Second Generation Biofuel Potential in India: Sustainability Considerations

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Publication date: 2013

Document Version
Peer reviewed version

Citation (APA):
Second Generation Biofuel Potential in India: Sustainability Considerations

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8th Conference on Sustainable Development of Energy, Water and Environment Systems
24 September 2013
Dubrovnik, Croatia
Outline of presentation

• Definition, scope setting, background to biofuel sustainability discussions

• Rationale for the study & objectives

• Methodology

• Results & discussions

• Concluding recommendations
Definitions

• Focused on **Liquid biofuels**

• IEA definition of Liquid Biofuels used in the study:
  Biofuels classified either as *conventional* or *advanced* based on level of maturity

• Conventional biofuel technologies = well established processes and biofuel being produced on commercial scale. Commonly referred to as 1\textsuperscript{st} Generation. E.g. sugar based ethanol, starch based ethanol, oil crop based biodiesel and straight vegetable oil

• Advanced biofuel technologies = processes that are still in R&D, pilot or demonstration phase. Usually referred to as 2\textsuperscript{nd} and 3\textsuperscript{rd} Generation. Eg. biofuels from lignocellulosic biomass i.e. cellulose ethanol, biomass-to-liquids diesel, algae based biofuels.
Need for policy support for 2nd generation biofuels

(Adapted from Ceres Ventures 2007)
Key sustainability concerns on biofuels

- Social & Environmental
Key concerns on biofuels

Social:
Food vs. fuel
Other SOCIAL concerns (contd.)

• Consultation & communication with local communities

• Biofuel production shall not take place on contested lands

• Compliance with national laws and ratified international laws on employment conditions and workers’ rights

• Fair wages and compensations

• Workers are informed about their rights

• Working hours are not excessive

• Freedom of association and right to collective bargaining
• No child nor forced labour, health and safety concerns,
• etc

Sources: ILO, RSB, GBEP
Major ENVIRONMENTAL concerns

• Net GHG balances
• Land use change (direct & indirect)
• Net energy balances
• Water (use and consumption)
• Biodiversity
• Soil quality & health
• Pollution (air, water, soil) – responsible use of chemicals
• Etc

Sources: Hill et. al, 2006; Searchinger et. al, 2008; Williams et. al., 2009; Ackom et. al., 2010
Why the interest in liquid biofuels?

- Volatilities in oil prices
- Uncertainties about sustained oil supplies
- Local energy security
- Rural development
- Diversification in agricultural and energy product streams
Rationale for the study

- National Policy:
  - biofuel blending targets in India

<table>
<thead>
<tr>
<th>Year</th>
<th>Petrol demand (Mt)</th>
<th>Bioethanol demand (Mt)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>5%</td>
</tr>
<tr>
<td>2010</td>
<td>14.2</td>
<td>0.7</td>
</tr>
<tr>
<td>2017</td>
<td>20.8</td>
<td>2.1</td>
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<tr>
<td>&gt;2017</td>
<td>31.1</td>
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Source: Adapted from Purohit & Fischer, 2013
Research question:

- How much of these mandated targets could be obtained from sustainably derived agricultural residue sources?

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Methodology

- Using data collected in the collaborating institutions

- Crop production statistics e.g. data from Government of India, Ministry of Agriculture; Kumar et al., 2002; Ravindranath et al., 2005; Purohit et al., 2006, Purohit and Michaelowa, 2007; Purohit, 2009; Purohit & Fischer, 2013;

- Estimation of residues and ethanol bioconversion using published peer reviewed data including: OECD/IEA, 2011; Simms et. al. 2010; Ackom et. al. 2013
Results & Discussions

Cereal crop production in year 2011

Intensity and spatial distribution of cereal production in 2010-11 (tons/km²)
(Source: Purohit and Fischer, 2013)
## India:

### 2nd Gen biofuel potential from agricultural residues

<table>
<thead>
<tr>
<th>Crop</th>
<th>Residue type</th>
<th>Prod. (tonnes)</th>
<th>RPR</th>
<th>Res. (dry wt.) (tonnes)</th>
<th>Sustain. Res. (20%)</th>
<th>Biochem. EtoH-low (litre)</th>
<th>Biochem EtoH-high (litre)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rice</td>
<td>Straw/husk</td>
<td>96.0E+06</td>
<td>1.8</td>
<td>173.0E+06</td>
<td>34.6E+06</td>
<td>3.8E+09</td>
<td>10.4E+09</td>
</tr>
<tr>
<td>Wheat</td>
<td>Straw</td>
<td>87.0E+06</td>
<td>1.6</td>
<td>139.0E+06</td>
<td>27.8E+06</td>
<td>3.1E+09</td>
<td>8.3E+09</td>
</tr>
<tr>
<td>Jawar</td>
<td>Stalk</td>
<td>7.0E+06</td>
<td>2.0</td>
<td>14.0E+06</td>
<td>2.8E+06</td>
<td>0.3E+09</td>
<td>0.8E+09</td>
</tr>
<tr>
<td>Surgar cane</td>
<td>Bagasse/leaves</td>
<td>342.0E+06</td>
<td>0.4</td>
<td>137.0E+06</td>
<td>27.4E+06</td>
<td>3.0E+09</td>
<td>8.2E+09</td>
</tr>
<tr>
<td>Bajra</td>
<td>Straw</td>
<td>10.40E+06</td>
<td>2.0</td>
<td>20.7E+06</td>
<td>4.1E+06</td>
<td>0.5E+09</td>
<td>1.2E+09</td>
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<tr>
<td>Maize</td>
<td>Stalk/cob</td>
<td>21.7E+06</td>
<td>2.5</td>
<td>54.3E+06</td>
<td>10.9E+06</td>
<td>1.2E+09</td>
<td>3.3E+09</td>
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<tr>
<td>Gram</td>
<td>Waste</td>
<td>8.2E+06</td>
<td>1.6</td>
<td>13.2E+06</td>
<td>2.6E+06</td>
<td>0.3E+09</td>
<td>0.8E+09</td>
</tr>
<tr>
<td>Tur (Arhar)</td>
<td>Shell/waste</td>
<td>2.9E+06</td>
<td>2.9</td>
<td>8.3E+06</td>
<td>1.7E+06</td>
<td>0.2E+09</td>
<td>0.5E+09</td>
</tr>
<tr>
<td>Other cereal</td>
<td>Stalk</td>
<td>4.6E+06</td>
<td>2.0</td>
<td>9.1E+06</td>
<td>1.8E+06</td>
<td>0.2E+09</td>
<td>0.5E+09</td>
</tr>
<tr>
<td><strong>Total</strong></td>
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## Summary of findings in addressing the research question

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Conclusions

• India's bioethanol blending targets could be met from environmentally benign 2\textsuperscript{nd} generation sources derived from agricultural residues

• However, increased investments in R&D would be required in order to bring the technology to commercial scale for this bioethanol potential in 2-G to be realised.

• Partnerships with global players would be required.
Thanks for your attention!

Emmanuel Ackom

email: emac@dtu.dk

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