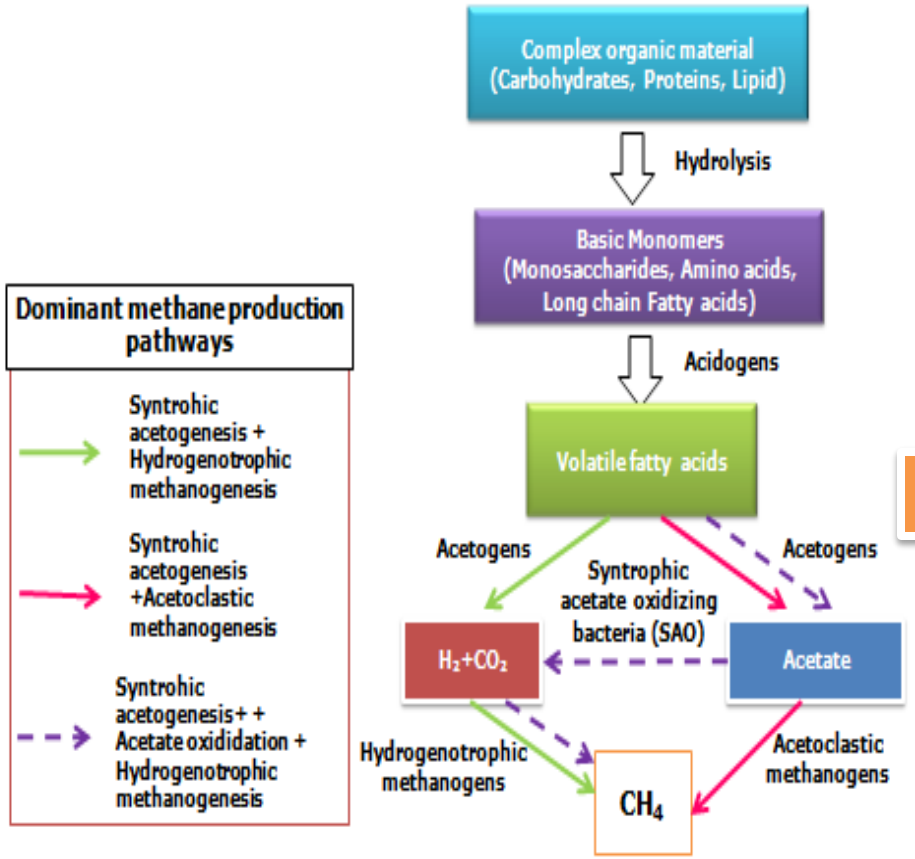
Energy recovery from organic waste can be a potential contributing factor to realize the objective of safe waste disposal, energy independence and import substitution

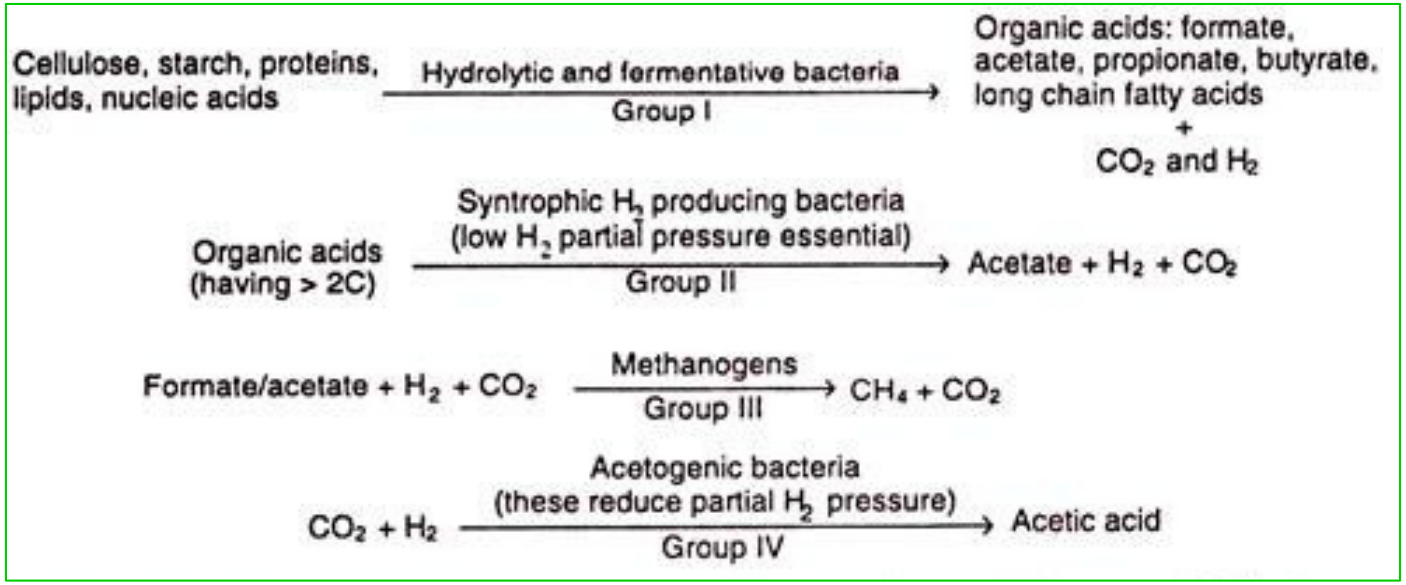
Biomethanation is a potential option for harnessing energy from organic waste

Biogas production process



Microbial management of Biomethanation process



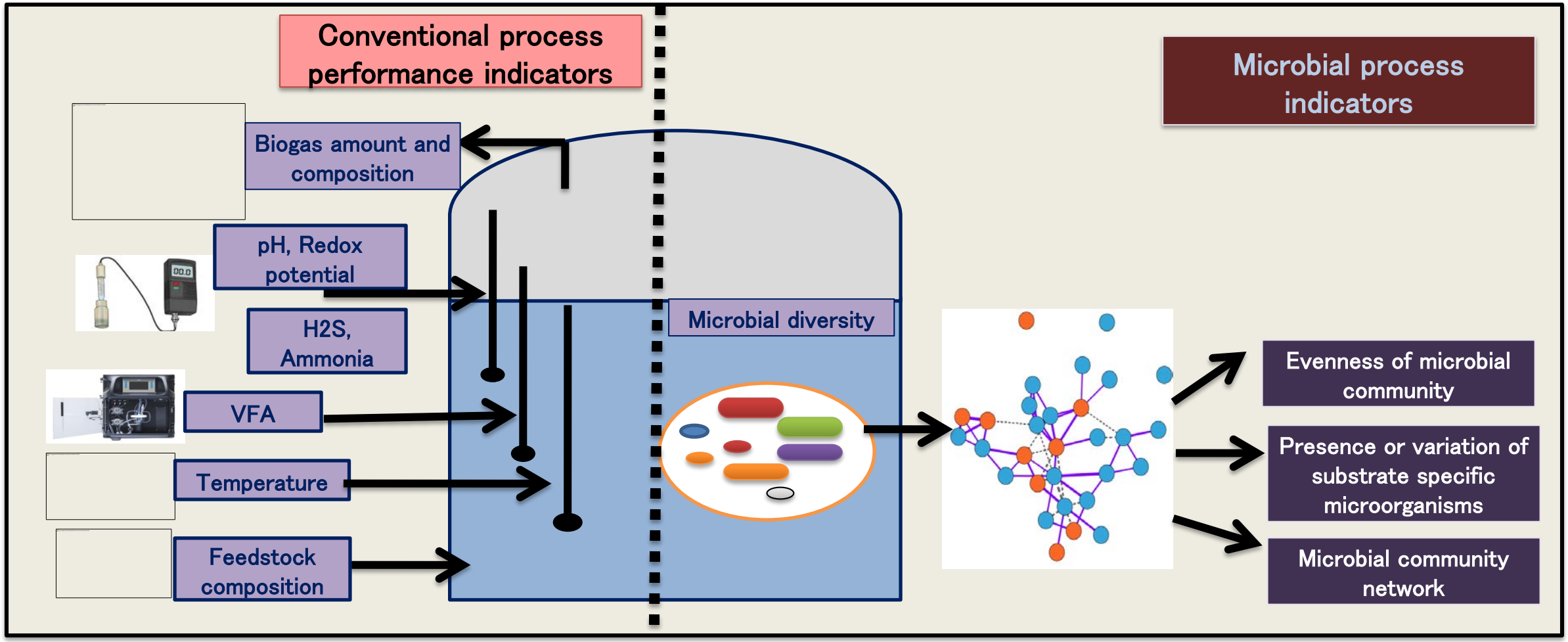


Understanding the microbiology and reactor design is the key

There is need:

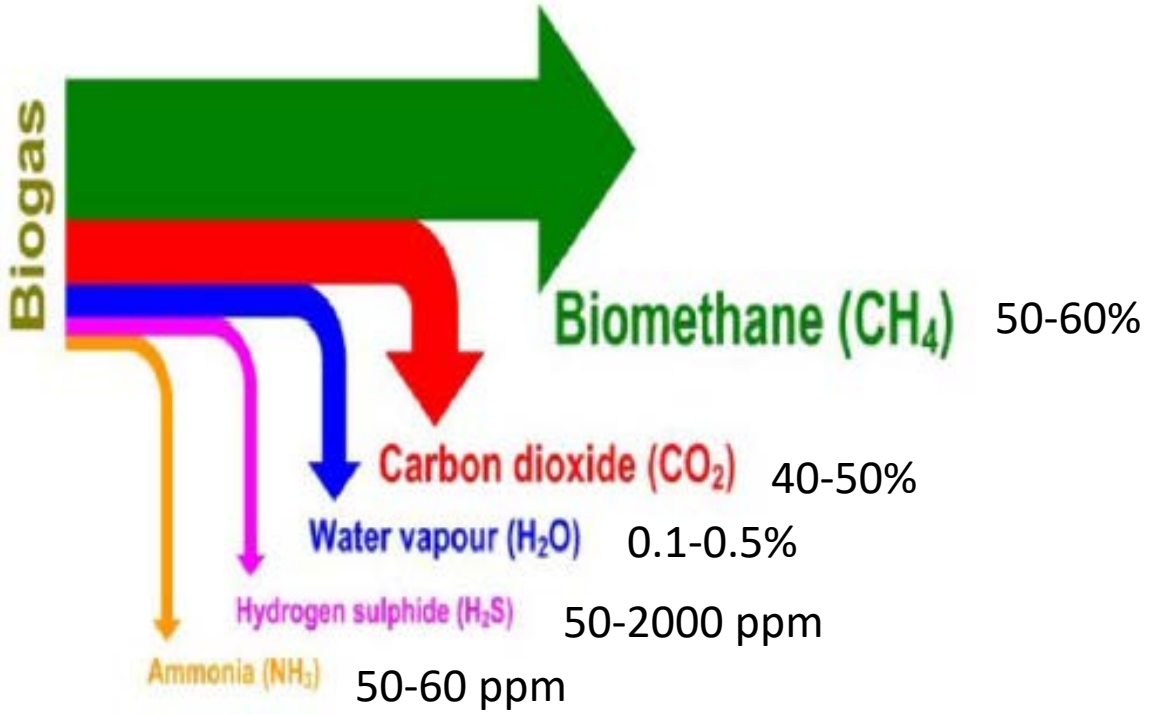
- To understand the behaviour of complex anaerobic microbiome against environmental and process disturbances in order to achieve high process stability.
- To set microbial indicators of optimal performance of reactors

Indicators for optimal performance of anaerobic digestion



Process control based on microbial diversity parameters is still missing. Hence, approach for exploring the influence of the microbial community on the digester functioning and stability is required.

Biogas Composition



Raw Biogas

Compressed Bio-Gas

What is Compressed Bio-Gas (CBG)?

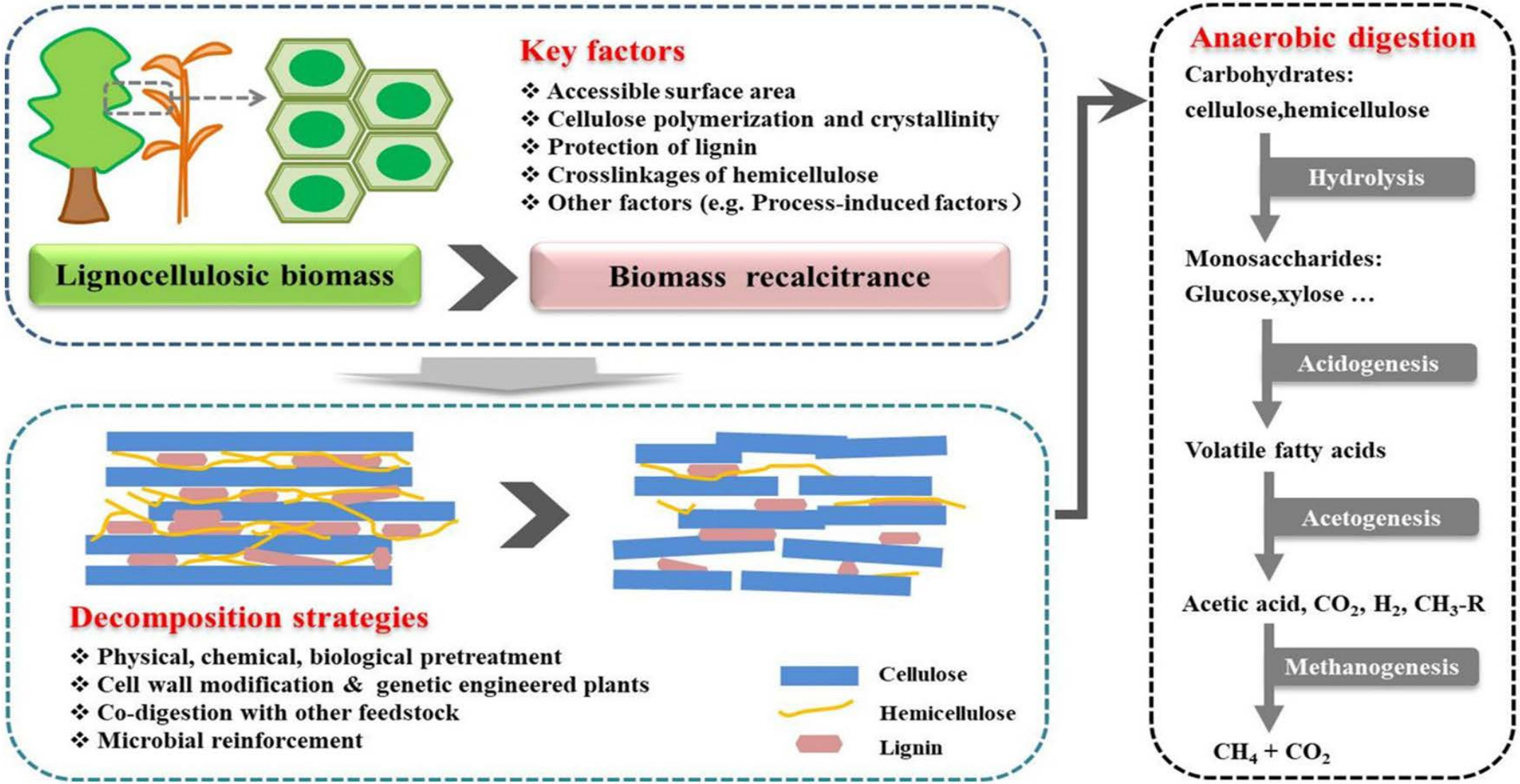
- Bio-gas after purification compressed and called CBG
- Compressed Bio-Gas is exactly similar to the commercially available natural gas in its composition and energy potential.
- Compressed Bio-Gas can be used as an alternative, renewable automotive fuel.

BIS Standard on Bio-methane IS 16087:2016

S. No.	Characteristics	Requirement	Method of test (Ref to)
1	Methane (%) Min	90	IS 15130 (Part 3)
2	Moisture, mg/m3, Max	05	IS 15641 (Part 2)
3	Total Sulfur(including H_2S) mg/m3(max)	20	ISO 6326-3
4	$CO_2+N_2+ O_2$ (%) Max (v/v)	10	IS 15130 (Part 3)
5	Only CO_2 % Max (v/v)	4	IS 15130 (Part 3)
6	O_2 (%), Max (v/v)	0.5	IS 15130 (Part 3)

SATAT Initiative aims to • Guarantee Production off take where Public Sector OMC to buy CBG at fixed rate • Set up CBG Plants mainly by independent entrepreneurs. • Provide an additional revenue source to farmers. • Reduce import of natural gas. • CBG to be sold through cascades initially at OMC fuel stations and later it can be integrated with gas grid.

Biomass to Biogas



Biogas Upgrading

Removal of H_2S

- Biological Fixation
- Iron chloride dosing
- Water scrubbing
- Activated Carbon
- Iron chelating

Removal of CO2

- Pressure Swing Adsorption
- Chemical scrubbing –Amine
- Membrane separation
- Water scrubbing

Biogas Upgrading

Comparative analysis of technologies to remove Hydrogen Sulphide

Method	Efficiency	Cap Cost	O&M	Complexity
Biological Fixation	Moderate	Moderate	Low	Moderate
Iron chloride dosing	Moderate	Low	Moderate	Low
Water scrubbing	High	High	Moderate	High
Activated Carbon	High	High	Moderate	Moderate
Iron Hydroxide or Oxide	High	Moderate	Moderate	Moderate
Sodium Hydroxide	High	Moderate	High	Moderate

Comparative analysis of technologies to remove Carbon Dioxide

Process	Water scrubber	PEG scrubber	Amine scrubber	PSA	Membrane
CH_4-enrichment	High	High	High	Good	High
O_2-/N_2-enrichment	Yes	Yes	Yes	No	Yes
CH_4-Losses	Low	Medium	Low	Medium	High
Produced gas dryer required	Yes	Yes	Yes	No	No
H_2S pre-treatment required	No	Yes	Yes	Yes	Yes
Waste gas treatment required	No	Yes	Yes	No	No
Utility demand	Medium	High	High	Medium	High
Power demand	€0.25/m^3 biogas	€0.32/m^3 biogas	€0.42/m^3 biogas	€0.25/m^3 biogas	€0.50/m^3 biogas
Level of emission	Medium	Low	Medium	Low	Low
Capital cost	Medium	Medium	High	Medium	High
Number of reference plants	High	Low	Medium	High	Low

IndianOil CBG Technology

Existing biomethanation technologies

- Single stage biomethanation process
- Existing technologies use undefined inoculum
- Major limitations of existing technologies
  - Large reactor volume and high HRT– High CAPEX
  - Low methane content in raw biogas
  - Low biogas yield
  - High purification cost
  - Large footprint

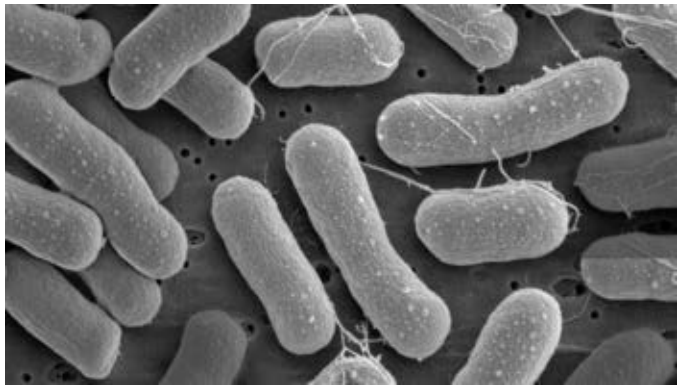
There is need:

- To understand the behaviour of complex anaerobic microbiome against environmental and process disturbances in order to achieve high process stability.
- To set microbial indicators of optimal performance of reactors

IOC's biomethanation technology

Innovation:

- Indigenous enviro–tolerant inoculant producing higher biogas with high methane and reduced CO2 content developed
  - **Biogas : high biogas yield**
  - **High methane content**
  - ***In situ* conversion of CO2 to methane**
  - **Suitable for multiple feedstock**



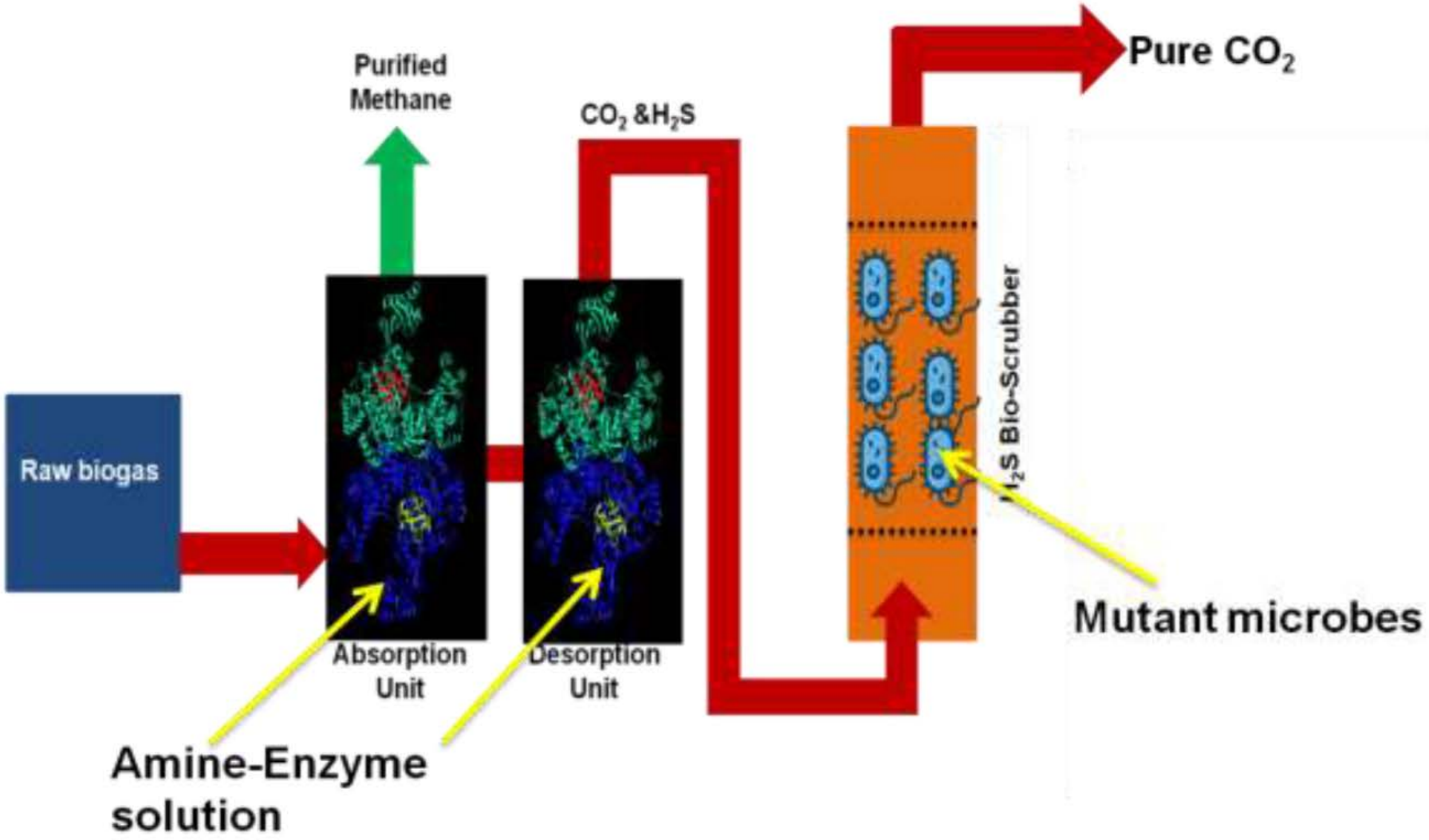
- Types of process
  - Two stage: IOC has two distinct bioinoculant for both the acidogenesis and methanogenesis phases of biomethanation
  - Single stage: Series of multiple reactors for simultaneous acidogenesis and methanogenesis
- Bioinoculant technology can be retrofitted with exiting single stage process

Feedstock Validation

- Food waste (both precooked and leftover) from various sources like food processing industries, households, and hospitality sector
- Horticultural/plant residues
- Animal waste (Cattle dung and Poultry droppings etc)
- Dairy waste
- Municipal Solid Waste (MSW)
- Press Mud
- Sewage sludge

Large Potential of energy recovery from above substrates & disposal of wastes

IOCL Biogas Purification Technology



Benefits: IOCL Biogas Purification Technology

Parameters	Conventional Amine system	Bio-assisted biogas purification method
CO2 uptake	2.25 mol/L	4.54 mol/L
H2S removal	No/Low H2S removal	Simultaneous CO2 and H2S removal
CH4 Yield	>99%	Higher than 99%
Amine gradation	Some amine loss due to thermal/oxidative degradation	Very Low amine loss due to degradation-Top-up required after long interval
Regeneration temperature	120 ^{0}C to 150 ^{0}C	90 ^{0}C
Foot print	High reactor footprint due to higher column size	Low reactor/column size
CAPEX	High	Low

Advantages of IOC R&D technology

Parameter	IOC Technology	Competing Technologies
Methane content in raw biogas vol %	> 80 (two stage) >70% (single stage)	50–60
Gas Yield	1.5–2.5 X	X
Hydraulic Residence time, days	8–10 (two sage) 21 (Single stage)	30–45
Purification cost	Low	High
CAPEX	0.85 X	X
Footprint	0.8 X	X

Biomanure: An important by-product

Solid manure

Liquid manure

Protection against drought and soil borne diseases

Increase in crop yield

Reduce consumption of chemical fertilizer by 25%

Active soil biologically

Restore natural soil fertility

Technology Demonstration Status

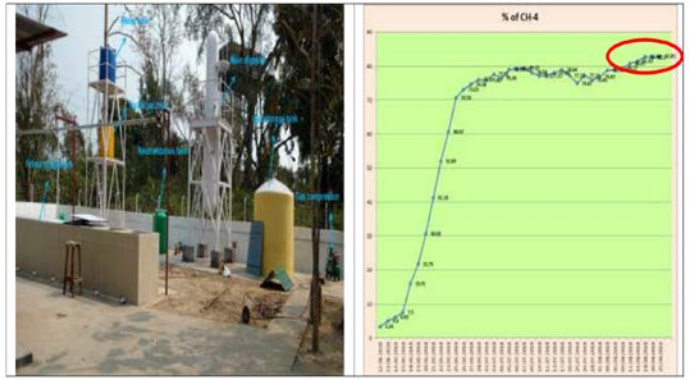
IOC R&D biomethanation technology has been implemented in both single and two stage plants

Location	Plant capacity	Waste used	Remark
IOC R&D developed Two-Stage biomethanation technology			
Faridabad (In collaboration with MCF)	5 Ton/day	Organic fraction of MSW	Successfully Operating
IOC R&D developed inoculum evaluation at existing Single-Stage plants			
Varanasi	5 Ton/day	Organic fraction of MSW	• Biogas production increased from 1.5 to 1.7 times • Methane content of biogas increased from 53.96% to 74.14%
Namakkal, TN	240 Ton/day	Press mud and Chicken litter	• Biogas production increased about 27% • Methane content of biogas increased abot 15%

Biogas plant at Varanasi, UP
Capacity : 5 TPD input
Input : MSW
Outcome: 1.5 times increment in biogas

IOT Biogas , Namakkal, TN
Capacity : 290 TPD input
Input : Press Mud, Chicken litter, Dairy Effluent
Outcome: 27% increment in biogas

Retrofitting of bioinoculant in the existing plants



AOD, Digboi
Capacity : 250 kg/day
Input : Kitchen waste
Outcome: Methane content ~80%

Biomethanation plant based on IOC technology

Conclusions

- Biomethanation is suitable technology for energy generation from organic waste
- IOC has developed in-house technology with higher methane content and improved gas yield for biomethanation of organic waste
- Biomethanation Technology of IOC is highly economical as compared to conventional technologies currently available.
    - High Methane content
    - Low HRT
    - Multi-feedstock
    - Low Capex
    - High Biogas Yield
    - Low cost purification technology
- IOC R&D to provide complete business solution for biomethanation technology comprising of process licensing, fabrication of the plant, purification technologies and continuous monitoring/ support.

Thank you !!