The use of biomass for green hydrogen energy and as a driver for mitigation of climate change.

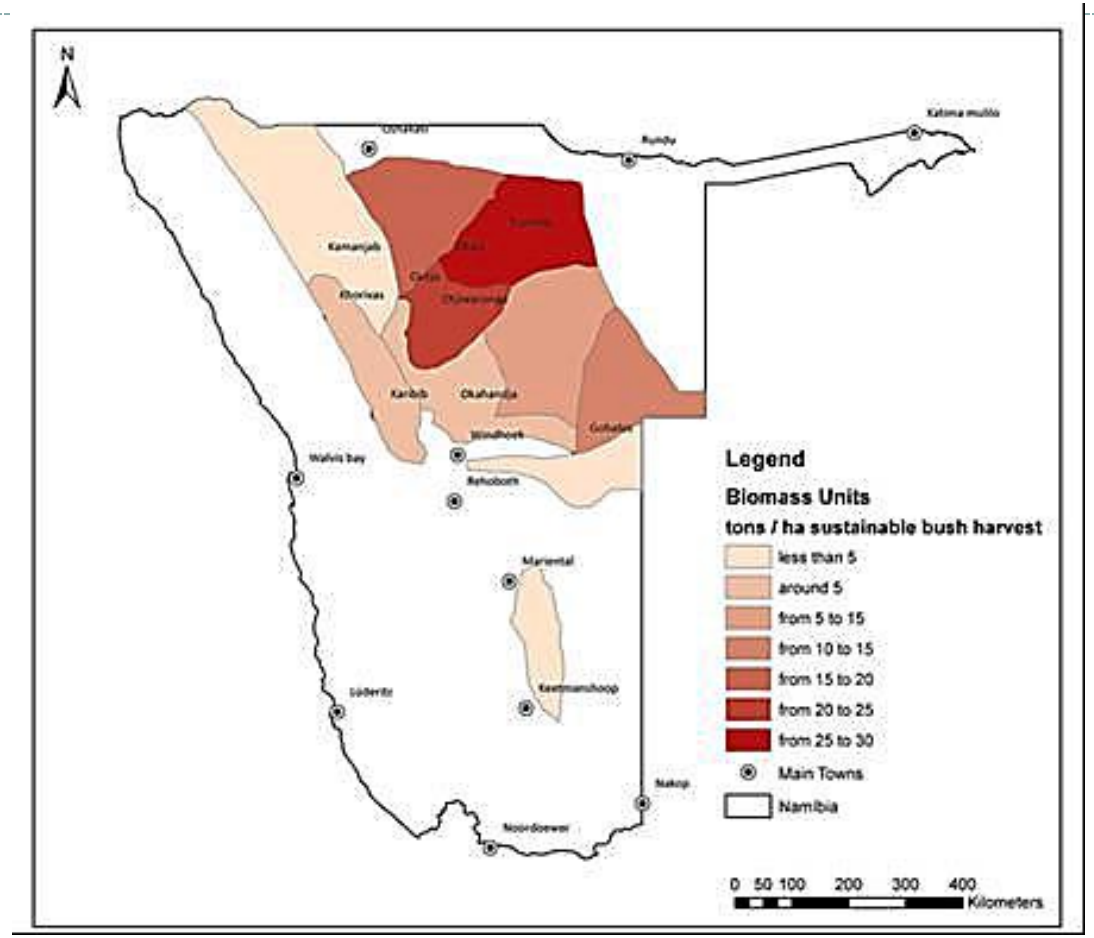
Benjamin Mapani, Rosemary Shikangalah & Shoopala Uugulu (2022).

Bush encroachment in Namibia

- Hydrogen production plays a very important role in the development of hydrogen economy.
- One of the promising hydrogen production approaches is conversion from biomass, which is abundant, clean and renewable.
- Bush encroachment negatively impacted the traditional grazing-based cattle industry, the biodiversity, groundwater sources and its recharge capacity.
- The flip side of the coin is that there are over 450 million tons of an untapped renewable resource, *id est* biomass, thriving on 45 million hectares.
- Biomass and its by-products can be used as alternative fuels, contributing substantially to reduce greenhouse gas emissions.

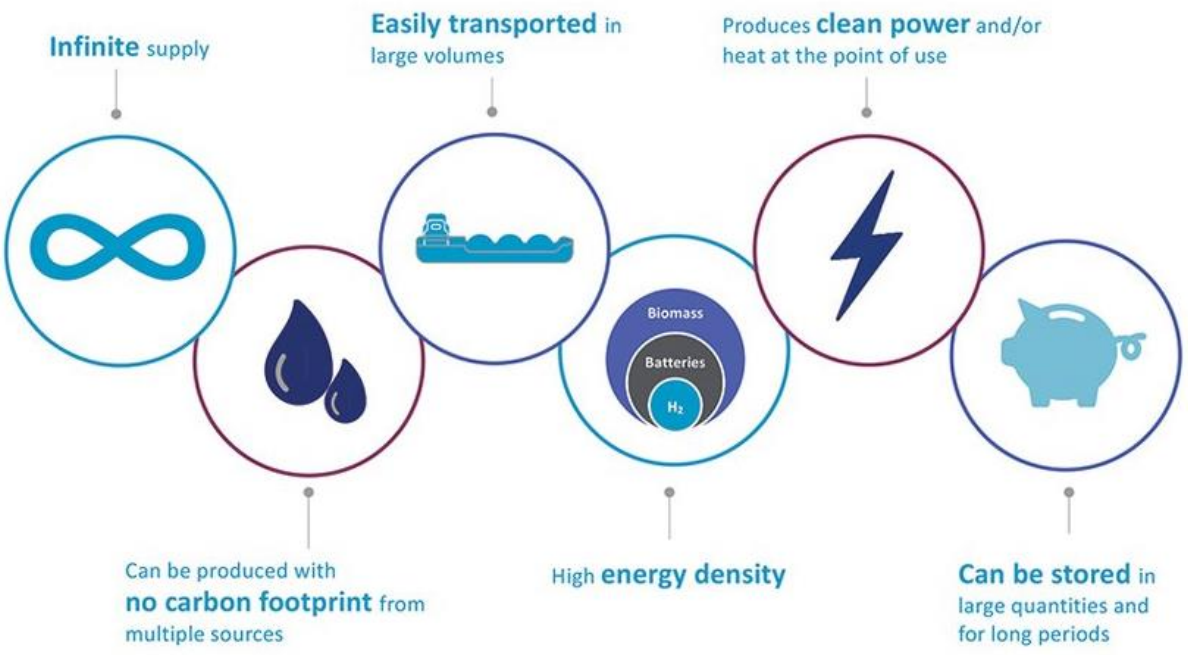
Biomass harvesting

- Over 30 million hectares of land in Namibia is affected by bush encroachment. According to Petrick and Katali (2017).
- There is sufficient encroacher bush biomass to supply 10 power plants of 20 MW each for more than 180 years (Cirrus Capital, 2018),



Why Hydrogen (Creamer, 2020)

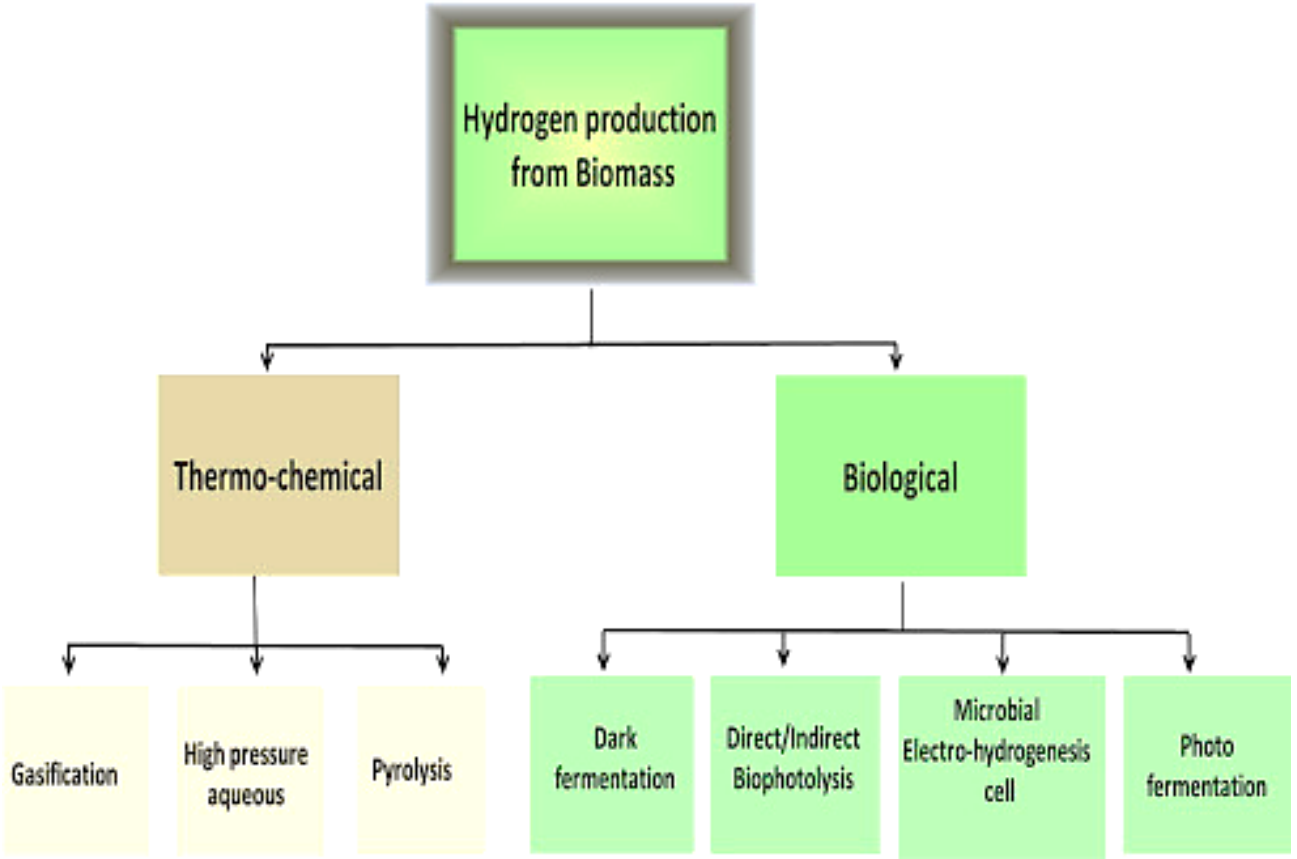
- Sustainable (Most abundant element, water is the only by-product produced on its combustion
- High power (high combustion energy, having maximum energy content per unit mass among all the known fuels)
- Save energy and reduced global warming (Convert to electricity with high efficiency)
- Easy storage and transportation (compared with electricity and hard coal)
- Efficient energy carrier.
- Can be used for trains, planes, boats.
- Can be used to electrify rural areas in Namibia.



Methods of hydrogen production from biomass (Navgi et al., 2018; Saghir et al., 2019; Singh& Das, 2019)

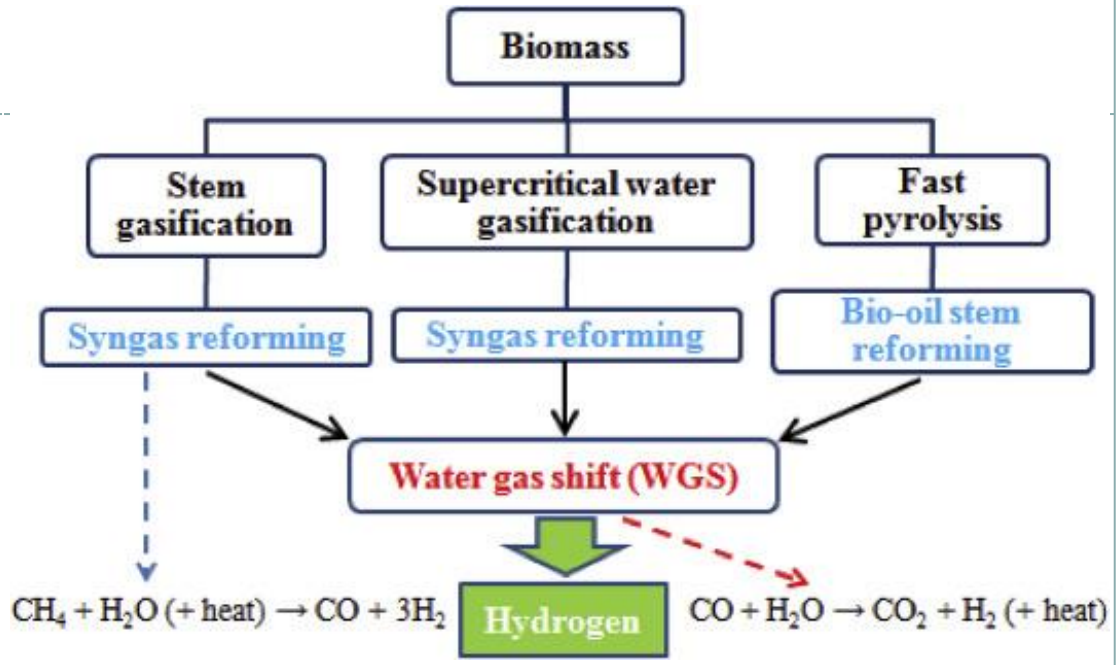
There are two major classes of the techniques for processing of biomass into bioenergy:

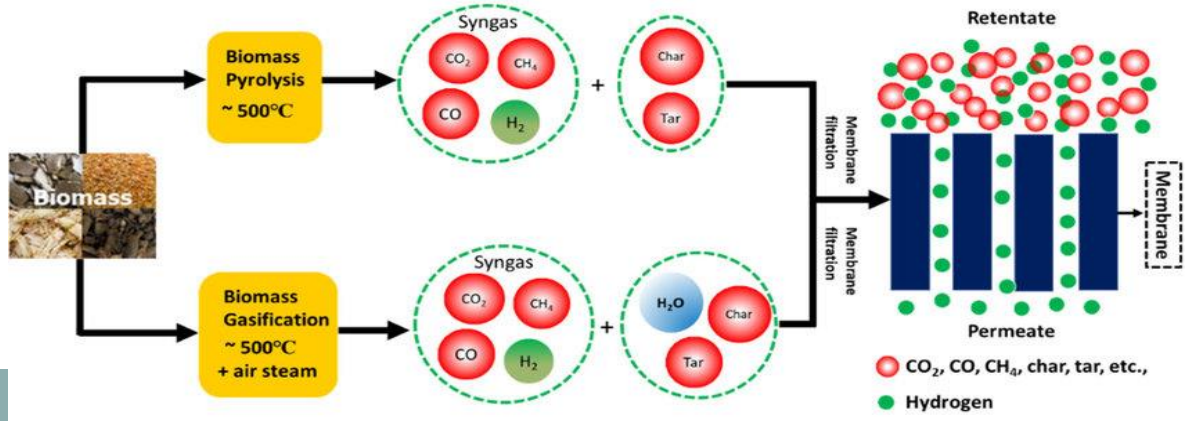
1. Thermochemical (pyrolysis and gasification) and
2. Biological (biophotolysis, water–gas shift reaction and fermentation).



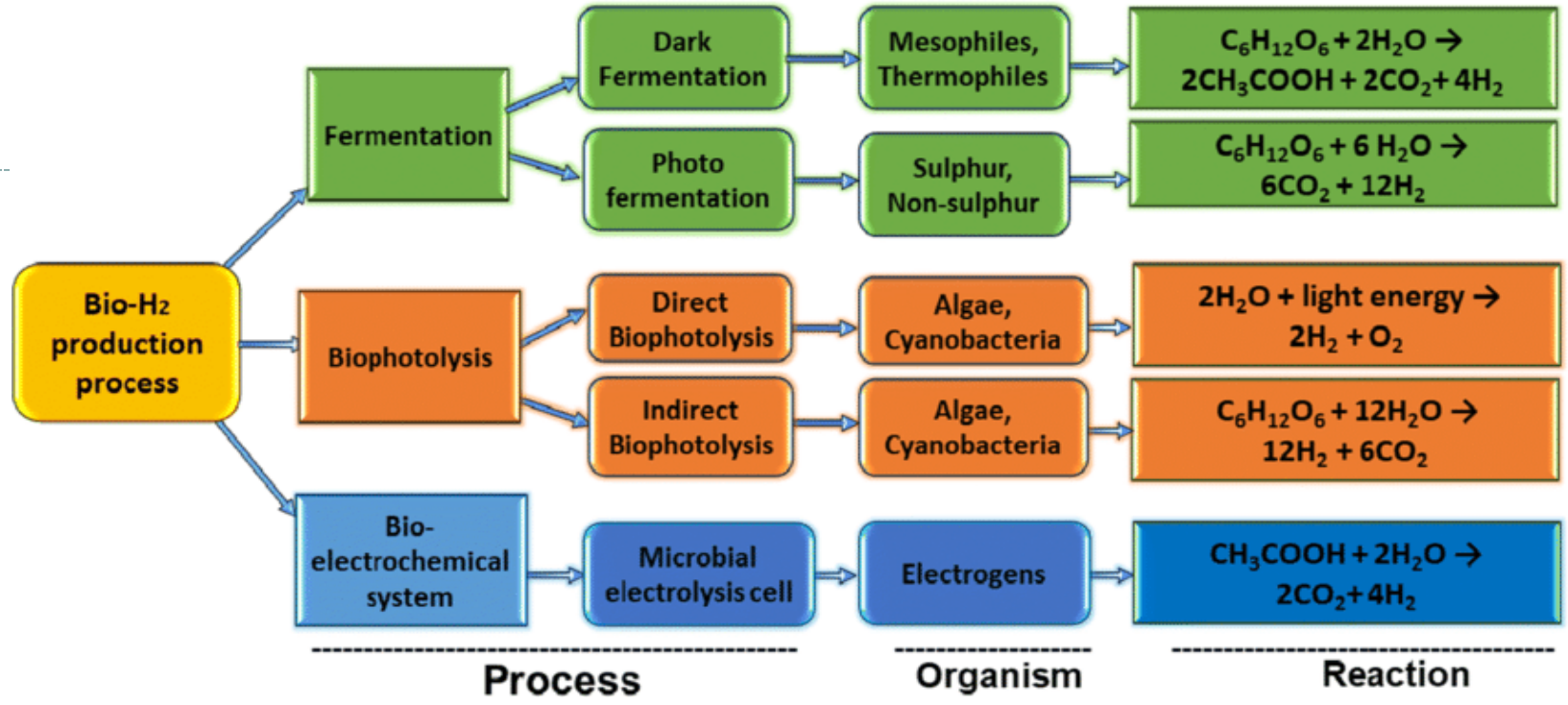
Thermochemical (pyrolysis and gasification) (Ebadi et al., 2019; Besha et al., 2020; Cao et al., 2020)

- Compared with pyrolysis, gasification is recognized to be more promising in industrial production because of their higher efficiency and H_2 yield.
- Hydrogen production from lignocelluloses gasification is utilised.
- Due to less feedstock, they both have faster reaction kinetics, fairly lower cost and efficiency (>50%).
- Membrane separation and purification for hydrogen are one of the most important applications.
- The mechanism of the
- separation lies in hydrogen selectively passing through the membrane driven by the partial pressure of
- the hydrogen in the feed side





Biological (biophotolysis, water–gas shift reaction and fermentation (Hallenback et al., 2018; Osman et al., 2020).



Two very different types of organisms carry out two light-dependent processes, biophotolysis and photofermentation.

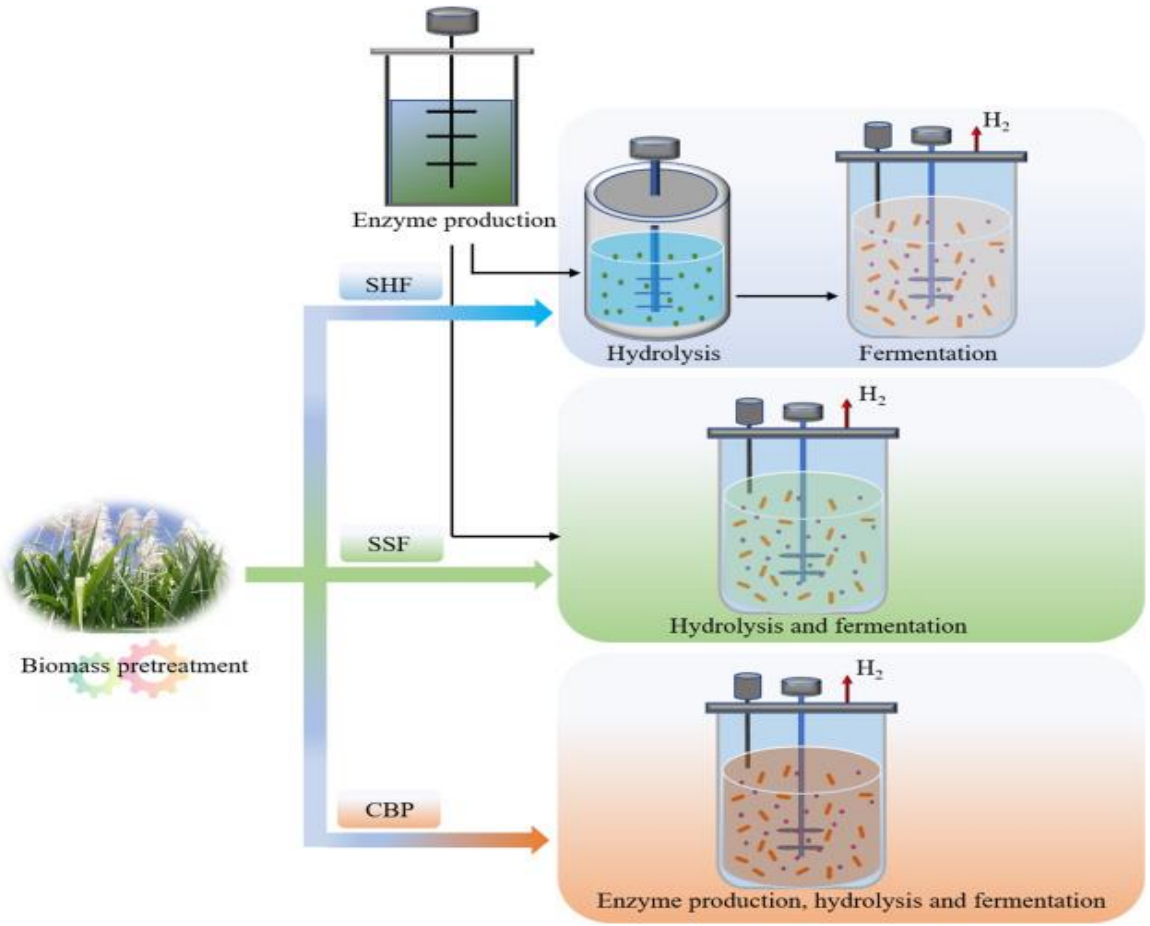
- Eukaryotic algae and cyanobacteria, which have plant-type photosynthesis and thus use water as a substrate, can catalyze **biophotolysis**.
- Photosynthetic bacteria, which only possess a single photosystem, carry out **photofermentation** with organic compounds as the electron donor.

Dark fermentation involves metabolic pathways, which catalyze the anaerobic breakdown of organic compounds (particularly sugars) to produce H2 and various byproducts, including particular organic acids and alcohols.

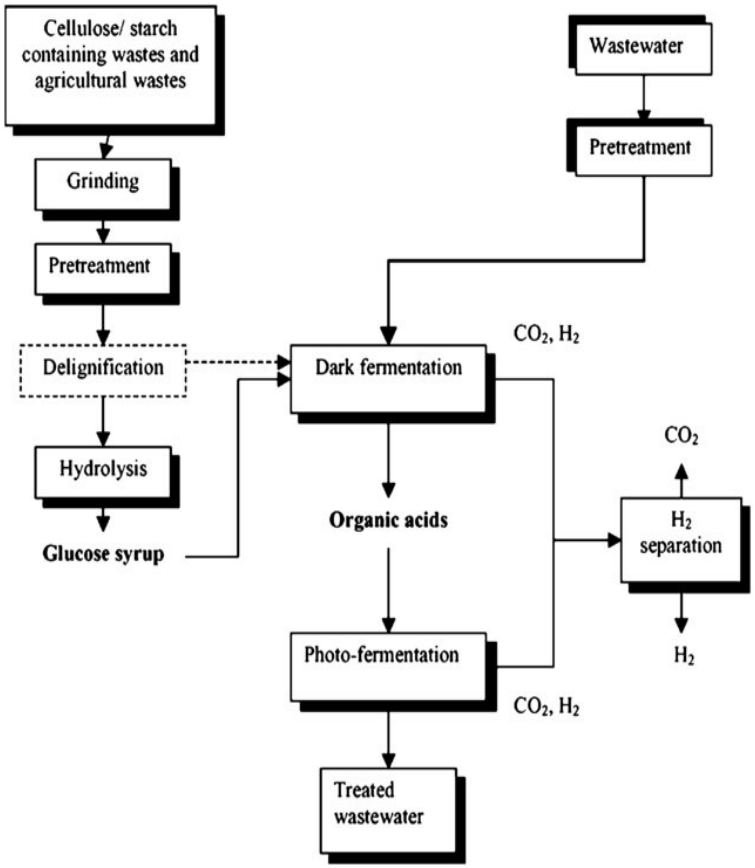
In **Microbial electrolysis Cell**, the anode accepts electrons from microbial anaerobic respiration, and supplementation with additional voltage drives H_2 evolution at the cathode .

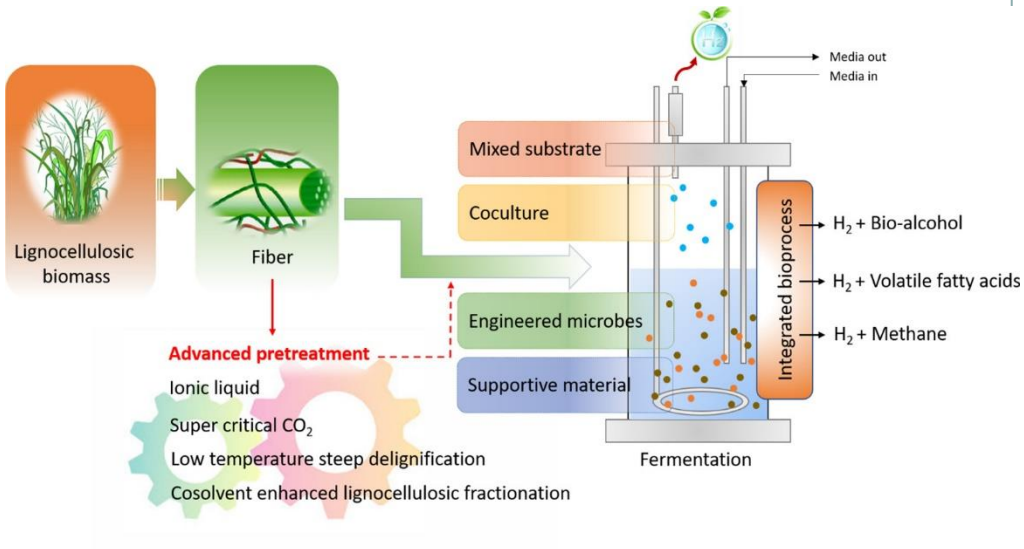
Different biobased technologies used to produce hydrogen (Bhatia et al., 2021)

1) Separate hydrolysis and fermentation (SHF),
2) Simultaneous saccharification and fermentation (SSF),
3) Consolidated bioprocess (CBP).



Hydrogen production by fermentation in detail (Bhatia, et al., 2021)





Actions

- As you can see from the presentation these are processes we can start doing using biomass
- Unless we start and experiment we can not progress
- It is now up to us to forge the way ahead and start the hydrogen production processes.

Thank you.