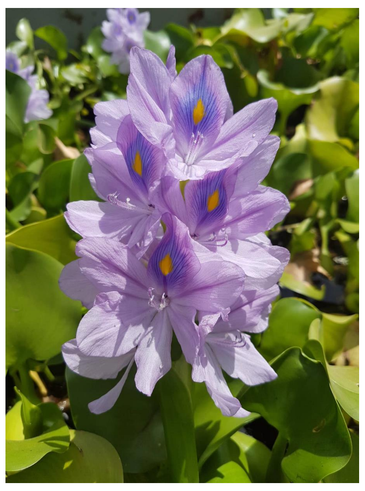
BEFWAM

Bioenergy, Fertilizer and Clean Water from Invasive Aquatic Macrophytes



BEFWAM: Bioenergy, Fertiliser and Clean Water from Invasive Aquatic Macrophytes

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Defiant Renewables, India, CREEC, Uganda

BIOGAS UPGRADING STRATEGIES

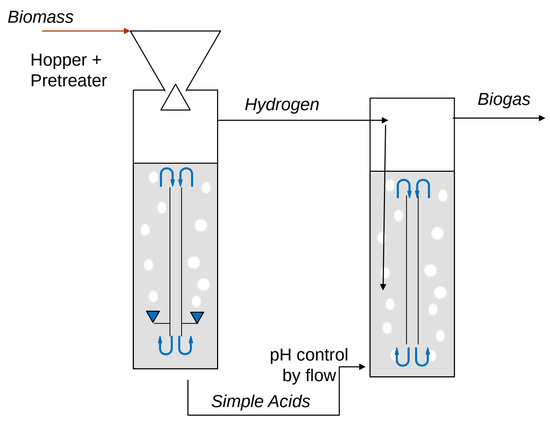
A key objectives of the BEFWAM project is to develop low cost biogas upgrading strategies to produce higher quality bio-methane. A number of upgrading strategies are investigated in **WP2 (Investigating routes to enhance methane yields and biogas quality)** including :

1. Two-stage anaerobic digestion
2. Bio-methanation
3. Biogas cleaning using microalgae

A key cross cutting theme in BEFWAM is the **development of immobilised bioreactor systems (WP3)** by the addition of biochar at different stages in anaerobic digestion. These bespoke carbonaceous support materials (modified biochars) are designed to facilitate nutrient retention, immobilisation of bacteria or adsorption of inhibitory material when added to anaerobic digestion. An additional approach being investigated for biogas upgrading is the use of immobilised microalgae for removing CO_2.

UPGRADING STRATEGIES

2 stage integration
(dark fermentation and bio-methanation)

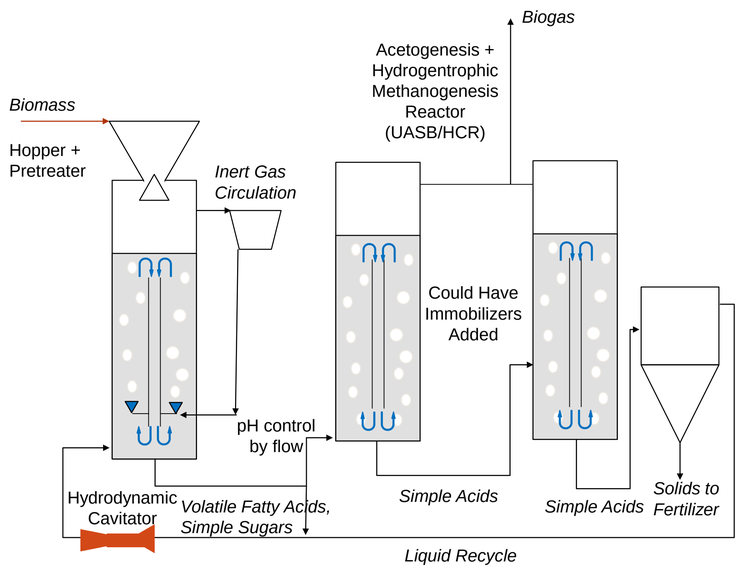


Investigate the benefits of two phase AD (dark fermentation and AD) from water hyacinth using acidogenic culture capable of H_2 and formate production (pH 5-6.5, 37ºC) before and after pre-treatment.

Investigate bio-methanation following pH adjustment of spent media from dark fermentation.

Investigate the integration of other forms of hydrogen production with single stage AD - e.g. using solar PV and electrolysis

2 stage integration
(Hydrolysis/acidogenesis and acetogenesis/methanogenesis)

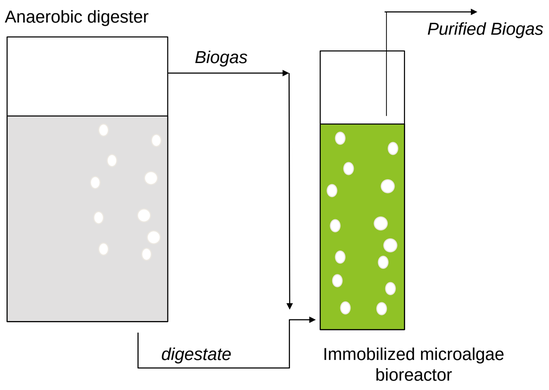


2 Phase Anaerobic Digestion generates a higher methane yield and higher methane content than single phase anaerobic digestion

Acidogenesis in CSTR, Methanogenesis in UASB + Fixed Bed Reactor → 80% CH_4 and >95% COD removal

In each case, a comparison will be made to single stage methanogenesis following pre-treatment as described in WP1

Immobilised Algal bioreactor



Development and testing of an immobilised algal biofilm reactor for CO_2 stripping using indigenous algal strains with subsequent energy recovery of algal biomass by AD

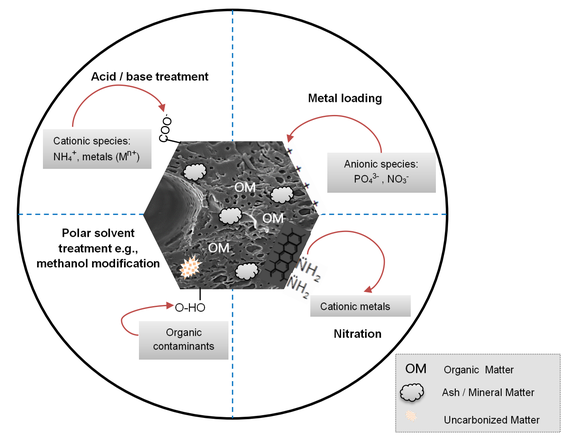
Preparation and characterisation of different immobilising agents (IMAs) including natural (e.g., alginates) and synthetic polymers (e.g., polyurethane and polystyrene), as well as carbon based supports and gelatinized-starch-polyacrylonitrile polymers.

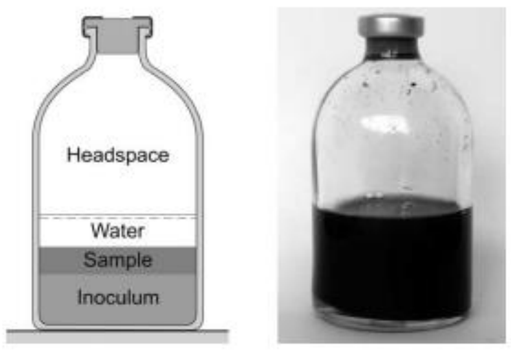
BIOCHAR PROPERTIES

Chemically modified biochars can be produced to enhance functionality increasing the adsorption characteristics of (i) nutrients, (ii) gases such as CO_2 and H_2 and (iii) microorganisms.

Preparation of a set of bespoke chemically modified biochars incorporating metals salts (e.g. Mg, Ca, Fe) and surface coating by pre-treatment of chars in the presence of additives (e.g. alginates).

Laboratory scale tests will inform the best types of biochar and pre-treatment processes for scale up in India and Uganda.





With added biochar

The addition of biochar in two phase and single phase AD using laboratory scale reactors will be performed to understand property/performance relationships and determine the influence of char on reactor stability, biogas quality (hydrogen or methane) and reactor performance

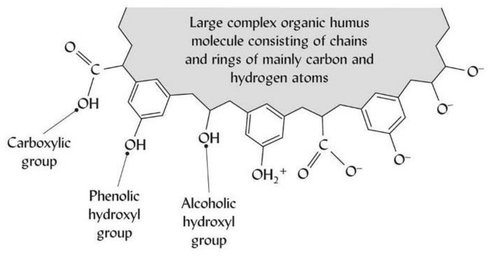
BIOCHAR AND ANAEROBIC DIGESTION

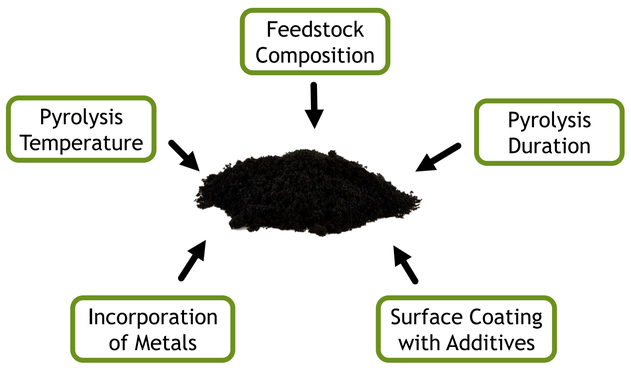
Underpinning each of these upgrading strategies is the integrated use of biochar in the anaerobic digestion system.

Biochar is a charcoal-like solid material produced from the pyrolysis of biomass and can exhibit high porosity and high surface functionality.

Such properties mean biochar has applications as a absorbent functional material as well as a microbial growth support platform

Bespoke, chemically-modified biochars are used to optimise upgrading strategies and will be derived from indigenous biomass in both India and Africa





The addition of biochar to AD systems can (i) provide a support for microbial growth (ii) reduce inhibition.

The addition of biochar to bio-methanation, can act as an absorption platform for hydrogen transfer.

The addition of biochar to digestate can trap nutrients, reduce fugitive emissions and enhance its properties as a fertiliser.

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