Biofuels: Demand for Ethanol and Biodiesel

Example: India

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Biofuel Sources

- **Ethanol**
  - molasses, beet, sweet sorghum, sugarcane
  - cellulosic (wood, grass, biomass residue)

- **Vegetable oils (non-edible)**
  - Jatropha curcas
  - Karanjia
Data per Government of India. According to the US Department of Commerce, the current demand for ethanol in India is 3.6 billion litres or 3,600 lakh litres.
Price of Petrol vs Cost of Ethanol

<table>
<thead>
<tr>
<th>Retail Petrol Per Litre</th>
<th>Production Cost of Ethanol Per Litre</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rs 45</td>
<td>Rs 15</td>
</tr>
</tbody>
</table>

INR

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**Biofuels: Bridge to Hydrogen Economy**

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of automobiles 2005 (60% 2-wheelers)</td>
<td>&gt; 60 million</td>
</tr>
<tr>
<td>New vehicles registered (50% 2-wheelers)</td>
<td>~ 10,000 per day</td>
</tr>
<tr>
<td>Actual Petrol consumed by automobiles</td>
<td>10 billion litres per annum</td>
</tr>
<tr>
<td>Total Petroleum consumption in 2006</td>
<td>&gt;130 million tons of crude</td>
</tr>
<tr>
<td>Diesel consumption</td>
<td>40 million tons</td>
</tr>
<tr>
<td>Imported petroleum</td>
<td>80%</td>
</tr>
<tr>
<td>2035: Fuel consumption by on-road automobiles *</td>
<td>60 billion litres</td>
</tr>
<tr>
<td>2035: Demand for Ethanol @ 10% (90EBG)</td>
<td>6 billion litres</td>
</tr>
<tr>
<td>Biomass residue (cellulose from crops &amp; plantations)</td>
<td>&gt; 500 million tons per year</td>
</tr>
<tr>
<td>Potential for Cellulosic Ethanol (200 litres per ton)</td>
<td>&gt; 200 billion litres per year</td>
</tr>
<tr>
<td>Potential for power generation from biomass</td>
<td>&gt; 500000 MegaWatts per year</td>
</tr>
</tbody>
</table>

*Projected by the Asian Development Bank*
Ethanol Use in India

- IOC R&D undertaken detailed studies using ethanol blended gasoline (EBG) including 5% (95EGB) and 10% (90EBG) for commercial use.

- Ethanol blended gasoline mandatory in many states and 90EBG approved on 1 October 2003

- Adequate supply of ethanol is not available

- Cellulosic ethanol preferred over grain ethanol
Ethanol Use in Brazil

- 360 million tons sugarcane from 5 million hectares producing 500,000 jobs on plantations and 500,000 jobs in production

- 25,000 petrol pumps dispensing Gasoline, EBG and Ethanol (Alcool)

- VW and GM flex-fuel vehicles (FFV) can run on any fuel or any blended fuel (mixtures)

- Brazil-India cooperation MOU signed in 2001
Biodiesel

- Renewable, non-toxic, biodegradable, non-edible vegetable oil
- Lower emissions compared to diesel (zero sulphur, 78% reduction of CO₂ and 50% reduction of CO)
- Better fuel properties (cetane number, lubricity, flash point)
- Daimler Chrysler India successfully tested cars running on 100% biofuel extracted from Jatropha curcas
- 11 million hectares of wasteland suitable for Jatropha cultivation
- 126,000 hectares adjacent to railway tracks owned by Indian Rail
Price of Petrol vs Cost of Biofuels

- **INR**
  - Retail Price of Petrol Per Litre
  - Cost of Production of Ethanol Per Litre
  - Cost of Production of Biodiesel Per Litre

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Rs 30/L Biodiesel: Profit/Hectare ~ Rs 25,000

INR

- Retail Price of Petrol Per Litre
- Cost of Production of Ethanol Per Litre
- Cost of Production of Biodiesel Per Litre
- Retail Price of Biodiesel Per Litre

In INR:
- Rs 30/L Petrol
- Rs 25,000 Profit/Hectare for Biodiesel
# Biodiesel: Profit & Jobs

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Lifecycle of plant</td>
<td>50 years</td>
</tr>
<tr>
<td>Oil content of seed</td>
<td>35%</td>
</tr>
<tr>
<td>Oil yield / kg of seed</td>
<td>250 ml</td>
</tr>
<tr>
<td>Plants / hectare</td>
<td>2,500</td>
</tr>
<tr>
<td>Job creation / hectare</td>
<td>0.25 FTE</td>
</tr>
<tr>
<td>Cost of maintenance / hectare / year</td>
<td>INR 20,000</td>
</tr>
<tr>
<td>Seed yield / hectare / year</td>
<td>7 tons</td>
</tr>
<tr>
<td>Oil yield / hectare / year</td>
<td>1750 litres</td>
</tr>
<tr>
<td>Cost of oil production / litre</td>
<td>INR 15</td>
</tr>
<tr>
<td>Cost of oil transport to Europe / litre</td>
<td>INR 5</td>
</tr>
<tr>
<td>Cost of oil production / hectare</td>
<td>INR 26,250</td>
</tr>
<tr>
<td>Pressed seedcake / hectare</td>
<td>4.5 tons</td>
</tr>
<tr>
<td>Selling price of seedcake / ton</td>
<td>INR 4,000</td>
</tr>
<tr>
<td>Cost of oil production &amp; maintenance / hectare</td>
<td>INR 46,250</td>
</tr>
<tr>
<td>Sales of oil @ INR 30/L and seedcake / hectare</td>
<td>INR 70,500</td>
</tr>
<tr>
<td>Gross earnings from biodiesel / hectare</td>
<td>INR 24,250</td>
</tr>
<tr>
<td>Area adjacent to railway tracks (hectare)</td>
<td>126,000</td>
</tr>
<tr>
<td>Earnings from biodiesel from 126,000 hectares</td>
<td>INR 30 CRORES</td>
</tr>
<tr>
<td>New job creation from use of 126,000 hectares</td>
<td>30,000</td>
</tr>
<tr>
<td>Wasteland</td>
<td>10 million hectares</td>
</tr>
<tr>
<td>Earnings from biodiesel per million hectare</td>
<td>INR 2,425 CRORES</td>
</tr>
<tr>
<td>New job creation per million hectare</td>
<td>250,000</td>
</tr>
<tr>
<td>Potential for new job creation from Wasteland</td>
<td>25 LAKHS **</td>
</tr>
</tbody>
</table>

** 1 LAKH = 100,000
- Trans-esterification, process optimization and commercialization
- Testing of locomotive engines with biodiesel (B100) and blends
- Vehicle performance and emission studies (Escorts, Tata, M&M)
- Field trials with buses in Gujarat
- Jatropha plantation on 70 hectares adjacent to rail tracks
- Studies on 16 cylinder engine (3100 hp) with B5, B10 and B20
- Shatabdi & Jan Shatabadi Train trial runs
- Trains through Lucknow using bio-diesel (B10) from June 2006
- Evaluation of B20 for 4 passenger cars and 2 commercial vehicles
- Tata Motors employee buses using B10 in Pune
- Haryana Roadways converts entire (Gurgaon) bus depot to use B5
• **Biodiesel policy involves PRIs for Jatropha plantations and oil extractions by establishing Rural Business Hubs**

• **OMC purchase price INR 25 per litre.**

• **Assistance for Jatropha plantation and oil extraction.**

• **IOC R&D to increase biodiesel content from 5% to 20%**
February 2006: BP invests $9.4 million in India for Jatropha biodiesel.
China: Biofuel Boom

- 13 million hectares for Jatropha plantation
- 200,000 tons of biodiesel by 2010
- 1 billion litres of Ethanol produced in 2006
- Production cost for cellulosic ethanol $0.25 / L
Biofuels in India: Potentially Profitable

- Significant profit from ethanol and biodiesel
- Export potential for higher profitability
- Ethanol-resistant yeast to improve yield
- Enzyme-catalysis for cellulosic ethanol
- Creates new jobs even in wastelands
- Implementable with minimal time
- Foreigners ready to grab market

Strengths
- Increasing Demand
  - ROI 15% of Capital
  - INR 20000 / ton capacity
- Robust supply chain
- Distribution Channels
- Job creation in wasteland
- No new carbon addition

Opportunities
- Decrease fossil fuel use
- Reduce carbon emissions
- Oil crisis mitigation
- Government regulation
- European distribution
- Worldwide awareness

Weaknesses
- Does not eliminate carbon emissions completely
- In the very long run may be more expensive than hydrogen via electrolysis
- Existing engine conversion

Threats
- US / EU investors
- Slow pace of bureaucracy
- MNCs land lease venture
- Failure to use new tools
- Lethargic approach
- Paralysis from analysis