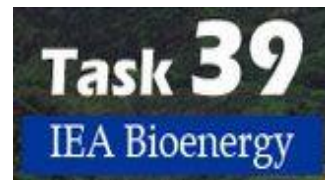




IEA Bioenergy
Technology Collaboration Programme



Feedstock-to-biofuel(s) supply chain analysis.

Focus on CAPEX and OPEX cost reduction opportunities for advanced biofuels

Alok Satlewal (RM) & Ravi.P. Gupta (GM),

Indian Oil R&D Centre, Faridabad, India

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Contents

- Objectives & Deliverables
- Biomass availability specific to Indian feedstock
- Pretreatment technologies and process schemes by 2G ethanol technology developers in India
- Biomass supply chain approaches prevalent in India
- Life cycle analysis & environmental impact assessment

Objectives

- To evaluate the advances in 2G ethanol production
- Identify the key challenges and the novel opportunities to reduce the process costs
- The report shall include data from India, USA, Brazil & Germany

Deliverables

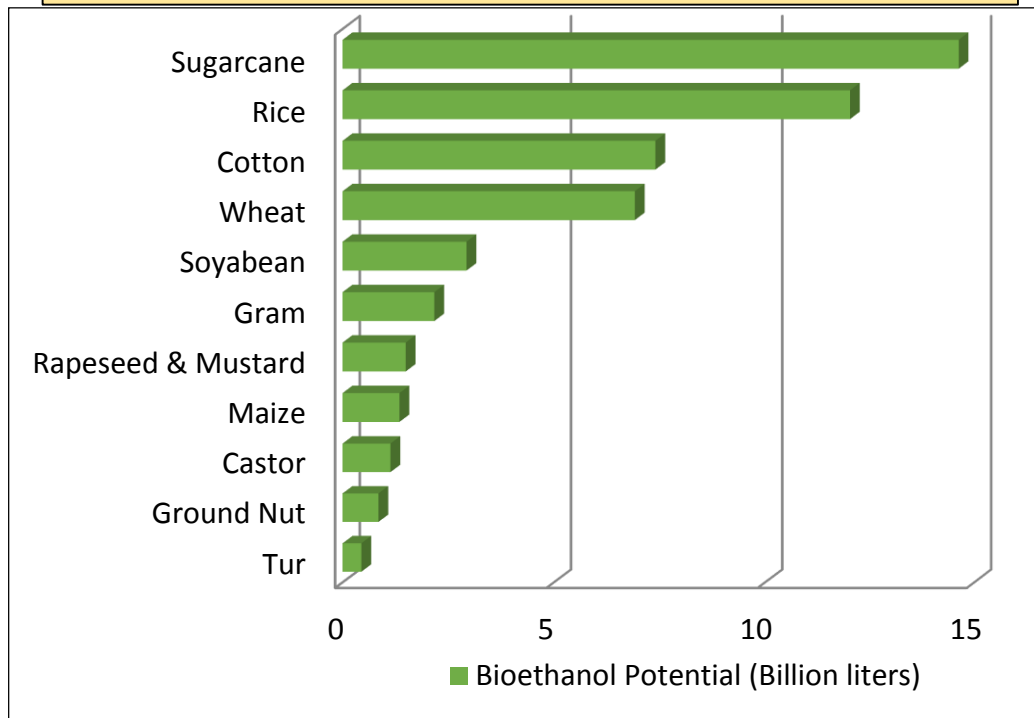
- Biomass availability, supply chain & 2G ethanol plants data from USA, Brazil & Germany is required - **May, 2021**
- Target Date for draft report completion for circulation- **June, 2021**

Feedstock Availability in India

- **Biomass availability**

- Total dry biomass generated in India was about 683 MT. Out of this total dry biomass only 178 MT (26%) was found to be surplus (TIFAC report - 2018)

Ethanol potential in billion liters vis-à-vis feedstock



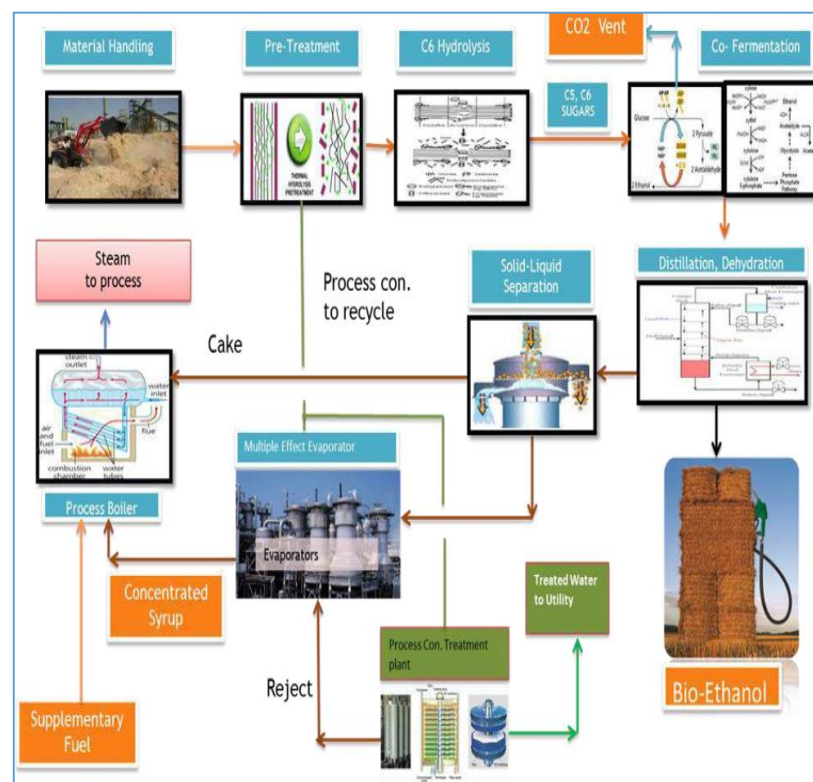
- **Chemical Composition & Validation**

- Chemical composition of India-specific agricultural feedstocks (Rice straw, Cotton stalk, Wheat straw, Sugarcane bagasse, Corn stover, Sorghum stalk, Mustard Stalk, Corn Cob, Jatropha prunings) are discussed
- Validation of biomass availability conducted through a survey carried out within the vicinity (50 m radius) of 12 commercial 2G ethanol plants planned to be set-up by the Indian Oil marketing companies

❖ Sugarcane & rice waste showed high bioethanol production potential in India

Pretreatment technologies & process schemes by 2G ethanol technology developers in India

- Salient features of different pretreatment approaches are evaluated
- The mechanism of action, potential & pros/cons for each type of pretreatment is discussed
- Pretreatment & process schemes of commercial scale (100 KLPD ethanol) plants being setup are evaluated

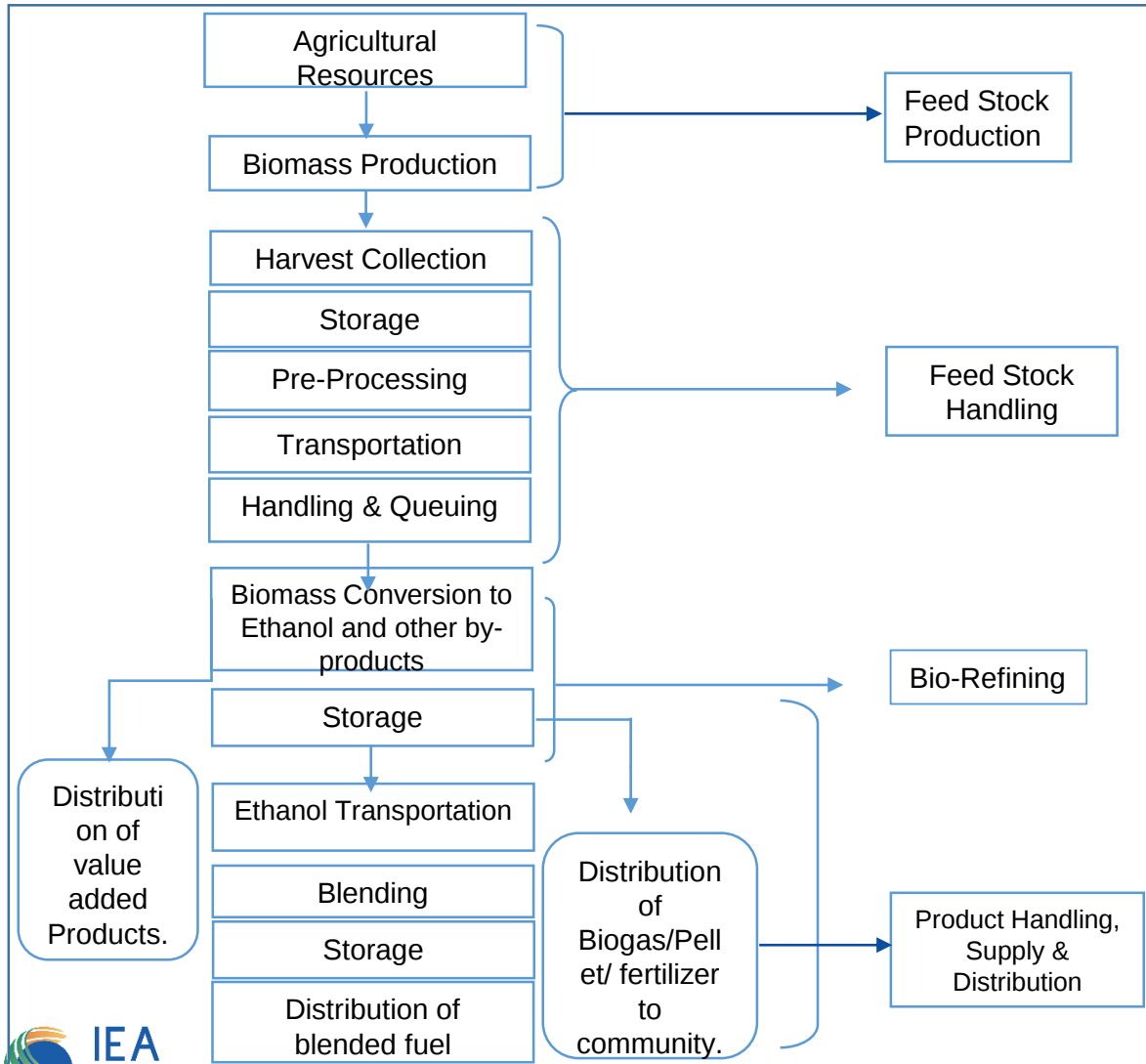


Process scheme of 2G ethanol technology at Indian Oil commercial plant at Panipat, Haryana

❖ First commercial 2G ethanol plant being set up by IndianOil is based on dilute acid pretreatment

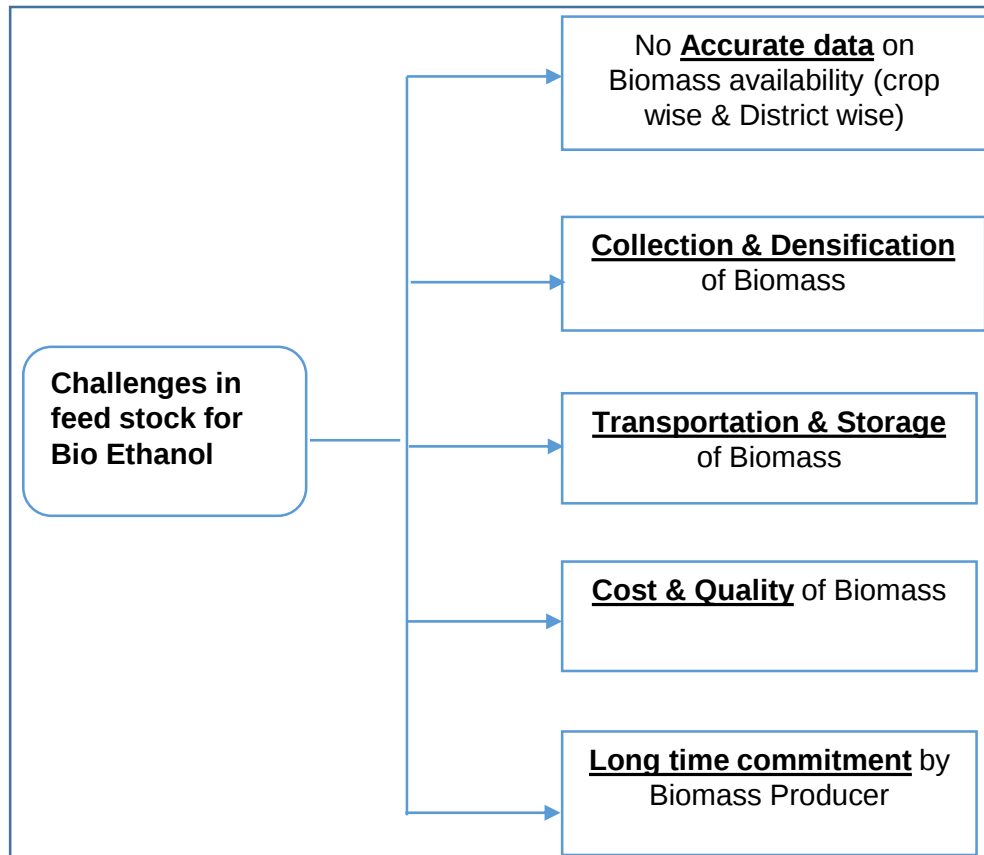
Biomass supply chain approaches prevalent in India

Process depicting the typical biomass supply chain analysis



- The value chain activities can be broadly classified as:
 - ✓ Biomass/Feedstock Production
 - ✓ Feedstock Handling
 - ✓ Bio-refining and Product Handling
 - ✓ Supply & Distribution

Challenges in Feed-stock for Bio Ethanol



- Biomass supply is critical to lignocelluloses based ethanol project which needs to be addressed well before the commencement of any commercial project
- For ensuring uninterrupted supply of biomass over a longer period at an optimal price, investors should consider various aspects of biomass production and supply chain management.

❖ Development of sustainable feedstock supply chain is critical for 2G bioethanol production

Models of Feedstock Supply Chain

Key features of different supply chain models are discussed

Supply Chain Model	Key Features
Model-I : Local supply through bio mass producers	▪ Direct contract with bio mass growers ▪ Sowing of the crop may be regularized by ethanol producing company like in case of sugar cane. ▪ The entire downstream related risk to be borne by the investors.
Model II - Supply through the Aggregator/ Organizer	▪ Creating mediators like cooperatives /NGO'S etc. for aggregation and possible densification or processing of biomass. ▪ Decentralized Primary biomass collection centre may be created by the company. ▪ Investors in upstream of the value chain may participate for ensuring consistent biomass supply. ▪ Extensive community participation in biomass collection and densification.
Model-III -Producer Organisation	▪ Producer organizations/co-operatives is formed by a group of producers for either farm or non-farm activities. ▪ Producers are shareholders in the organization. ▪ It deals with business activities related to the primary produce/product.
❖ Models Applied in Rural India for Agri-produced Logistics evaluated (ITC E-Choupal, Amul Model, PRESPL (Punjab Renewable Energy Systems Private Limited), Food Security Army, Kerala, Producer Organization- SAFAL(NDDB)	

Life cycle analysis & environmental impact assessment

- Life cycle analysis with a focus on Indian subcontinent in particular with the Indian specific feedstocks & pretreatment technologies were evaluated
- Actual experimental inventory data collected in the pilot scale facility commissioned at Indian Oil R&D Centre was used
- Two different pretreatment approaches (dilute acid & steam explosion) were evaluated for the Greenhouse gas (GHG) emissions, net energy ratio (NER) and net energy balance (NEB).

LCA of steam explosion and dilute acid pretreatment

LCA assessment of steam explosion & acid pretreatment using rice straw (1 MT basis)

S.No.	Salient features	Steam explosion pretreatment	Dilute acid pretreatment
1	GHG emissions (kg CO2 eq.)	292	288
2	Avoided GHG emissions (kg CO2 eq.)	-246	-208
3	GHG emission reductions of 100% ethanol with respect to gasoline process (%)	~90	~80
4	Energy consumption (MJ)	1378	1736
5	Net energy balance (MJ/L)	16.3	14.9
6	Net energy ratio	2.7	2.3

❖ GHG emissions were lowest with steam explosion as compared to dilute acid

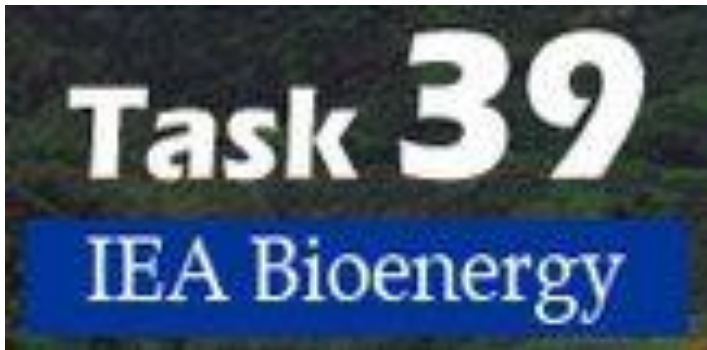
Thanks!!!

Alok Satlewal,

Research Manager,

Indian Oil Corporation Limited, R&D Centre

satilewala@indianoil.in



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