Biofuels

Fuel for thought

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Biofuels – Fuel for Thought

Now that scientific opinion has firmed on the question of the link between human activity and global warming, environmental concerns have been elevated to the top of the agenda. Governments and big businesses the world over have begun to sit up and take notice. Amongst the innovations that are poised to transform our lives in the pursuit of sustainable development, biofuels have attracted the most investment and yet also the most controversy. Proponents hail a new era of energy derived from carbon-consuming plant matter, while detractors point to the high price paid in terms of deforestation and rising agri-food prices. Can “green” fuel save us?

The need for renewable resources

Renewable energy – particularly power from wind, water, solar energy and biomass – is a key front in the battle to fend off global warming. By avoiding the burning of fossil fuels for energy, renewable energy has an important role to play in reducing carbon dioxide (CO2) and other greenhouse gas (GHG) emissions which, the scientific consensus now holds, are major contributors to global warming. By generating energy without burning fossil fuels, renewable forms of energy avoid the release of new sources of carbon into the earth’s atmosphere where they would tend to trap the heat from the sun. In so doing, they help to avert rising global temperatures which are threatening to inundate human settlements in coastal areas and destroy much of the world’s bio-diversity.

Fig. 1: Global fossil fuel consumption, 2004

Around 40 percent of total energy consumption requires liquid fossil fuels like gasoline or diesel fuel (with much of the balance coming from the most pollutive fossil fuel of all, coal).

According to the World Bank’s World Development Indicators (2006), trade in fuels totaled US$715 billion worldwide in 2004. The biggest consumers are the United States, China and the European Union (EU), accounting for more than half of all fossil fuel consumption (see Fig. 1).

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1 Includes 25 countries.  
2 Includes 135 countries

Liquid fuels, like all fossil fuels, tend to release carbon into the atmosphere when consumed, hence contributing to global warming. Coupled with the fact that fossil fuel supplies are diminishing at an alarming rate, renewable energy sources are expected to compete economically with more conventional energy sources in the long term.

**How biofuels may save the earth**

Biofuels are not a new concept. Derived from biomass (recently living organisms or their metabolic byproducts), biofuels have been around for much longer than the internal combustion engine, if you count the oats used to power horses and other beasts of burden.

However, the concept has been given a new lease on life by the current global warming crisis. And with petroleum prices hovering around US$70 a barrel, biofuels are increasingly cost competitive with fossil fuels, arousing interest and excitement from the investment community and policymakers alike.

Biofuels are touted to produce far less carbon dioxide and other GHGs than oil, reduce other forms of air pollution (such as carbon monoxide and sulfur dioxide), are immediately usable within current infrastructure, and support agricultural development. Perhaps the most important of these advantages is the climate-mitigating factor, as environmental audits of the life-cycle of biofuels show them to be not only carbon-neutral (since plants absorb CO2 while growing) but also carbon-reducing by anywhere from 20 to 100 percent.

These positive claims have businesses clamouring to jump on the bandwagon. From the plethora of biofuel products that have been mooted, biodiesel and ethanol have emerged as the leading alternatives.

**Current biofuel production**

The most widely-used biofuels today are biodiesel and ethanol. Global ethanol production more than doubled between 2000 and 2005, while the production of biodiesel (which started from a smaller base) expanded nearly four-fold. Oil production, in contrast, increased less than 10 percent over this period.

**Ethanol** is a clear, highly flammable and volatile fuel made of alcohol primarily derived from the fermentation of sugars and starches, and cellulose (a complex carbohydrate that is composed of glucose units). It is primarily being promoted as a replacement for gasoline in automobiles.

Brazil, the world leader in biofuel, produced 16.5 billion litres of fuel ethanol in 2005, roughly 45 percent of the world’s total, with the United States a close

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2 WorldWatch institute, Biofuel for Transportation
second (see Table 1). Brazil currently has six million hectares of land devoted to ethanol production from sugar cane.

Table 1: World fuel ethanol production (1,000 tonnes)

<table>
<thead>
<tr>
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<th>2004</th>
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<tbody>
<tr>
<td>World</td>
<td>23,608</td>
<td>26,890</td>
</tr>
<tr>
<td>Asia, of which</td>
<td></td>
<td></td>
</tr>
<tr>
<td>China</td>
<td>885</td>
<td>1,090</td>
</tr>
<tr>
<td>India</td>
<td>800</td>
<td>800</td>
</tr>
<tr>
<td>Thailand</td>
<td>80</td>
<td>240</td>
</tr>
<tr>
<td>Australia</td>
<td>5</td>
<td>50</td>
</tr>
<tr>
<td>Brazil</td>
<td>11,700</td>
<td>12,900</td>
</tr>
<tr>
<td>Canada</td>
<td>200</td>
<td>200</td>
</tr>
<tr>
<td>Columbia</td>
<td>-</td>
<td>120</td>
</tr>
<tr>
<td>European Union (EU)</td>
<td>491</td>
<td>730</td>
</tr>
<tr>
<td>United States (US)</td>
<td>10,300</td>
<td>11,800</td>
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Ethanol has been widely used as a vehicle fuel in Brazil for decades. The Brazilian government launched its National Fuel Alcohol Program in the mid 1970s and by 1980, ethanol use had overtaken gasoline. Today ethanol accounts for as much as 20 percent of Brazil’s transport fuel market.

Biodiesel is derived from organic plant oils mixed with alcohol. It is thick and combusts at a very low temperature. It has a wider industrial applicability than ethanol, though current biodiesel production levels are dwarfed by ethanol.

Produced mainly from palm, rapeseed or sunflower seed, biodiesel comprises 80 percent of Europe’s total biofuel production. The EU accounted for nearly 90 percent of all biodiesel production worldwide in 2005, with over 3.1 million metric tonnes, an increase of 65 percent from the 2004 figures.

In short, the biofuel industry is not a recent and untested creation of the environmental movement but rather a substantial and rapidly maturing global industry in its own right, with a significant rate of innovation driven by competitive pressures.

Jatropha – biofuel of the future

- While palm oil currently dominates biodiesel production, castor oil made from jatropha (a non-edible oil-bearing crop) may be the renewable energy of the future.
- The characteristics of jatropha are comparable with those of rapeseed oil, making it highly suitable as fuel for diesel engines.
- In addition, jatropha is better-suited to marginal, dry soils, another advantage over palm oil which can be grown in a much more limited range of soil types.
- Maturity is quicker as well and yields can be reaped beginning from the third year of cultivation.
- In the long-term, jatropha is expected to overtake palm oil as the biodiesel of choice.

Source: Spire Research and Consulting, Diligent Energy Systems and other sources

3 Palm oil, on the other hand, is not fluid at room temperature. Using palm oil in car engines would require substantial modifications.
4 European Biodiesel Board, Statistics – The EU Biodiesel Industry
5 Shell official website
dynamics. For example, Shell, which has been distributing first-generation biofuels for over 30 years, sold over 3.5 billion litres in 2006, mainly in the USA and Brazil—enough to avoid nearly four million tonnes of CO2 production.

**Fuelling the crisis**

While biofuels appear to offer an environmentally safe fuel source, it is increasingly apparent that they constitute a double-edged sword. Beyond supply logistics issues, including how to efficiently harvest, transport, store, and process biomass feedstock, there are potential environmental and economic conflicts that arise with energy crop production. Armed with a range of scientific and economic theories, critics have stepped forward to call a halt to this growing industry.

**The truth is out there**

A 2005 Cornell University study found that producing ethanol and biodiesel from corn and other crops may not actually be worth the energy. The study demonstrated that turning plants, such as corn, soybeans and sunflowers, into fuel uses much more energy than the resulting ethanol or biodiesel generates.

Fossil energy is used in the production of biofuel itself—during cultivation, transportation and refining. If biofuels are transported around the world, and made with fossil energy, then their overall environmental benefit will be considerably reduced, possibly even made negligible. Moreover, the burning of biofuels may, like fossil fuels, release non-carbon pollutants into the atmosphere.

Texas seems to agree—the state almost became the first to place a ban on biodiesel. In 2005, The Texas Commission on Environmental Quality (TCEQ) had adopted low diesel emission standards in an attempt to reduce pollutants in the state’s smoggiest 110 counties. According to TCEQ, blending 20 percent or more of biofuel with diesel could push the amount of nitrogen oxide emissions over levels permitted by the state. The ban is currently under review for another year.

**Going green means being grey**

In June of 2005 British journalist George Monbiot published a column titled “Worse than Fossil Fuel: Biodiesel enthusiasts have accidentally invented the most carbon-intensive fuel on earth”. In the column, Monbiot cited a report about the impact of massive deforestation in Southeast Asia in order to create palm oil plantations used to supplement the European biodiesel feedstock market: “In terms of its impact on both the local and global environments, palm biodiesel is more destructive than crude oil from Nigeria.”

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8 Cornell University News Service, July 2005
9 Alternative Energy, Biodiesel banned in Texas, 4 December 2006
Biofuel cultivation needs land – lots of it – and demand for fuel production can place pressure on forest land that serves to protect bio-diversity and absorb carbon.

In Brazil, for instance, the cultivation of sugar cane to make ethanol has led to large-scale forest loss. In Indonesia and Malaysia, there has similarly been a major expansion in the planting of palm oil trees, both to provide a source of cheap fat for the food industry and increasingly as a source of fuel for vehicles. The growth of palm-oil plantations has not only been responsible for massive deforestation, but has also been blamed for adverse social impacts, including conflicts over land and the abuse of workers.

Food for thought

Large-scale cultivation not only leads to forest loss but could also divert agricultural production away from food crops, especially in developing countries. Some analysts have argued that energy crop programmes compete with food crops for scarce land, labour and production resources – thus pushing up food prices for the world’s poor.

The UN Food and Agriculture Organization and the US Department of Agriculture (USDA) estimate that the 2006 world harvest, which fell short by about 24 million tons (one percent less than the previous year), was not enough to feed everyone for the sixth time in seven years.

Roughly 60 percent of the world grain harvest is consumed as food, 36 percent as feed, and three percent as fuel. While the use of grain for food and feed grows by roughly one percent per year, that used for fuel is growing by over 20 percent per year.

Already, the growing pressures on world food supply are beginning to show. Late last year, Mexico saw its tortilla wars, as people found the price of their staple food – corn – had doubled. The hike was blamed on the crop’s new market as a source of vehicle fuel and the control over the crop exercised by US corporations.

However, this ‘food versus fuel’ controversy is more complex than has generally been presented. Food availability also relates to agricultural and export policy and the politics of food distribution. Technically, the world already grows more than enough food to feed everyone. There is more food per capita now than there has ever been before – enough to provide at least 4.3 pounds of food per person a day. While biofuels may increase pressure on arable land, they are not fundamentally to blame for the phenomena of global malnutrition and inequitable food prices.

10 Central Chronicle, Biofuel: Good idea, bad practice, May 2007
11 Journey to Forever, Biofuel for Food
On the other hand, biofuels have the potential to offer an opportunity for poverty alleviation. Biofuels may help increase the economic security of farmers who may otherwise be over-dependent on a single cash crop with volatile global prices. They may also encourage crop rotation, which benefits soil quality.

But, of course, not everyone has a farm. As with everything else, the biofuel revolution will have differential effects on different countries and population segments across the world. What is wine to one man may be poison to another, as the controversies have shown.

Where, then, is this “green” journey headed?

**Government directives**

Faced with the need to reduce greenhouse gas emissions while at the same time seeking to diversify sources of energy, government bodies have clearly opted to press ahead to introduce pro-biofuel legislation and policies that impact the energy and transportation industries\(^\text{12}\) (see Table 2).

**Table 2: Government initiatives on biofuel development**

<table>
<thead>
<tr>
<th>Nation</th>
<th>Government Initiatives</th>
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| Brazil          | - The government is considering the possibility of moving forward its obligatory 5% biodiesel mix in diesel fuel – currently legislated for 2013 – to as early as 2008\(^\text{13}\). Under current legislation, Brazil has mandated an obligatory 2% biodiesel mix in all its diesel fuel, or roughly 800 million litres of biodiesel per year, starting next year.  
- Brazil also mandates an obligatory range of 20% to 25% ethanol mix in the country’s gasoline. Currently, the mix is at 23%. |
| European Union (EU) | - Set the goal of obtaining more than 5% of transportation fuel needs from biofuels by 2010 in all member states.  
- Adopted an ambitious strategy in February 2006 with a range of potential market-based, legislative, and research measures to increase the production and use of biofuels.  
- Germany and France, in particular, have announced plans to rapidly expand both ethanol and biodiesel production, with the aim of reaching the EU targets before the deadline. |
| USA             | - Renewable Fuels Standard passed in 2005 will require the use of 28.4 billion litres of biofuels for transportation by 2012.  
- Energy Policy Act of 1992 dictates that many government fleet vehicles that run on diesel fuel are now required to use B20 (20% biodiesel) blends. |
<p>| Asia Pacific    |                                                                                                                                                                                                                       |</p>
<table>
<thead>
<tr>
<th>Country</th>
<th>Actions and Programs</th>
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<tbody>
<tr>
<td>Australia</td>
<td>Since 2001, the Australian Government has set a target for biofuels to contribute at least 350 million litres to total fuel supply by 2010(^{14}). In 2003, it announced it would provide over US$30 million for one-off capital grants for new biofuels production facilities or expansions to capacity.</td>
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<tr>
<td>China</td>
<td>In June 2002, the Chinese government began mandating the use of bio-ethanol blend gasoline. In October 2004, the government introduced the compulsory use of a 10% blend of bio-ethanol to gasoline (E10) in all areas of Heilongjiang, Jilin, Liaoning, Henan, and Anhui. The government plans to expand the E10 program to 27 cities within Shandong, Jiangsu, Hebei, and Hubei from 2006. The Chinese government has encouraged research, development and phased introduction of these biofuels to China over the past two decades. According to the Dow Jones Commodities report, Chinese bio-ethanol production in 2005 stood at approximately 920,000 metric tons.</td>
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<tr>
<td>India</td>
<td>A rejuvenated sugar ethanol program calls for E5 blends throughout most of the country. The government plans soon, depending on ethanol availability, to raise this requirement to E10 and then E20.</td>
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<tr>
<td>Indonesia</td>
<td>Indonesia may be the first country in the world to commercially use biofuel produced from jatropha, a non-edible oil-bearing crop which can be grown on marginal land. Already, the nation is planning to increase biofuel crop production 43 fold to meet projected world biodiesel demand, consequently opening up 20 million more hectares to crop production(^{15}). The Indonesian Department of Industry is currently responsible for managing four biofuel plants with 6,000 ton capacity per year. US$33 million was earmarked for this project which is expected to begin operations at the end of 2007.</td>
</tr>
<tr>
<td>Japan</td>
<td>The Japanese government has permitted low-level ethanol blends in preparation for a possible blending mandate, with the long-term intention of replacing 20% of the nation’s oil demand with biofuels or gas-to-liquid fuels by 2030. The agriculture ministry plans to build three large facilities in Hokkaido and Okinawa under the fiscal 2007 budget to produce an annual 10,000 kilolitres of bio-ethanol.</td>
</tr>
<tr>
<td>Malaysia</td>
<td>To deal with an unstable palm oil price and the fast depletion of fossil fuels, the Malaysian government formulated the National Biofuel Policy in August 2005. The government has granted licenses for 32 biodiesel plants with a potential annual capacity of 2.6 million tones(^{16}).</td>
</tr>
<tr>
<td>Philippines</td>
<td>The Philippines has implemented its mandates – 2% biodiesel to</td>
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</tbody>
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\(^{14}\) Grains Research & Development Corporation, Ground Cover Issue 65
\(^{15}\) Green Options, Biofuels Will Not Solve Global Warming: IPCC’s Report Sparks Protest, May 2007
\(^{16}\) United States Department of Agriculture, Biofuel Programs in China, Malaysia and Japan abstract
With unanimous support from governments and Asia’s tropical geography that encourages biofuel cultivation, private and state-owned organizations alike are eagerly pursuing “greener pastures” amongst Asia’s biofuel plantations.

**Major private investments in biofuel**

Private companies are responding to the biofuel phenomenon, and in a big way. Microsoft founder Bill Gates, also the world’s richest man, has invested US$84 million in an American ethanol company\(^\text{17}\). And he is not a lone contender in this corporate war for biofuel.

**Fine-tuning the fuel**

The Philippines inaugurated Asia’s first large-scale biodiesel plant in May 2006. It is able to produce up to 60 million litres a year of the alternative fuel from coconut oil. Chemrez Inc, a Manila-based oleo-chemicals maker, built the plant for US$12.6 million, ahead of the legislation requiring petrol refiners and distributors to sell biodiesel.

NewGen Technologies announced a joint venture in Asia in September 2006. In addition to the operation of planned biodiesel plants in Asia, their focus will be the development and implementation of shipping, logistics and feedstock strategies for NewGen’s local and global raw material requirements\(^\text{18}\).

Chinese energy giant China National Offshore Oil Corp is among 59 foreign and local energy investors who signed many biofuel-related renewable energy agreements worth US$12.2 billion with Indonesia in early 2007\(^\text{19}\).

Canada-based BioMaxx is completing the final stage of planning for the design of its biodiesel demonstration plant\(^\text{20}\). BioMaxx will be building this facility in Southeast Asia and is in the last stages of site selection. The plant could be located in Indonesia, Malaysia or Thailand.

BP has announced plans to spend US$500 million over the next ten years on finding new applications for bioscience in the energy industry, including better ways to produce the bio-components that can be blended into traditional fossil-

\(^{17}\) Mongabay official website, High oil prices fuel bioenergy push, May 2006


\(^{19}\) Asia Times Online: A who's who of Indonesian biofuel, May 2007

\(^{20}\) BioSpectrum: Canadian biofuel company to set up plant in Asia, April 2007
based transport fuels. The company is also funding a US$9.4 million project in India to examine the possibility of using jatropha as a biofuel ingredient\textsuperscript{21}.

Natural Fuel, a global group of renewable energy companies headquartered in Western Australia, announced in early 2007 that it had chosen Singapore as its site for their US$130 million state-of-the-art biodiesel production refinery\textsuperscript{22}. Expected to be the largest biodiesel facility in the world, it is currently undergoing construction on Jurong Island, Singapore’s petrochemical hub, and scheduled to begin production by the end of 2007.

Such expansions of biofuel production have begun to raise interest further down the supply chain as global automotive corporations drive initiatives to modify engines for greener fuel.

Driving green

Ford Motors, the first manufacturer to market a low CO2 bio-ethanol-powered car in 2001, is joining two European alternative fuel projects, PROCURA and BEST, underlining its commitment to bio-ethanol initiatives across the continent\textsuperscript{23}. As the leading manufacturer of bio-ethanol-powered flexible-fuel vehicles (FFVs) in Europe, Ford aims to take its expertise into these new multi-stakeholder initiatives with the ultimate goal of making mobility more sustainable.

Renault, too, has made a commitment that it will adapt its engines to run on biofuels in order to reduce CO2 emissions. Under the Renault Commitment 2009, the company has made several promises to address environmental issues, including engine adaptation to biofuels.

Hyundai has moved quickly to assure owners and buyers that all current and future models easily meet the New Zealand government biofuel aims announced in 2007. "Every current Hyundai car and SUV can accept biofuel levels well above the targets set for diesel and petrol," said the Managing Director of Hyundai Automotive NZ, Philip Eustace\textsuperscript{24}. "For several years now we have been working with government agencies, the fuel industry and others here in New Zealand to help assess and develop alternative fuels as blends in diesel and petrol. Right now in 2007 Hyundai is ready to move to a five percent blend of biodiesel and 10 percent bio-ethanol in petrol."

At many levels, the biofuel industry appears set to drive down a long, victorious road – but one which may see it changing itself, along with the world.

\textsuperscript{21} BP official website
\textsuperscript{22} Singapore EDB: “Singapore Chosen As Site For World's Largest Biodiesel Facility”, January 2007
\textsuperscript{23} Ford official website
\textsuperscript{24} Hyundai official website
Safe and sound

Despite the controversies arising from biofuels, authorities the world over are forging ahead with plans to push the growth of this industry. Their stance represents not so much a repudiation of the “anti-biofuel lobby” as a reaction to the urgency of the global warming crisis. It may also be driven by a deeper sense that the world will eventually figure out how to make and use biofuels sustainably—hence it is better to make one’s economy “biofuel-friendly” sooner rather than later.

“For me personally, not enough research has been done to back up this claim [of environmental consequences]. So far, biofuels are still the answer to energy and environmental problems. Good management is the most essential priority to address all of these problems. For example, if governments can manage to utilize arable land instead of planted land, then the problem of deforestation or logging can be avoided,” says Sonny Solistia Wirawan, director of the Agency for the Assessment and Application of Technology in Indonesia.25 “The use of biofuels is a must, without any exception, as the environmental benefits it provides outweigh the costs of producing it.”

However, is the rush to biofuels placing the world’s forests, biodiversity and food supplies at risk, so as to slake our thirst for energy?

“If we are to reap benefits from biofuels, some environmental safeguards are necessary, such as protection for important ecosystems and regulation of production methods and the energy used in manufacturing and distribution,” says Director of Friends of the Earth, Tony Juniper.26 “It seems to me that a certification scheme is needed so that companies such as BP and Shell, who will be selling this stuff, could show what level of environmental benefit (if any) is actually being achieved, both in terms of land use and savings in carbon dioxide emissions.”

Simply put, biofuels offer the irresistible prospect of generating carbon-neutral energy that will power economic growth without worsening global warming. But to truly realize this potential, proper regulatory regimes need to be put in place to ensure that the practice delivers on the theory. There is a clear case for this to be done on an international basis under the auspices of the United Nations. Until this comes about, the world will look to individual countries to show leadership in not only mandating biofuel use and promoting biofuel production and refining, but also policing its production, distribution and consumption so as to maximize environmental benefits while minimizing economic costs.

And while biofuels evolve down this path, no doubt many voices will continue to echo the arguments of Al Gore in his award-winning movie “An Inconvenient Truth” – that whatever governments and companies do, there is still a need for

25 Spire Research & Consulting expert interview, 2007
26 The Guardian (UK): Fuelling the crisis, January 2007
individuals to be far more conscious of our carbon and energy footprints than we now are, and to act accordingly.