TECHNOLOGIES FOR THE PRODUCTION OF BIOFUELS

RENEWABLE ENERGY TRAINING PROGRAM
MODULE 8 | BIOENERGY

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CONTENTS

WHY BIOFUELS?

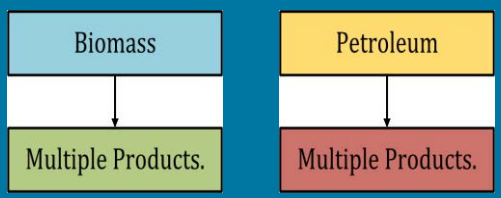
Environmental impact

Impact in rural zones

Other reasons:

oil imports reduction, integral policies or just business

NEW RAW MATERIAL: BIORESOURCES



Alcohol + gasoline
Biodiesel + Diesel

DIFFERENT BIOFUELS: LIQUIDS AND GASES

All produced by biotechnology

- **Alcohols: Bioethanol and Biobutanol**
- **Vegetable oils and Biodiesel**
- Biogas
- Biohydrogen

However thermal or chemical ways exist as for example gasification, and pyrolisis but not really at industrial level. Only combustion as direct bioenergy production system is a high scale industry.

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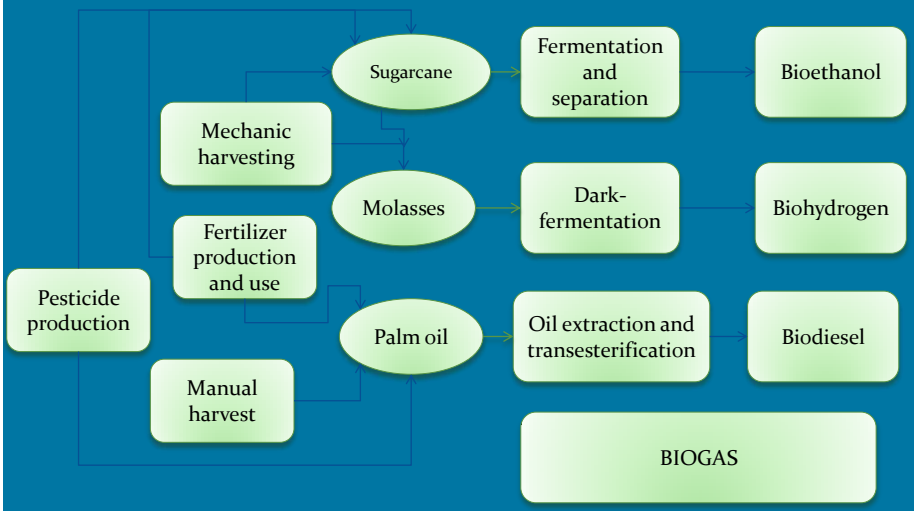
BIOFUELS SUPPLY CHAIN. EXAMPLE



BIOETHANOL: THE MOST PRODUCED LIQUID BIOFUEL

Advantages:

- Higher oxygen content
- High octane number
- Ethanol is less toxic than methanol
- Decrease of oil and gas imports
- Use of renewable sources, including residues
- Trade and employment increment

Disadvantages:

- Higher production costs
- Greater volatilization
- High corrosive
- Dependent on sugar market
- Increasing food prices in some cases
- Higher aldehyde content in combustion

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Bioethanol

- Ethyl alcohol produced by fermentation of sugar-containing feedstocksfrom:
  - Lignocellulosic biomass
  - Bioenergy plantations: sugar or starch
- The emissions generated by combustion of bioethanol are compensated by the CO_2 absorption during the growth of the crops
- Bioethanol has a greater octane number than gasoline (neat: 97, blended: 111)
- Reduces the CO, NO_X and HC emissions
- 1 L EtOH has 2/3 of caloric content of 1 L gasoline

RAW MATERIALS

Sugar crops

Starchy crops

Lignocellulosic materials

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ETHANOL TECHNOLOGY MATRIX

For Sugarcane/molasses

Step 1 for all processes: Pre-treatment washing, milling

Transformation	Separation units	Purification	Effluent Treatment	Co-generation
Yeast fermentation Batch	Sedimentation	Destillation atmospheric	Evaporation + Incineration	Low pressure boiler
Yeast fermentation Continous	Centrifuge	Molecular Sieves	Evaporation + Compost	Medium pressure boilers
Bacterial Fermentation Continuous		Pervap.	Evaporation + Fertilization	High pressure boiler
			Anaerobic Digestion	
			Irrigation	

BIOETHANOL PRODUCTION FROM SUGAR CROPS

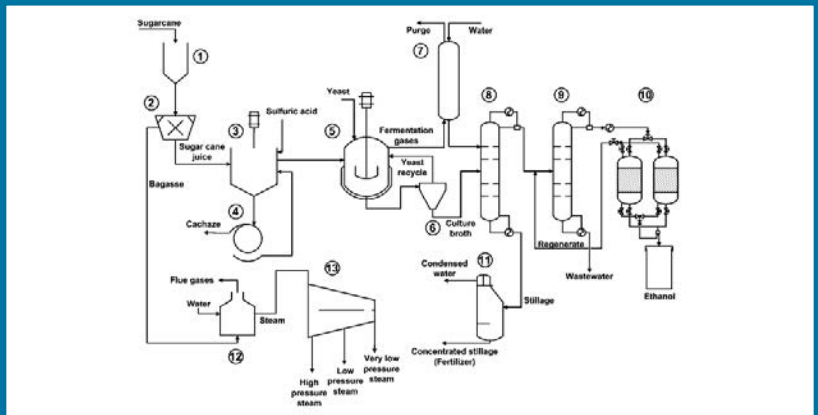

Fig. 2. Simplified flowsheet of fuel ethanol production from sugarcane. 1. Washing tank, 2. Mill, 3. Clarifier, 4. Rotary drum, 5. Fermenter, 6. Centrifuge, 7. Ethanol absorber, 8. Concentration column, 9. Rectification column, 10. Molecular sieves, 11. Evaporator train, 12. Combustor, 13. Turbogenerator.

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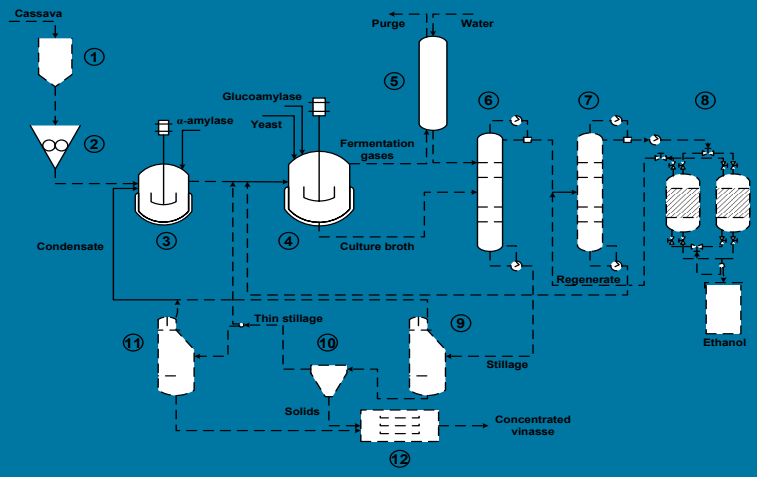
BIOETHANOL PRODUCTION FROM STARCHY CROPS



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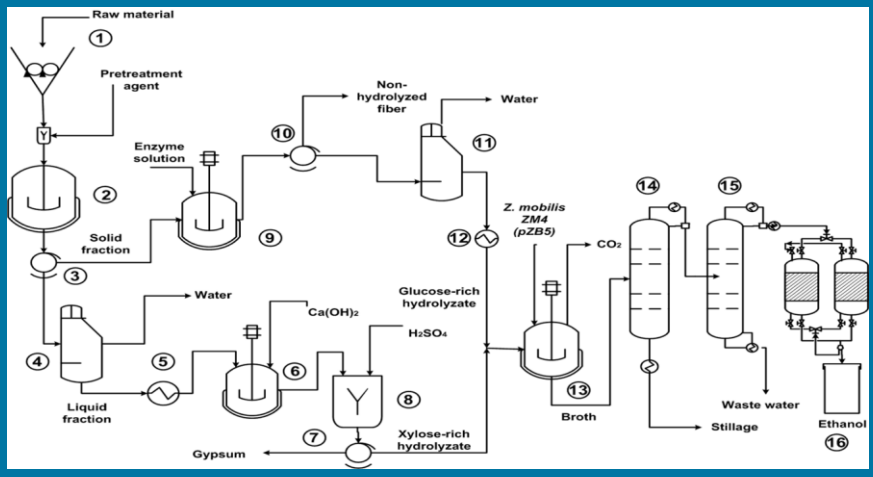
BIOETHANOL PRODUCTION FROM LIGNOCELLULOSIC MATERIALS



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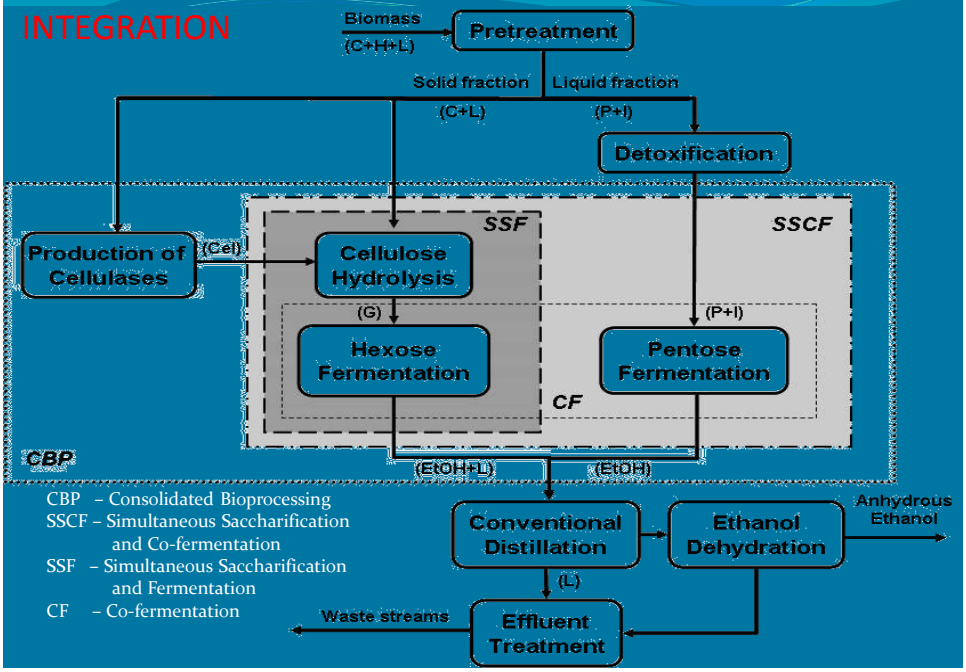
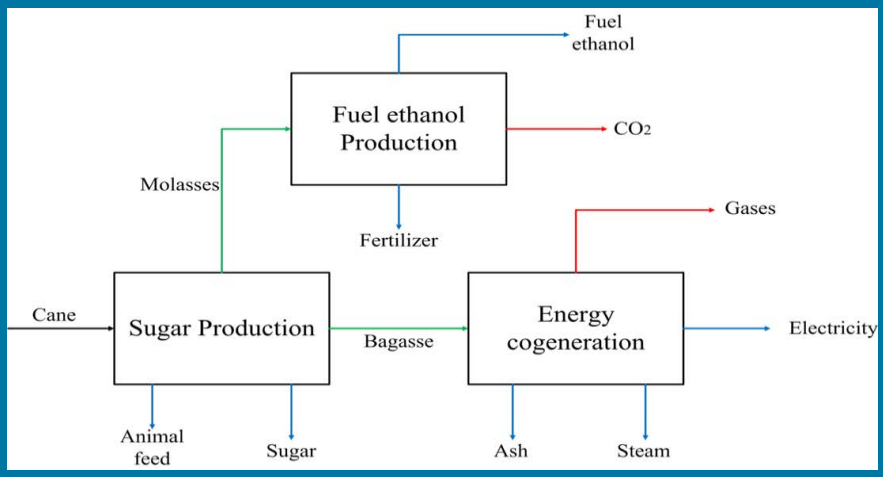
BIOETHANOL PROCESS INTEGRATION



CBP – Consolidated Bioprocessing
SSCF – Simultaneous Saccharification and Co-fermentation
SSF – Simultaneous Saccharification and Fermentation
CF – Co-fermentation

ACTUAL SUGAR CANE MILLING CONFIGURATION . HIGH EFFICIENCY



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BIODIESEL

Advantages:

- SOx are not produced during combustion .
- Reduction of particulate matter in 65%
- Higher viscosity
- Employment increment

Disadvantages:

- High nitrous oxide emissions
- Fluency problems at low temperatures .
- Dependent on availability of methanol
- Palma is associated to displacement and attack to the jungle
- Incompatibility with some plastics and rubbers

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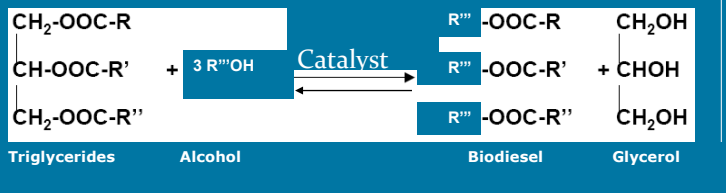
BIODIESEL PRODUCTION

- Vegetable oils
- Animal fats
- Frying oils

- Methanol
- Ethanol
- Butanol



- Basic Catalyst
- Acid Catalyst
- Enzymatic Catalyst – whole cell catalysis

RAW MATERIALS

First generation:

Second generation

Third generation

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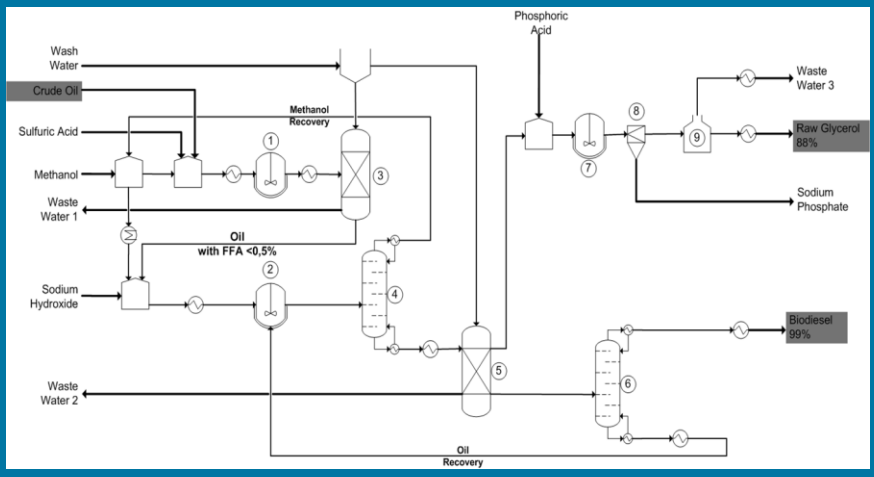
BIODIESEL PRODUCTION



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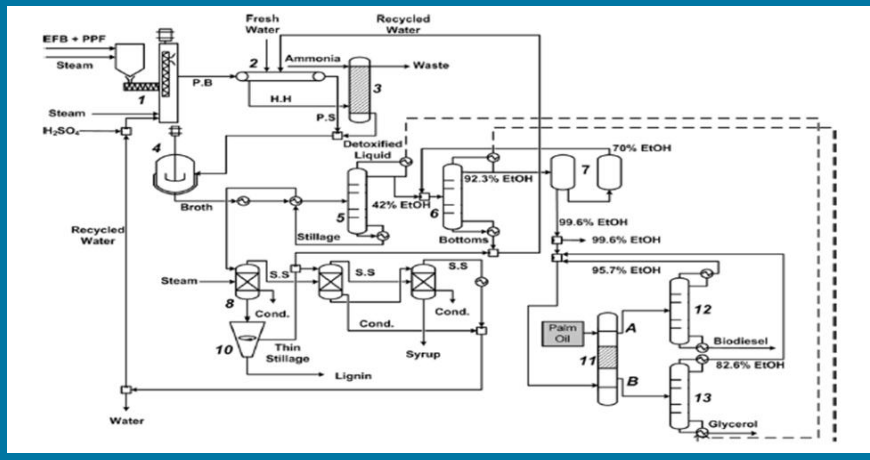
INTEGRATION BIOETHANOL AND BIODIESEL PRODUCTION



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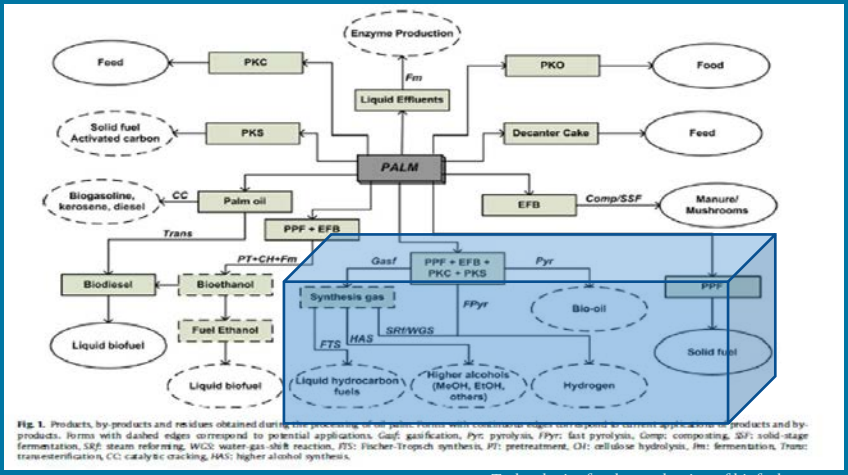
INTEGRATION BIOETHANOL AND BIODIESEL PRODUCTION



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BIOGAS

Advantages:

- The biogas used as fuel.
- The digested residue is almost odorless and stabilized.
- Nutrients are retained as biofertilizer.
- Low emission of hazardous pollutants.
- .

Disadvantages:

- Large facilities, some times expensive.
- require certain handling precautions.
- The process is sensitive to temperature, pH, speed and load changes.
- The anaerobic digestion process is not energy supplier

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RAW MATERIALS





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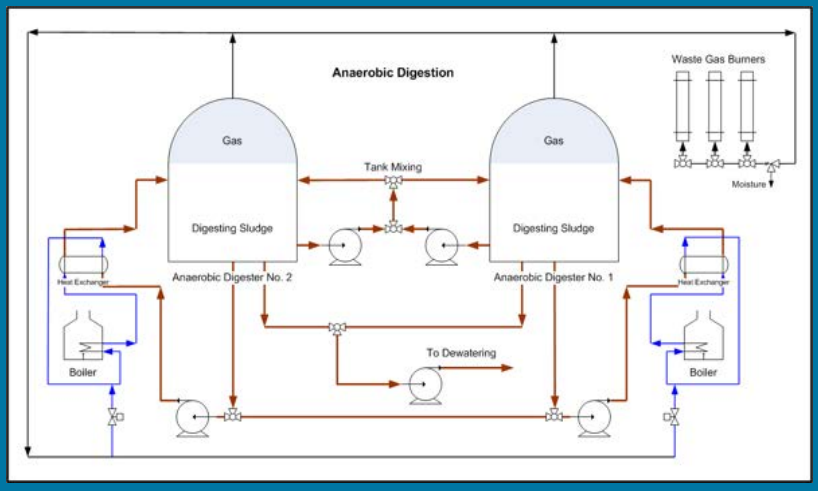
BIOGAS PRODUCTION



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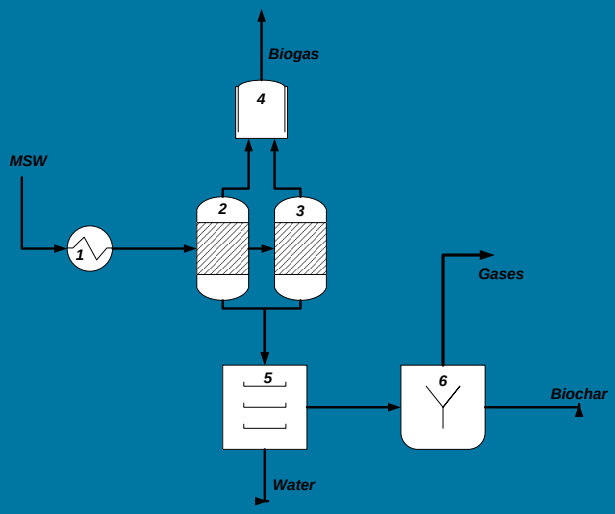
BIOGAS FROM MSW



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BIOHYDROGEN

Advantages:

- Undoubted environmental and climate change benefits.
- Its avoidance of irreversibilities and, thus, its exergizing ability, providing more technical work from less primary energy.
- Highest energy efficiency

Disadvantages :

- Lacking storability and transportability to enter the global energy trade.
- Product gas mixture contains CO_2 which has to be separated.
- Uptake hydrogenase enzymes should be removed to stop degradation of H_2.
- Light conversion efficiency is very low, only 1–5%.

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RAW MATERIALS

The sky is the limit..

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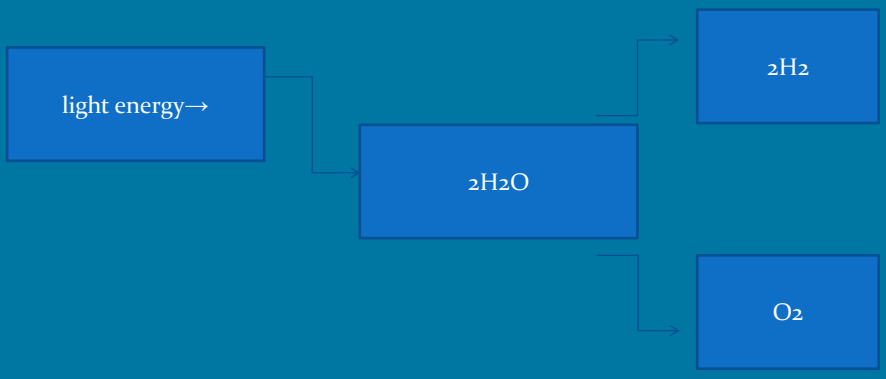
BIOHYDROGEN USING DIRECT BIOPHOTOLYSIS



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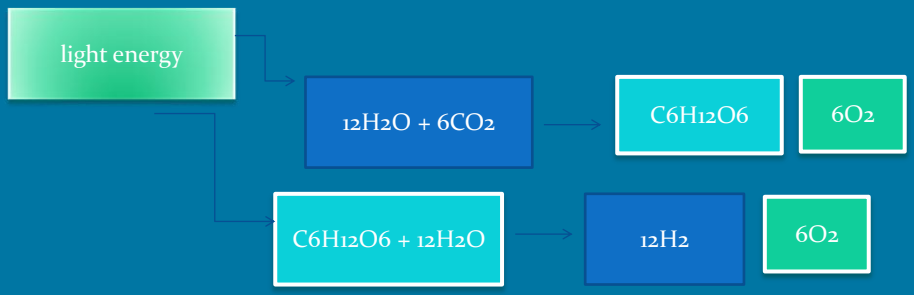
BIOHYDROGEN USING INDIRECT BIOPHOTOLYSIS



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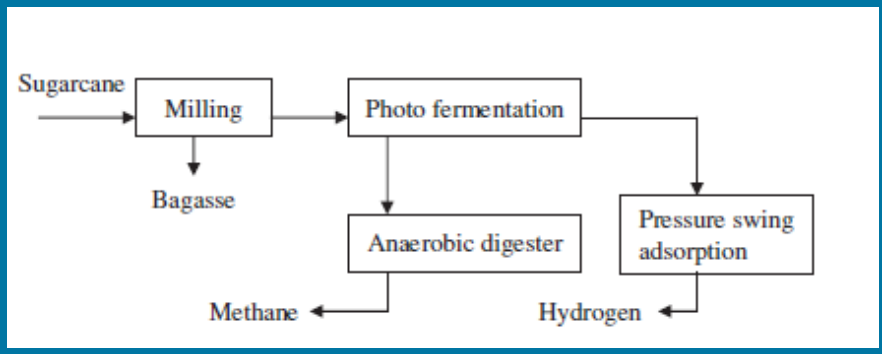
BIOHYDROGEN USING PHOTO-FERMENTATION



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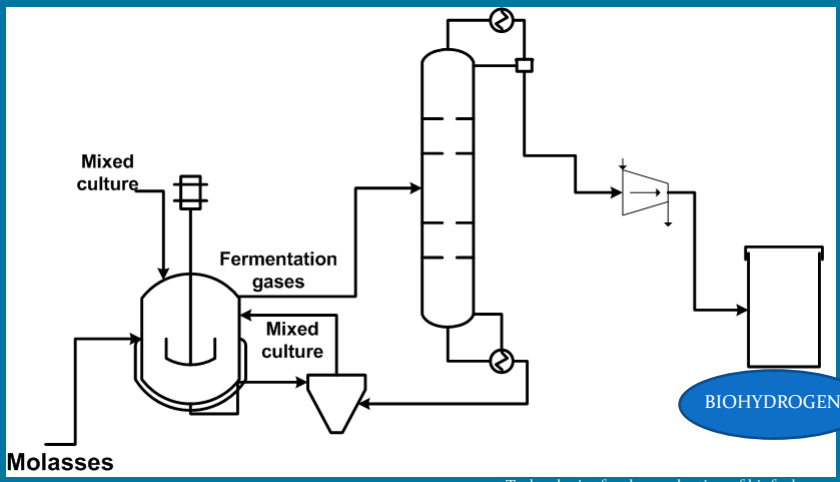
BIOHYDROGEN USING DARK FERMENTATION



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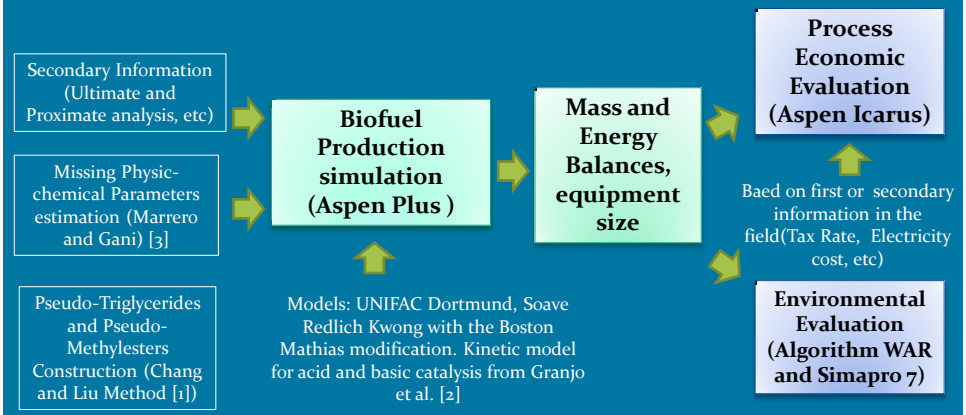
DESIGN ANS D ASSESSMENT METHODOLOGY



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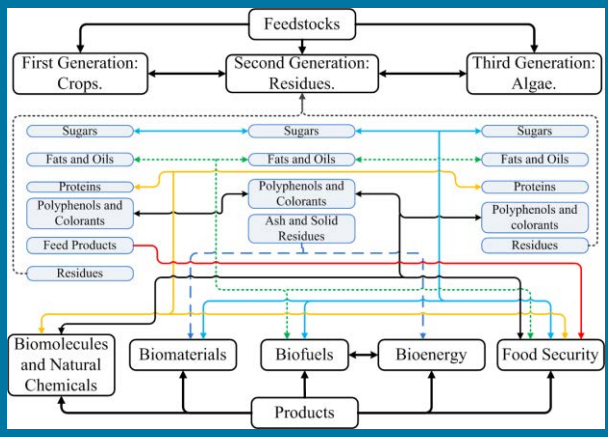
BIOFUELS IN A NEW CONTEXT

Hierarchy: Feedstocks and Products



Hierarchical decomposition of feedstocks and products (Moncada et al., 2012)

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BIOFUELS IN THE FUTURE

Reductions in greenhouse gas emissions.

Minimal impact on food supplies.

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ADDITIONAL TECHNOLOGY PERSPECTIVES

- Lignocellulosic biomass. Pretreatment.
- Jet biofuels based on octanol.
- Jet biofuels based on algae flexibility in oils composition.
- Biobutanol vs. bioethanol
- Gas biofuels introduction
- New raw materials

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THANKS FOR YOU ATTENTION!

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