Identifying ‘Key Value Drivers’ and ‘Determinants for Backward Integration’ in Biofuel Industry

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Background

The issues of climate change and energy security have become much higher priorities in recent times. The climate change targets set under the Kyoto Protocol has pushed European Union (EU) Member States’ (and many other countries around the world) to search for ways in which to reduce emissions from all sectors. One of the areas suggested by Hammond et al. (Hammond, Kallu, & McManus 2008) where this push has been seen is in the transport sector. The energy crisis of the 1970s, according to Allen (Allen 2008), marked a turning point in the world’s petroleum-based energy economy. He further indicates that as the view of our currently fossil-fuel driven world energy outlook is darkening, mankind is searching for other appropriate energy sources that will be sustainable.

Investment in renewable energy, both in research and development (R&D) and in production capacity, has grown as a sum of public and private investment during the current decade (International Energy Agency 2008; Rajagopal et al. 2009). Further, post-9/11 geopolitics of oil, economic growth in non-OECD countries, peak oil concerns, and consensus on mitigating climate change suggest that current interest in renewable energy is likely to be sustained (Himmel et al. 2007; Pickett et al. 2008).

Several technologies are in the running as alternatives to oil: biofuels, hybrids, plug-in electrics, compressed natural gas, or hydrogen-fuelled vehicles can each become a significant player under the right economic and policy conditions. Of these new energy sources, bioenergy is proving to be particularly attractive and viable and, therefore, is becoming an important consideration (Allen 2008). Because of simplicity and cost advantages, liquid biofuels appear to have a head start in this race (Rajagopal et al. 2009).

Global Biofuel Industry

Fossil fuels continue to account for the overwhelming share of global energy consumption, together accounting for nearly 80% of the total. Other renewables, including hydro, account for only 3% of all primary energy consumption. (Johnson & Rosillo-Calle 2007). The global production of biofuels is shown in the figure below.

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1 'The Kyoto Protocol is a protocol to the United Nations Framework Convention on Climate Change (UNFCCC or FCCC), an international environmental treaty with the goal of achieving "stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system." (Source: Article 2, UN Framework Convention on Climate Change, 2005.)

2 'The Organisation for Economic Co-operation and Development (OECD) is an international organisation of 30 countries that accept the principles of representative democracy and free-market economy. Most OECD members are high-income economies.' (source: en.wikipedia.org/wiki/Organisation_for_Economic_Co-operation_and_Development)
The production costs for biofuels can vary widely by feedstock, region, scale of production and conversion process. The major component of overall costs for biofuels is the cost of feedstock (crops). Depending on the type used, feedstock accounts for 50%–80% of the final cost and has a huge effect on producer returns (Khanna 2009). Zhang’s study (Zhang et al. 2003) identified the main economic factors for biofuel production such as capital cost, plant capacity, process technology, raw material cost and chemical costs.

The trade of biofuels is of particular interest to developing countries. Many developing countries cultivate crops which are required as feedstock for biofuel production. Moreover, it offers an opportunity to such developing countries to export a value-added product (i.e. biofuels) rather than exporting raw biomass (such as sugarcane etc.). Drivers and barriers for the international trade of biofuels have been listed in the table below.
<table>
<thead>
<tr>
<th>International Trade Drivers</th>
<th>International Trade Barriers</th>
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<tr>
<td>Progress on climate change: implementation of Kyoto and further post-Kyoto decisions;</td>
<td>Tariff and non-tariff trade barriers;</td>
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<tr>
<td>Clearer long-term policy in U.S.A. in favour of alternative transport fuels;</td>
<td>In most countries ethanol fuel programs have been aimed at the domestic rather than the</td>
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<td>external market. International trade requires a change in mentality;</td>
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<td>Improving attitude of the automobile industry toward alternative fuels;</td>
<td>New investments in infrastructure and adaptations to new programmes;</td>
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<td>Technological progress, including cellulose-based ethanol;</td>
<td>Direct domestic production subsidies to ethanol fuel actually hinder longer-term market</td>
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<td>development because of market risk perceptions in light of political uncertainty of</td>
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<td></td>
<td>future support schemes.</td>
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<td>Interest in supporting rural development in developing and developed countries alike.</td>
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Source: Adapted from (Johnson & Rosillo-Calle 2007)

Why are Biofuels being supported over other Alternative Energies? The first reason is that trillions of dollars have been invested to build the infrastructure (pipelines, gas stations, automobiles, and so on) to process, ship, and use liquid fuels. With some modifications, this infrastructure can be easily used with biofuels. The modification would be substantially less for biofuels than for a pure electricity infrastructure that might arise from adoption of solar or nuclear technology. The second reason is that biofuels, like petroleum, enable very high-density energy storage and even a teacup of petrol can move an automobile several kilometres at 40 kmh. A battery, on the other hand has to be many times heavier to do the same, and would take hours to charge.

Many developed and developing countries are supporting biofuels derived from agricultural crops. These countries are planning to address multiple policy objectives such as energy security, climate change mitigation, and rural development. But the efficiency and effectiveness of biofuels to address these objectives has raised doubts in minds of many and most often it is regarding the potential negative food security due to the use of food crops for producing fuel.

**Indian Biofuel Industry**

The Indian context does not entail use of food crops for biofuel production and is dependent on second-generation biofuels grown on wastelands. In India, bioethanol is usually produced...
from sugarcane. Molasses is a by-product of sugar manufacture and is fermented to produce bioethanol. The other feedstocks for ethanol production are sweet sorghum and sugar beet. Biodiesel is generally made from vegetable oil though animal fat can also be used. Depending on the availability, the choice of feed is country specific. Since India is a net importer of edible oil, the most suitable biodiesel feedstock would be non-edible oil. It is estimated that the potential availability of such oils in India amounts to about 1 million tons per year; the most abundant oil sources are sal oil (180,000 t), mahua (180,000 t), neem oil (100,000 t) and Pongamia Pinnata, also known as Karanja oil (55,000 t) (Gonsalves 2006).

**Value Drivers for Biofuel Industry**

Biofuel output grew slowly from the mid-1980s to 2001 but since 2000, the overall production of biofuel has increased manifold. Several incentives, including environmental regulations, petroleum prices, tax credits, mandates and grants and loans have played a significant role in the expansion of biofuels market. This report aims to deepen the understanding and importance of the existing incentives and thus systematically explore underlying competitive and national policy drivers of success within biofuels.

**The Key Value Drivers identified are**

i. The Value Drivers for the Biofuel Industry are –
   a. Economic Drivers
      - Rural Development and Socio-economic Factors
      - Political Risk and Petroleum Prices
      - Good Fuel Properties
   b. Environmental Drivers
   c. Institutional Drivers
      - Energy Security
      - Policy and Regulatory Framework
      - International Agreements

ii. The importance of different value drivers varies depending on the socio-economic and political conditions of a country. For example, ‘petroleum prices’ might be an important driver for biofuel industry in India but not for oil-rich middle-eastern countries. Similarly, ‘rural development’ might be the key driver behind biofuel industry in Africa but not in Western Europe.
The Value Drivers for India

i. The most important value driver for biofuel industry in India is ‘Policy and Regulatory Framework’. Government policy will have a long term impact on the sector and has set the broader framework and provided the initial thrust required for the development of the sector.

ii. The analysis of government documents clearly points that ‘Rural Development’ stands as major basis for government support of biofuel industry in India.

iii. The third major driver in India is ‘Political Risk and Petroleum Prices’. The variability in petroleum prices has immediate impact on the short term demands and investments in biofuels.

iv. India produces only 25% of its total petroleum consumption and has to fulfil the remaining requirement by importing oil. This excessive dependency on imported oil leads to a high strategic risk related to availability, demand and price fluctuation of petroleum. Therefore, the government’s motivation to reduce this risk is another important driver for biofuel industry in India.

Supply Chain Management

Normally, several independent firms are involved in manufacturing a product and placing it in the hands of the end user in a supply chain—raw material and component producers, product assemblers, wholesalers, retailer merchants and transportation companies are all members of a supply chain (La Londe & Masters 1994). Biofuel producers have managed their supply chain through backward integration as a process for supply chain management.

Supply chain management through ‘vertical integration’ in biofuel industry involves integration of different processes in the supply chain such as cultivation, biofuel production etc. The focus of this section is to understand the importance of backward integration for a biofuel producer (stage 3) and how producers can increase their operational profitability through backward integration.
The companies operating in the biofuel sector are mainly biofuel cultivators or biofuel producers\(^3\) therefore they can be positioned either at stage two or at stage three.

1. **Companies at Stage Two** – These companies focus on feedstock production for the biofuel industry. Such companies engage marginal farmers to bring about large scale biofuel and food crop cultivation.

2. **Companies at Stage Three** – Companies at this stage are involved in processing the feedstock into biofuels. Such companies source feedstocks and then sell the biofuel to fuel distributors for blending.

**Determinants**

i. **High Input Cost** - Feedstock constitutes over 70% of the total cost; such a high input cost is a key determinant for backward integration to manage supply chains.

ii. **Hedging Future Contingencies** - For companies with large geographical range, hedging the future risk associated with availability and price of the feedstock becomes an important factor for moving towards vertical integration.

iii. Backward integration is more likely when the downstream firm such as the biofuel producer commits to large sunk investments in assets such as refineries.

iv. Backward integration will insulate companies from vagaries of feedstock supply due to market forces of demand and supply.

v. **Ex Post Lock-in** - Firms integrated to avoid bargaining problems arising from ex post lock-in with the feedstock suppliers.

The feedstock cost constitutes 70-80% of the biofuel cost (Khanna 2009) and by having access to company-owned feedstock, company (Stage 4) can have better control over the input costs of biofuel and can have reduced dependence on the market for sourcing feedstock. Feedstock is a commodity and therefore its demand and price fluctuates with the market forces of supply and demand. Hence, too much dependence on market-sourced feedstock will affect the operational profitability of the company and make the business risky.

Backward integration offers some attractive benefits to biofuel producer (Stage 4). It can lead to potential disadvantages also. A backward integrated supply chain will lack feedstock supplier competition which might lead to potentially higher costs due to low efficiencies. The company will have to build excess capacity for feedstock cultivation to ensure its massive refineries have sufficient supply at all times. The upstream investments in cultivating a

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\(^3\) Although there are companies engaged in biofuel distribution such as Shell, BP etc., the quantity is very small. Also, the focus of this project is companies at Stage 2 or Stage 3.
particular crop might make it less possible to be flexible and switch to another more economical crop.

However, a backward integrated business model with sustainable farming practices can give company an economically viable and long term, environmentally friendly solution.

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<thead>
<tr>
<th>Company</th>
<th>HQ</th>
<th>Stage 1 (Feedstock Technologies, Biotechnology, R&amp;D)</th>
<th>Stage 2 (Cultivating Feedstock)</th>
<th>Stage 3 (Biofuel Production)</th>
<th>Stage 4 (Transport Sector (Blending, Technology))</th>
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<td>D1 plc</td>
<td>EU</td>
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<td>Mission NewEnergy</td>
<td>Aust.</td>
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<td>IOCL</td>
<td>Asia</td>
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<td>Reliance</td>
<td>Asia</td>
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<td>Umoe Bioenergy</td>
<td>US</td>
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<tr>
<td>Choren</td>
<td>EU</td>
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<td>AE Biofuels</td>
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<td>BP</td>
<td>EU</td>
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<td>Tata Chemicals</td>
<td>Asia</td>
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<td>Gushan</td>
<td>Asia</td>
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<td>DaimlerChrysler India Ltd</td>
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Table 1: Vertically Integrated Supply Chain in the biofuel industry

Impact of Backward Integration

The observations from the critical analysis of an integrated supply chain are listed below.

i. **Advantages** – An integrated supply chain gives greater flexibility, ensures better control on the supply chain, thus making it relatively easy to implement process or product innovations, minimise the exposure to the risk of demand and price fluctuations, and facilitating faster decision-making and implementation process.

ii. **Disadvantages** – Inaccessibility of cheaper feedstock in market, and market dependence during the initial 3-4 years of feedstock maturation.
References


