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The European Biofuels Challenge

Developments in European Union Policy and Industry Drivers

by Urmila Doraswami

A Report Buyer Publication

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1. Executive Summary

Biofuels have become a global household word due to the raging debate on their use between policymakers, non-governmental groups (NGOs), producers, public and the media. The subject was an important issue at the recent G8 summit held in Tokyo where soaring food prices and shortages held centre-stage. It also caused headlines when an article in *The Guardian*, quoting extracts from an unpublished World Bank Report, claimed that biofuels were responsible for hiking the food prices up by 75%.[1]

Biofuels have generated an array of reports and proposals from both EU governments and NGOs on the benefits versus damages that large-scale production of biofuels would cause.

Europe in particular has been a quick starter in adopting biofuel targets. As part of the European Union's (EU) 'green' commitment, politicians have made speedy commitments towards technologies that seem to offer solutions to the twin problems of climate change and Europe's dependence on imported energy. However, the media have recently strongly suggested that the EU to be back-pedalling on the implementation of its biofuels targets.[2]

However, the main reasons galvanising the growth of the European biofuel market remain unchanged. They are:

- rising oil prices and geopolitical undercurrents surrounding global oil production and distribution strategies;
- climate change;
- government subsidies such as Europe's Renewable Energy Sources (RES) Directive.

The biofuels industry has, since its inception, drawn encouragement from government support. Yet in early July 2008, there have been suggestions of the EU backtracking on the adoption of their ambitious biofuels target.

For instance, EU MEPs backed a proposal to obtain just 4% of road transport fuels from renewable sources by 2015. The 27-nation EU's official line still remains that it will adhere to the target of obtaining 10% of motor vehicle fuel from renewable sources by 2020. This forms a vital component of the overall goal of the EU to reduce carbon emissions by 20%.[3]

There have been growing signs from individual governments, however, that the tide supporting the biofuels industry could well be turning. The British Government has said it would 'proceed cautiously' over the introduction of biofuels, taking into account The Gallagher Report which looked at the knock-on effects of biofuel production.[4] Recently there have also been reports that some French politicians have questioned the biofuels policy. Germany, for its part, has already done away with tax breaks for green fuels.

Biofuels have been both seen as an alternative to fossil fuels and implicated in several studies as contributing to food shortages and an increase in food prices the world over. Due to this, their use has been passionately opposed by social and environmental groups leading to a fiery media debate on their real potential. This has also led to the formulation of certain sustainability criteria that biofuels must ideally meet.

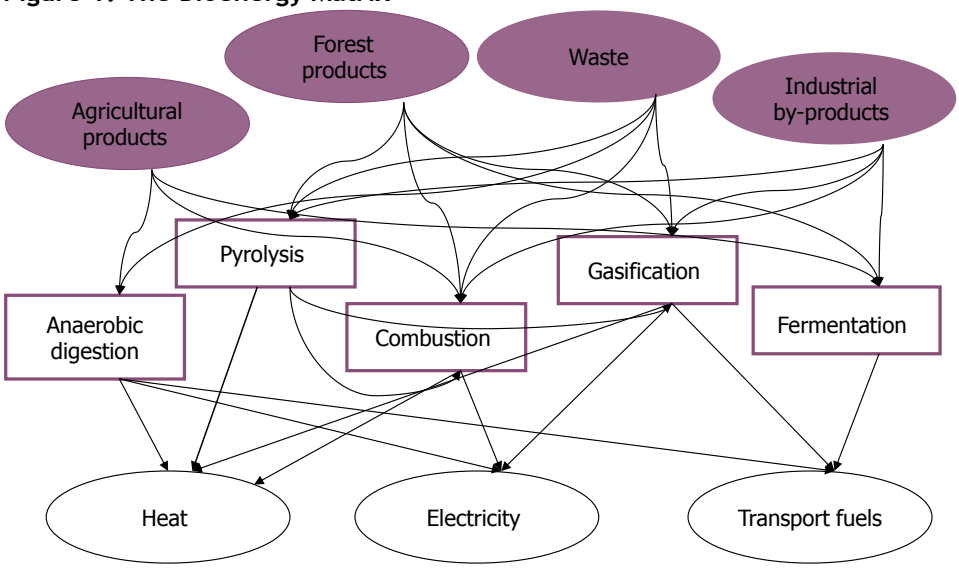
All biofuels are no longer equal. There is beginning to be a distinction between first- and second-generation biofuels. Although it will be some time before second-generation biofuels are available, these are seen as being important future contributors to the alternatives for fossil fuels.

This report briefly outlines what first- and second-generation biofuels are; describes the different types of biofuels currently in use; and outlines the political and environmental reasons for their importance. It examines the drivers and obstacles to the market, outlines trends in the European market such as production heading to Eastern Europe, and analyses the media backlash and furore over the food vs. fuel debate. Additionally, the report examines the sustainability criteria for biofuels, touches on the emerging new technologies, and highlights examples of industry entrepreneurship.

2. Bioenergy

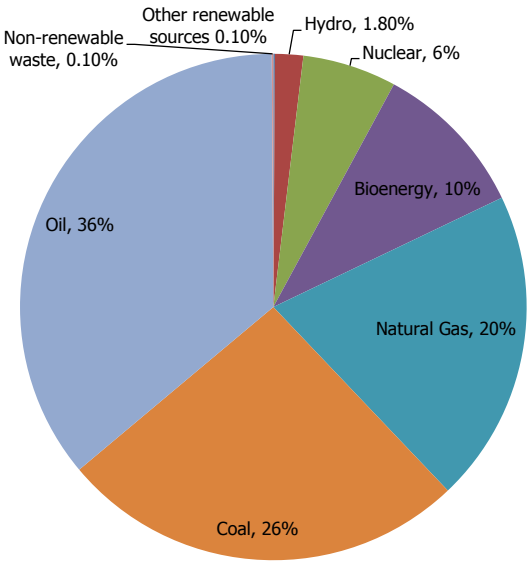
Biofuels are a part of the bioenergy matrix. Bioenergy is defined as energy derived from biomass: essentially, solar energy that has been bound up in biomass during the process of photosynthesis. Bioenergy can be used to generate electricity, produce heat, and is the energy produced by biofuels. Bioenergy is therefore a renewable energy resource.

Figure 1: The Bioenergy Matrix



Source: IEA Renewables Information 2007, European Commission, Directorate General for Energy and Transport.

Figure 2: The Share of Fuels in World's Total Primary Energy Supply (2005)



Note: Biofuels presently supply about 10% of the world's total primary energy supply.
Source: Directorate General for Energy and Transport, Bioenergy Europe 2008

What are biofuels?

Today, the word 'biofuel' has generally come to mean ethanol and diesel made from crops such as corn, sugarcane and rapeseed. The word is an abbreviation of bio-organic fuel, and when plants are specifically cultivated for fuel needs, they can also be called agro-fuels.[5] The UK oil giant, Shell, defines biofuels on its website as 'fuels that are produced from biomass such as plants or organic waste'. They can be blended at low concentrations with petrol (gasoline) or diesel for use in today's vehicles. If they are used at high or 100% concentrations, vehicles typically need some form of adaptation.[6]

Technically the word 'biofuels' can mean any kind of fuel made from living things, or from any waste materials produced from living things. Biofuels can include wood in the form of chippings and straw, as well as pellets or liquids. Typically bio-ethanol, an alcohol, is combined with petrol, while biodiesel is either used independently or in a mixture.

Advantages of using biofuels

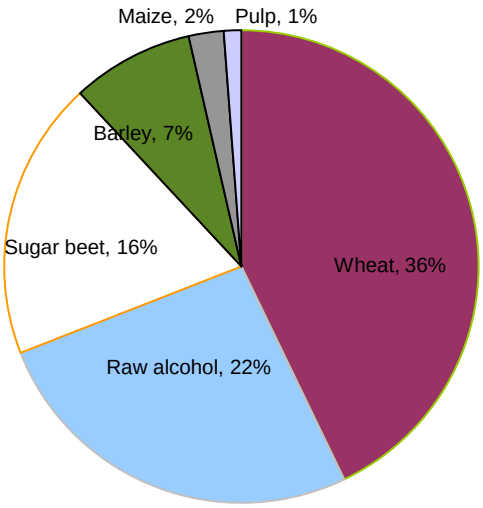
Biofuels are seen as being 'greener' than conventional fossil fuels. In fact, their appeal largely comes to the foreground when they are compared to fossil fuels. Most importantly, biofuels are seen as carbon-neutral in the environment. This is because although, in principle, biofuels release a certain amount of carbon dioxide into the atmosphere when they are burned, they also absorb comparable amounts of carbon dioxide from the atmosphere for photosynthesis when they are growing as plants. It is their alleged role in being able to reduce greenhouse-gas emissions compared to conventional transport fuels that makes the promotion and use of biofuels so attractive to policymakers.

However, it is important to note that biofuels are not universally seen as 'green' or environmentally friendly options. As energy, very often from fossil fuels, is utilised in farming and processing the crops used to produce biofuels, they can sometimes be just as polluting as petroleum-based fuels, depending on the crop grown and how it is treated. In effect, although many biofuels are associated with lower greenhouse-gas emissions, they also have greater aggregate environmental costs than gasoline.[7]

What are biofuels made from?

Biofuels are made from a wide variety of feed stocks. While ethanol is made from sugar cane, corn, and sweet sorghum, biodiesel is made from soybean, rapeseed oil, coconut, palm, canola and jatropha. Additionally, trees, grass, agricultural residue, and municipal solid waste can also be converted into biofuels. Cellulose, which is a major structural component of a plant, can be broken down into sugars, which can then be fermented and turned into ethanol.

Figure 3: Raw Materials Used in the Production of Bioethanol (2006)



Source: Ebio, Bioenergy Europe 2008, London

Types of biofuels

There are several different ways of classifying biofuels based on the feedstock or source of production, or even by their effect on the environment. This is an important principal as not all biofuels are equal in terms of their environmental costs.

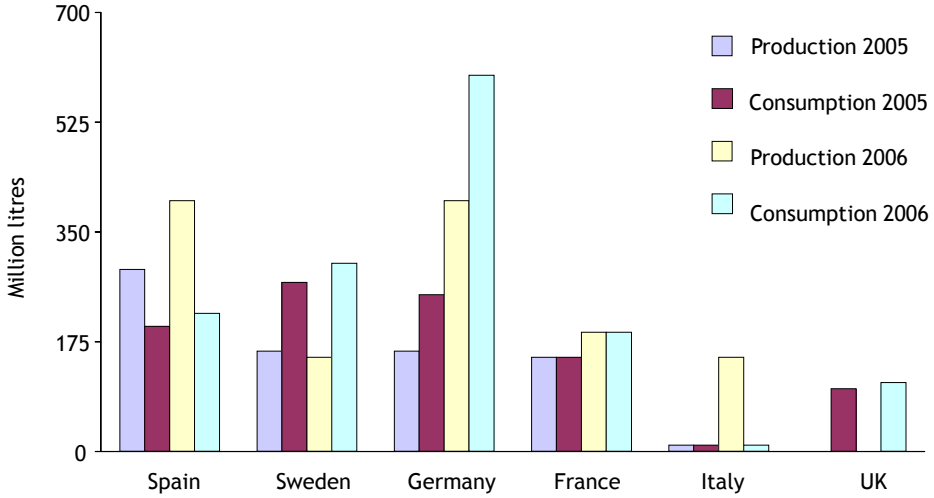
The two main types of biofuels are first- and second-generation biofuels. First-generation biofuels are made from food crop feedstocks while second-generation biofuels are made from agriculture and forestry waste, such as woodchips and straw.

First-generation biofuels

First-generation biofuels, made from food crops, can offer some CO_2 benefits and can help to improve domestic energy security, say experts. But concerns exist about the source of feedstock, including the impact it may have on biodiversity, land use, and competition with food crops.

The two main types of first-generation biofuel in commercial use are ethanol and bio-esters. Ethanol is produced by fermenting plant-derived sugars, such as sugar cane and corn. Under current gasoline specifications, ethanol can only be blended with standard fuel up to 10% in the USA and 5% in Europe. Neat ethanol or higher concentrations can be used in specially modified vehicles; for example, in Brazil all gasoline contains around 20–25% ethanol and vehicles are adapted to run on the fuel.

Figure 4: Bioethanol Production and Consumption in 2005 and 2006 in Six EU Countries

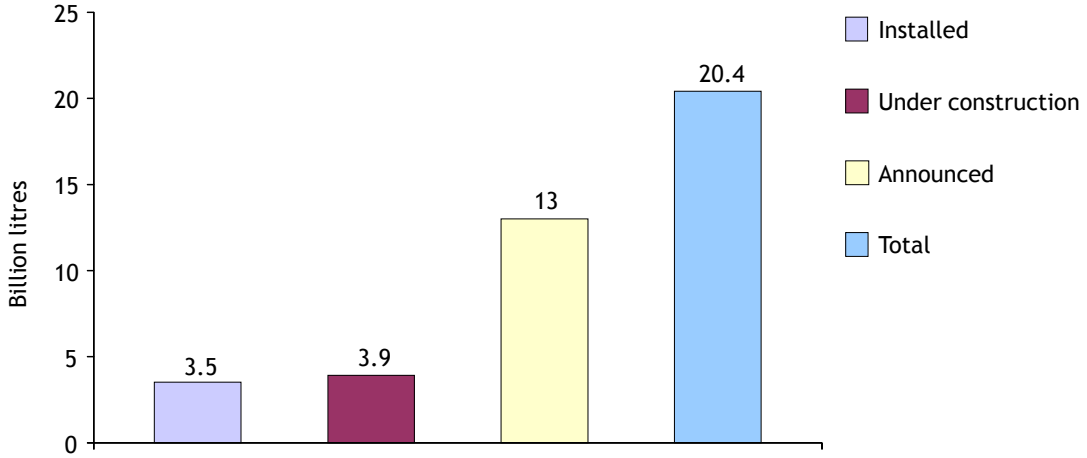


Source: Ebio, Bioenergy Europe 2008, London

Bio-esters are produced by a chemical reaction between vegetable oil (e.g. rapeseed or soya bean oil) and an alcohol. The properties of bio-esters are very close to those of diesel fuel and the two can be mixed: this blend is known as biodiesel. Bio-esters can be used in current vehicles as a blend at low concentrations or in their pure form in modified vehicles. Bio-esters are mostly used in Europe where fuel specifications allow 5% blends.

Examples of first generation biofuels: Bioethanol from corn, sugarcane, wheat and sugar beet.

Figure 5: EU Bioethanol Production Capacity



Source: Ebio, Bioenergy Europe 2008, London

Second-generation biofuels

These are biofuels that are produced from agricultural wastes such as straw, and farmed energy crops such as willow. As they are made from non-food feedstock, they are highly advantageous, in that they can significantly reduce CO_2 production, but without competing with food crops. Some second-generation biofuels can offer better engine performance.

From the commercial perspective, the cost of second-generation biofuels could possibly be brought down to match standard petrol and diesel. Tne important consideration is that second-generation biofuels will not be available in significant commercial quantities for 5–10 years.

Examples of second-generation biofuels: Ethanol made from agricultural waste or lignocellulose

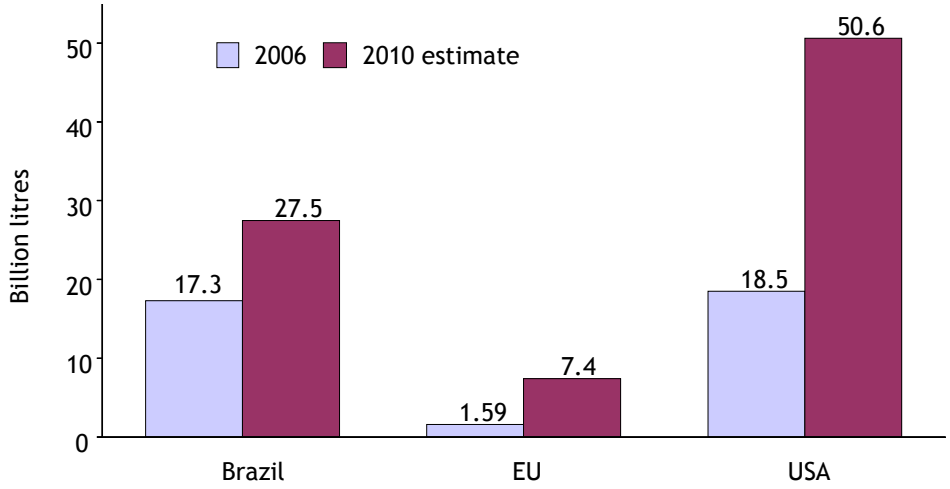
3. European Union Legislation

Spurred on by a growing concern about security and continuity of oil and gas supplies, rising energy prices and climate change, the European Commission (EC) had strongly supported the production and use of bioenergy and biofuels within the EU using legislation and formal directives. In fact, EU analysts believed that US policymakers are closely monitoring European policy in order to glean valuable information on successful policy choices that might work in the USA.

Recently however, EU legislators proposed going back and retracing the ambitious target to raise Europe's use of biofuels in what NGOs and the media see as a definite indication of retrenchment.[8] The European Parliament committee backed a proposal to source just 4% of road transport fuels from renewable sources by 2015.

Until this point, European governments had set a target for 10% of transportation fuels to be derived from biofuels by 2020. This is the EU Biofuels Directive, adopted in 2003, which promotes the use of a minimum percentage of biofuels to be marketed and distributed in order to reduce import dependency and greenhouse-gas emissions.[9] In January 2008, the EC outlined a plan to increase the use of biofuels in the EU. The commission confirmed on 23January 2008 that biofuels must form 10% of transportation fuels used in every EU state by 2020. The new development have been seen as an about-turn by the EU, which up until now has endorsed increased use of biofuels as one of the components of the strategy the EC had adopted to reduce the EU's greenhouse-gas emissions by 20% by 2020.[10]

Figure 6: Comparison of bioethanol Production plus Capacity by 2010 in Europe, Brazil and the USA



Source: Ebio, Bioenergy Europe 2008, London

Protests and demonstrations by environmental lobby groups, who believe that the EU needs to rethink its policy on biofuels because of their potentially harmful effects on the environment have also led the EC to set out certain sustainability criteria for biofuels that are produced in or imported into the EU. The EC has said that biofuels used in the EU will have to provide a minimum of 35% greenhouse-gas saving over fossil fuels if they are to count towards a new target for biofuels use.

Dr Kyriakos Maniatis, Head of Sector, Biofuels and Polygeneration, Directorate General for Transport and Energy, European Commission, and the International Energy Agency (IEA) energy chair, said at the Bioenergy Europe 2008 conference (London, UK; 18–19 February 2008) that the three pillars of EU energy policy were sustainability, security of supply, and competitiveness. He said that the January 2007 energy package proposed targets for 2020 of Green House Gas (GHG) reduction, 20% energy efficiency improvement and 20% renewable energy including 10% biofuels. This was broadly endorsed by the member states in the European Council in March 2007, and was also endorsed by the European Parliament in September 2007.

Currently the EC is promoting biofuels that do not contain raw materials from undisturbed forests, biodiverse grassland and nature protection areas, unless taken without harm. Additionally, there is to be no conversion of wetlands and continuously forested areas for biofuel production. This, says the commission, is to protect carbon stocks. The EC also stipulates that all EU biofuels must meet 'cross-compliance' environmental rules.

If certain biofuels do not meet these criteria, they will not count towards country targets. They will be eligible for neither national biofuel obligations nor for tax exemptions or similar financial support.

The EC also states that member states have to introduce biodiesel blends with 7% biodiesel by 2010, and 10% biodiesel by 2014. The present limit is 5%. As per the EC's directives, member states are mandated to give a bonus in their biofuel obligations to biofuels made from wastes, residues, cellulosic and lingo-cellulosic material.

According to Dr Maniatis, work has already begun on a White Paper on internationally compatible biofuels standards. He indicated that the road map for the paper had been agreed by the EU-USA summit in early 2007. By September 2007, the work programme was defined and it was adopted at the International Biofuels Forum in Brussels in July 2008.

The commission has said it would also put in place a system to check the impact of the biofuels target on food prices.

Background to the EU policy on biofuels

The EU has committed to the Kyoto Protocol, by which it has committed to an 8% reduction of carbon dioxide (CO_2) emissions by the end of 2012. Various analyses have suggested that both biodiesel and bioethanol produce substantially less CO_2 emissions (depending on the particular feedstock) than their fossil fuel counterparts. These factors led the EC in 2005 to set a long-term goal of replacing 20% of conventional motor fuels with alternate fuels (e.g. biofuels, natural gas, and hydrogen fuels) by 2020.[11]

In January 2008, the EU's environment chief Stavros Dimas told the BBC, 'We have seen that the environmental problems caused by biofuels and also the social problems are bigger than we thought they were. So we have to move very carefully.' He indicated, however, that draft legislation would be altered keeping sustainability criteria in mind, as well as social and environmental implications, in order to prevent the loss of biodiversity.

The EU's Renewable Energy has been lauded for being a clear directive that covers all renewable sectors. It has given out unambiguous directions to both industry and public. The directive has outlined mandatory goals in terms of mandatory national targets, and also made provisions for National Action Plans (NAPs).

The January 2007 energy package proposed targets for 2020:

- 20–30% GHG reduction;
- 20% energy efficient improvement;
- 20% renewable energy including 10% biofuels.

The EC's Directorate General for Energy and Transport points out that these were broadly endorsed by member states in the March 2007 European Council and European Parliament during the Thomsen Report of September 2007.

The following is a summary of the EC's proposals made in January 2008.

- A new EU emissions trading scheme with a European (as opposed to National) cap and auctioning of allowances to generate reductions in GHG of 21%.
- New national targets to achieve 10% GHG reduction in non-ETS sectors.
- A framework to promote the development of CO_2 capture and storage.
- New guidelines on state aid for environmental protection.
- An update on the implementation of the Energy Efficiency Action Plan.
- New directive to reach the 20% RES target and 10% biofuels target.

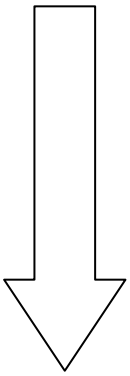
The RES Directive (1)

- Sets mandatory national targets for RES shares, including 10% biofuels share, in 2020 (Articles 3 and 5).
- Requires national action plans (Article 4).
- Standardises 'guarantees of origin' and also RES origin of electricity or heat.
- Enables the transfer of guarantees of origin to give member states the opportunity and leeway to meet their targets by developing cheaper, non-domestic, renewable energy.

The RES Directive (2)
Articles 15–18 of this directive create a sustainability regime for biofuels.

The Association Européenne pour la Biomasse (European Biomass Association; AEBIOM) has stated that the industry would appreciate clear interim targets as there is a danger of member states not taking action until the eleventh hour, and the commitment terms of politicians ending before that. Additionally, trade associations feel that the penalties for non-compliance are not severe enough, and that there should be an adequate support framework for new biofuel technologies.

Figure 7: RES Directive Timelines



Policy proposal made, January 2007

Endorsed by the European Council, March 2007

Endorsed by European Parliament. September 2007

Legislative proposal of the European Commission, January 2008

Discussion of the proposal by Council of Ministers, European Council and European Parliament

Adoption by April 2009?

The next steps in EU policy therefore, involve a co-decision procedure between the EU parliament and EU council. There will be a review of the Biofuels Directive, and policies will be defined for the next 10 years at this time.

Dr Maniatis told *Report Buyer* that there will be an upcoming directive on fuel quality.

Biofuels target could be affected by European Parliament election

The European Parliament elections in June 2009 could affect the plan that biofuels comprise 10% of all transportation fuels used in the EU by 2020, said European Forum for Renewable Energy Sources (Eufores).[12]

Bioenergy Business, a publication containing market and finance information for biomass and biofuels, reports that the Jan Geiss, Managing Director of Eufores stated that the election could impede the co-decision process required to pass the EU directive establishing the 10% requirement.

It is expected that the European parliament will have a first and second reading on the proposed directive during the course of 2008. The European Parliament and European Council will then make a co-decision to approve the directive by early 2009.

Biofuel production is heading to Eastern Europe

The biofuels industry is in its infancy across much of Eastern Europe, but construction of several new plants has begun in the region. Both local and international companies producing biofuels are increasingly looking to set up production plants in Eastern Europe. Emerging destinations of choice in the region are Romania, Bulgaria, Ukraine and Greece.

There are several factors driving companies to set up or expand operations in Eastern Europe; for example, the national economies of the first three countries depend heavily on agriculture and this indicates that their biofuel production capacity is significant.[13] As early as 2005, BioMat Net had predicted in a Final Review article[14] that Central and Eastern Europe would become the biofuels store of the EU.

In March 2008, Sime Darby, the world's largest listed palm-oil producer, said it would be building new palm-oil processing plants in Eastern Europe to exploit booming edible oil demand. Chief Executive, Ahmad Zubir Murshid, told Reuters in a recent interview that the company believes Europe has huge potential and that at least three countries in Eastern Europe had been identified as locations for plants.

Similarly, an article in the e-zine *Cleantech*[15] quotes Reuters that EOP Biodiesel, a German biofuels producer, anticipates a high development potential in the Baltic countries of Romania and Bulgaria. The article says EOP has several international projects and operates in processing rapeseed in Romania, Ukraine, Latvia and Austria.

In 2007 the Illinois-based Archer Daniels Midland Company, one of the world's largest agricultural processors of soybeans, corn, wheat and cocoa, joined a list of other companies to venture into Eastern European biofuel development when it completed the acquisition of a seed-crushing facility called Ilitchevskiy Maslo Extractionniy Zavod (IMEZ) in the Ukraine.[15]

New legislation in the Ukraine in recent months has introduced favourable tax incentives for biofuel developers. Ukrainian officials are believed to have estimated at least 20 biodiesel plants will be built in the country in the near future, with a combined capacity of at least 623,000 tonnes a year.

Likewise the Russian Biofuels Association website contains a Reuters article[16] reporting that Bulgarian firms have announced plans to build several biodiesel plants with a total annual capacity of about 300,000 tonnes. The article also states that approximately 17 new biodiesel plants have been scheduled to be created in Poland over the next few years, according to the Polish Biofuels Chamber. Their total production capacity is estimated at up to 1.2 million tonnes.

The type of raw materials and resources available in Eastern Europe will be vital in identifying the production technologies that will be interesting and relevant for the Eastern EU market. Traditionally the region does not have a large-scale crop cover of corn, instead it possesses large-scale plantations of rapeseed, a hardy plant that works as a soil cover in the cold winter months.

4. The backlash against biofuels

The idea of increased production and use of biofuels has been dogged by controversy. Mainstream media has recently reflected the growing dissatisfaction of NOGs, academics and the public. For instance, in late March 2008, *The Guardian* carried a series of articles quoting leading scientists expressing doubts over the EU's policy and environmental viability of biofuels.

Some scientists believe that the carbon benefits derived from biofuels may be currently disproportionate to the negative effects from their production. Indeed several leading scientists are adding to the growing chorus of cautioning voices highlighting the unintended environmental and economic consequences that could offset the potential benefits of biofuels.

Professor Robert Watson, the chief scientific adviser at the UK's Department for Environment, Food and Rural Affairs, reportedly told the newspaper that 'if one started to use biofuels... and in reality that policy led to an increase in greenhouse gases rather than a decrease, that would obviously be insane'. He then clarified that such a situation would certainly be 'a perverse outcome'.[17]

The same article also quoted the UK's former chief advisor, Sir David King, as saying that biofuel quotas should be stalled until a review commissioned by ministers is completed and the results taken into account. John Beddington, the UK government's current chief scientific adviser, has gone on record to say the rush for biofuels is endangering global food production. An article in *Yahoo News* reports that Professor Beddington issued a warning in a statement where he said, 'it's very hard to imagine how we can see the world growing enough crops to produce renewable energy and at the same time meet the enormous demand for food'.[18]

Critics of biofuels emphasise three main arguments.

1. Food crops are being diverted towards the production of biofuels, which is driving upthe price of food: this is the food vs. fuel debate.
2. Large-scale biofuel production causes losses in biodiversity.
3. Biofuels are not as environmentally attractive as they are made out to be.

Food vs. fuel debate

The economics of agriculture are seeing a shift, having to contend with a world where crops once meant for nourishment now being used in the production of energy. The prime example of such a crop is corn.

Corn is at the centre of a tug-of-war between ethanol plants and food. In the USA, increased use of corn in the production of energy has meant that there has been a debate over whether corn will be used to feed the nation's belly or fuel the car tanks. US corn-based ethanol production has more than tripled since 1998.[19]

The basic argument is that energy-crop programmes compete with food crops in various ways; for example, they compete in terms of arable land, rural investment, infrastructure, water, fertilisers, and skilled labour. Also, as agricultural products that would be used as nourishment are diverted to energy production, so there are food shortages and sharp rises in price.

Chief scientist of the International Union for Conservation of Nature (IUCN), the World Conservation Union, Jeffrey McNeely, says in a BBC article that the grain required to fill the petrol tank of a large 4-wheel-drive offroader with ethanol is sufficient to feed one person per year. Assuming the petrol tank is refilled every 2 weeks, the amount of grain required would feed a hungry African village for a year. Additionally, the article also states that food prices are already steadily rising: with only 10% of the world's sugar harvest being converted to ethanol, the price of sugar has doubled. The price of palm oil has increased 15% over the past year, with a further 25% gain expected next year.[20]

Environmental journalist George Monbiot echoes his views on the subject in an article, 'Food for Nought', in *The Guardian* in December 2004. He finds that if there is to be an EU-wide uptake of biofuels, 'most of the arable surface of the planet will be deployed to produce food for cars, not people'.[21]

It is not just corn that will see a sharp rise in price, but also products made of corn, and meat such as poultry or pork where animals are fed corn as a foodstock product. In the USA, farmers have already reported that foodstock prices for poultry and pigs have risen, and that this would be reflected in the price of meat. Social scientists are particularly concerned about how these increases in price will impact the poor in particular, as people in developing nations already spend large percentages of their wages on food.

The price of food has risen worldwide due to a variety of factors. *The Boston Globe*[22] finds that unpredictable weather and vast changes in the global economy, including higher oil prices, food reserves shortages, and growing consumer demand in China and India comprise some of the reasons for the change is food pricing. The article points out that the Food and Agriculture Organisation (FAO), the largest autonomous agency within the United Nations, has predicted that consumers will face at least 10 years of more expensive food.

Destruction of biodiversity

Independent scientists and environmentalists have now long been sounding a warning about the impact of biofuels on biodiversity. They say the widespread production and use of green and biofuels could turn out to have negative implications for not only human and societal imbalances, but could also be detrimental to the environment.

It is the growing of crops to be used to produce biofuels that causes the damage to the environment. As multinationals begin to race to grow biofuel crops such as corn, soy and sugarcane there is concomitant deforestation, and damage to valuable ecosystems and carbon sinks.

Analysts say that planting of biofuels already one of the world's major causes of tropical forest destruction. The development of a new market for biofuels has created an industry that has already destroyed most of Brazil's Cerrado grasslands (one of the world's most biodiverse environments) and much of its rainforest. The Cerrado grasslands have been replaced by soybean, a starting point crop for ethanol used in the USA.

A *New York Times* article[23] about the growing greenhouse threat from biofuels quotes Dr Joseph Fargione, a scientist at the Nature Conservancy, highlighting the impact of large-scale cropland in the USA being directed towards the growth of corn. He points out that previously US Midwest farmers had alternated between corn and soy plantations year-on-year. Now they are growing solely corn, which means that the world's soy supply has to come from elsewhere.

Dr Fargione told the newspaper that soy was now being grown in Brazilian land that was previously forest or savannah. He said, 'Brazilian farmers are planting more of the world's soybeans — and they're deforesting the Amazon to do it.'

Brazil is not the only country to witness this damage. Damage has also occurred in Indonesia where, spurred on by government tax incentives, many Indonesian and foreign companies are ploughing in millions in expanding plantations and refining facilities. As American biodiesel incentives are instrumental in raising palm oil prices, this has led to a rapid plantation of palm at the expense of carbon-rich peat swamps and tropical rainforests. Similarly there has been a shift from small-scale farming towards concentrated growth of monocultures.

There is also growing concern from academics that increased biofuel production, by growing more crops, could put an important strain on water resources as well.

Mark Avery, Director of Conservation at the Royal Society for the Protection of Birds (RSPB), in a joint press release issued by the UK's leading environmental groups states that the Renewable Transport Fuel Obligation (RTFO) 'threatens to accelerate the destruction of some of the world's most precious habitats and wildlife. Without environmental standards, biofuels will be little more than a green con.'[24]

Certification and environmental issues

Sustainability has become one of the key issues in the biofuel industry. Presently the EU guidelines fall short of making it mandatory for biofuels to meet agreed sustainability criteria. There has, however, been debate since 2006 surrounding the issue of whether the EU should introduce a certification scheme to distinguish between 'poor performing' biofuels and 'better performing' ones. Currently, all biofuels are simply classified as renewables.

Groups concerned with the environment have long been calling for the EU to endorse a mandatory eco-certification of all biofuels used in the continent. They have repeatedly drawn attention to how, despite the EU's stress on the gravity of minimising the environmental impact of biofuel production, it does not explicitly demand obligatory certification of all biofuels used in the region.

As there is a strong likelihood of the EU being unable to meet its biofuel needs from domestic sources, campaigning groups stress that any certification scheme that is introduced must ensure that even imported biofuels fall within their remit, that any certification system adopted must take into account the overall climate benefits of any biofuel, including factoring in any energy intensive production methods. Both scientists and campaigning groups highlight that some biofuels could offer little or no advantage over conventional fuels in terms of total greenhouse-gas emissions.

One important challenge is to create a certification scheme that can be applied internationally, but one that is also flexible enough to take into account local conditions.

The EU's Directorate General for Energy and Transport has taken the stance that most biofuels bring environmental benefits. However, they have taken on board the concerns expressed by campaign groups and are working on a set of sustainability criteria.

The EU believes that a system is needed to tackle problems such deforestation, and production techniques that result in high GHG. It goes a step further to promote and distinguish high carbon balance biofuels. It is believed that the better fuels in terms of carbon savings will be rewarded.

Specifically, the EU will look at the sustainable provision of feedstock and take into consideration the potential of European agriculture and forestry, and impacts on food and material markets both within the EU and globally.

The EU's Directorate-General for Energy and Transport also aims to look at other possible uses of biomass. There will be focus on research and technological development to refine optimised production and mix of raw materials. More cost-effective conversion technologies will be the focus of development, and more diverse feedstocks will be researched.

The UK's Royal Society has published a report making four clear recommendations that need to be taken into consideration while assessing the contribution.[25] Firstly, it believes that each biofuel must be assessed on its own merits. This is because the term 'biofuel' covers a wide variety of products with many different traits and a wide range of potential savings in terms of greenhouse-gas emissions.

Secondly, the report also finds that when biofuels are being assessed and evaluated, the entire environmental and economic aspects of the complete cycle — growth of the plant, transport to the refinery, the refining process itself (including potential by-products such

as specialty chemicals), wastes produced, distribution of the resultant fuel to consumers, end use, and potential for pollution — should be documented.

Such assessments would help to determine the extent to which different biofuels are carbon-neutral.

Thirdly, widespread deployment of biofuels will have major implications for land use, with associated environmental, societal and economic impacts that must in turn be assessed. Here, in particular, unintended consequences may reduce or override the expected benefits.

Fourthly, the assessments must address the global and regional impacts, not just local ones.

EcoWorld, an information resource on nature and clean technology, has outlined the following criteria that biofuels ideally need to meet.

- Biofuel crops should not displace food crops.
- Biofuel crops should not displace rainforest.
- Biofuel crops should not displace critical wildlife habitat.
- Production of biofuel must be decisively energy-positive.
- Biofuel must not exacerbate water scarcity, either in the growing or the refining process.
- Biofuel plantations should not exploit local labour, or exclude local ownership.
- Biofuel use should be encouraged in the most efficient applications, such as combined heat and power, and not automatically be directed into the automotive sector.
- Biofuel produced using cellulosic extraction must not prevent valuable organic matter from returning to the soil.

Figure 8: European Sustainability Criteria for Biomass

	Netherlands	UK	Germany	EU
Application of biomass	Biofuel and bioenergy	Biofuel	Biofuel and bioenergy	Biofuel
Current status	Framework of sustainability criteria ready and awaiting parliamentary	Final proposal expected early in 2008	Ministerial proposal expected	Proposal ready
Sustainability criteria covered				
Biodiversity		x	x	x
Land-use change	x	x	x	
Environmental protection	x	x	x	
Welfare	x		x	
Well-being (workers' rights, land rights)	x	x	x	
Competition with food and other materials	x	x	x	
Greenhouse gas balance	x	x	x	x

Source: Biox and *Bioenergy Business*

*Some recent scientific breakthroughs and alternatives to bioethanol**

Bioethanol produced from waste materials

Researchers at University of Maryland have been working on a certain process by which bacteria from Chesapeake Bay may be able to convert large amounts of different plant products — right from paper wastes to the dregs from brewers — into ethanol and other biofuel alternatives to gasoline. The process has been worked on by University of Maryland professors, Steve Hutcheson and Ron Weiner, and is the basis for their incubator company, Zymetis.[26] The microbial basis to the technology is a Chesapeake Bay marshgrass

* Note: Coincidentally all these research breakthroughs mentioned have come from the USA, not Europe.

bacterium, *Saccharophagus degradans*, which has an enzyme that quickly breaks down plant materials into sugar that can afterwards be turned into biofuel.

The Zymetis process can make ethanol and other biofuels from many different plant waste products called cellulosic sources. Importantly, these can be non-grain plant sources including corncobs and husk, as well as switchgrass. The researchers have are now producing the enzyme, ethazyme, in their own laboratories. This enzyme can break down the entire plant material into biofuel-ready sugars in one step, at a significantly lower cost and with fewer caustic chemicals than is achievable with current methods.

Researchers estimate that when fully operational, the Zymetis process could potentially lead to the production of 75 billion gallons/year of carbon-neutral ethanol.

New techniques create butanol, a biofuel superior to bioethanol

Researchers headed by an environmental engineer at Washington University in St Louis are attempting to produce biobutanol, a fuel that yields more energy than ethanol. Butanol can be made from lignocellulosic materials such as woody stems, corn fibres and husks. The team is using a special mixture of thousands of bacteria to convert these wastes into butyrate after breaking down the waste first. The woody wastes, which may be pretreated corn fibre, are first broken down both physically and chemically. Once converted to butyrate, it is a step away from being transformed chemically into butanol in fermenters.

Researchers say that butanol is considered to be a better biofuel than ethanol because it is less corrosive and has a higher caloric value, giving it a higher energy value. Like ethanol, butanol is being considered as a fuel that will be mixed with petrol.

Developments in green gasoline production

Researchers are also pointing to green gasoline, as an appealing alternative to bioethanol. They point out that it can be used in existing engines and does not need as much energy as bioethanol does to be produced. This means it has a smaller carbon footprint and is cheaper to produce.

The April 2008 issue of the science journal, *Chemistry & Sustainability, Energy & Materials* carries a paper by George Huber of the University of Massachusetts-Amherst (UMass) and his graduate students that announces the first direct conversion of plant cellulose into gasoline components.

Some key factors influencing the biofuels market in Europe

There are several factors which directly influence the European market for biofuels.

Renewable Energy Directive

The European biofuels market is a policy- and regulation-led market. The primary driver of trade and profitability is government action and heavy government influence. Producers and industrialists fully support the EU's clear target and binding RES Directive and its mandate of 10% which creates a framework within which they can operate businesses, although there have been recent reports on policy change at the EU level. Producers have been questioning why there is no article on security of supply. Producers also claim that they would favour an intermediate target for biofuel use.

Sustainability criteria

The proposed sustainability criteria have been welcomed by industrialists, as well as the cross-compliance rules. Some industrialists have stressed that while the greenhouse-gas emissions savings target of 35% is too steep for a young industry, it does mean that this will translate to delivering a substantial CO_2 saving. The biofuels producers' associations feel that if sustainability criteria are introduced, these then should also to apply to the fossil fuel industry, and not single out of the biofuel industry.

National biofuel policy and regulations
With the EU comprising 27 member states, the differences in the national policies of each member state is a factor that affects the market. In a sense, the EU is a collage of the different policy instruments adopted by individual member states. The national policy of each member state, in turn, is a matrix of factors such as tax measures, obligations, and penalties on one hand, and a range of how open the market is on the other.

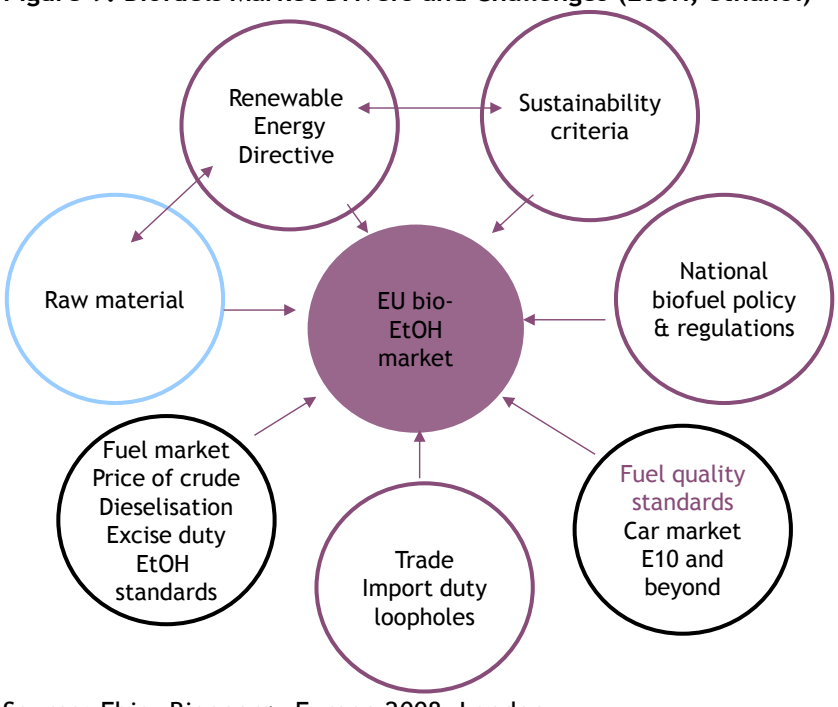
Fuel quality standards and car market
The present laws restrict direct blending of ethanol to a maximum of 5% volume by volume (v/v). There is a new law currently under review which will permit an increase in the bioethanol blending to 10%v/v. It also proposes a waiver on the vapour pressure limit. The producers, unsurprisingly, favour the 10% bioethanol blending level as a minimum.

Trade import duty loopholes
Traders say that some countries in the EU comprise the world's most open market. In fact, they point out that there are different import duties that include loopholes that can be exploited (see section on Splash and Dash). Producers in Europe assert that there is an urgent need to establish a coherent trade policy by 2012. Additionally, they are of the opinion that there should be a single import duty on ethanol for fuel, and that it is vital to introduce a clear limit on ethanol imports if an EU biofuels industry is to be developed.

Fuel market and price of crude dieselisation
The rising price of oil has been one of the driving forces behind the move to encourage use of biofuels. Oil prices climbed to a record high at US$100 a barrel in January 2008, having doubled since January 2007 and more than quadrupled since 2002. This, along with concern over the EU's energy independence and security, is a crucial driver of EU biofuels policy.

Weather
The New York Times, citing the example of recent storms and floods in the USA's Midwestern region and the consequent damage to corn crops, said that weather can directly hold the country's fuel supply as a hostage. The article[27] calls the weather 'a new economic hazard' and states that as the USA relies more on biofuels, it will become more exposed to the weather due to its effect on the crops being used in biofuel production, thus affecting its fuel prices.

Figure 9: Biofuels Market Drivers and Challenges (EtOH, ethanol)



Source: Ebio, Bioenergy Europe 2008, London

Investment perspective

Summary of reasons to invest in biofuels

From the investment point of view, the top three reasons to invest in biofuel production would be as follows.

1. Fossil oil importation is currently prohibitively expensive, and there is a strong likelihood of emerging markets in countries where second-generation biofuel production is possible.
2. Biofuels could provide region-specific benefits, where there is a national mandate turning to renewable fuels.
3. In most cases, from the transportation industry perspective, biofuels can be integrated without high cost changes to infrastructure. A case in point is that car engines running on ethanol can easily be adapted to run on bioethanol or biodiesel. Biofuels can also be dispensed just as gasoline is today.

On the other hand, there are some factors that need to be considered.

1. Feedstock for biofuel production is usually in direct competition with food markets.
2. There has been some scientific evidence to show that fuel cell technology could be a better alternative.
3. Some countries have found that large numbers of vehicles are unable to cope with biofuel blends, especially when there is a higher concentration of bioethanol.

Germany puts brakes on biofuel roadmap for cars

The German government has backed away from its schemes to be at the vanguard of a worldwide biofuel shift, after it was found that too many cars in the country would be incapable of running on the planned ethanol-petrol combination. There were government plans to introduce the new biofuel-blend, called E-10 to motorists in 2009. The blend consisted of 90% petrol and 10% ethanol. Execution of the shift to E-10 was seen as a pivotal step in Germany fulfilling its goal of 20% of all its fuel being made up of biofuels by 2020.

The German Automobile Club (ADAC), which represents car importers, indicated that around 3.7 million cars would be unable to function on the combination fuel. German Environment Minister, Sigmar Gabriel, told *The Guardian* that the number of cars affected was higher than the 'pain threshold' he expected, of 1 million cars. He also indicated that he would prefer to retract his 'roadmap to biofuels' than spark off a debate that could create new uncertainty and delays.

Mr Gabriel had previously stressed that he saw the directive as central to Germany's efforts to lead worldwide climate change efforts. The German government's target is to cut the country's CO_2 emissions by 40% within the next 12 years.[28]

The US 'Splash and Dash' trade scheme

The UK newspaper, *The Guardian*, recently reported that biofuel companies were taking advantage of a US subsidy to take part in a 'trading scam' that had a detrimental effect on the environment. In an article entitled 'Demand for Crackdown on Biofuel Scam' the newspaper reported that up to 10% of biofuel exports from the USA to Europe are believed to be implicated in the scheme.

The scheme is referred to as the 'splash and dash' scam (or 'U-boat' trade) as it involves transporting biodiesel from the EU to the USA, where a tiny dash of fuel is mixed in. As the subsidy is linked to the act of blending, traders take in boats of soy or palm-based biodiesel from Europe, add some local diesel, claim the subsidy, and then ship it straight back to sell at lower than domestic market prices. US companies involved in biodiesel production are also concerned about the practice and refer to it as U-boat trade because the boats turn around and leave immediately. Traders involved in the practice benefit from being able to claim the £0.11/litre US subsidy, and are then able to sell in Europe for a lower-than-market price, undercutting Europe's biofuel industry.

Industry experts clarify that the trade is not illegal, but that it goes against the core values of 'green' fuel as it involves unnecessary transatlantic transportation for material gain. Environmental groups have been expressing concern about damage to the environment from shipping.

In March 2008, *Bioenergy Business*, a UK-based trade magazine, reported that the European Biodiesel Board (EBB) was anticipating registering a complaint against US biodiesel blending subsidies. The organisation was trying to curtail the easy entry of cheap biodiesel imports from the USA into the UK by filing a dumping complaint.

Raffaello Garofolo, EBB Secretary General, told Environmental Finance's recent Bioenergy 2008 conference in London that EU biodiesel producers were 'fed up with the situation'. *Bioenergy Business* also reported that he said, 'This is an unfair trade practice and I hope that we can stop it.'

Analysts find that British, German and Spanish biofuel producers have mothballed their facilities and are not seeing financial gains even despite the fact that biodiesel prices remain high.

Mr Garofolo emphasised at the conference that the subsidy made imports more cost-efficient than biodiesel raw materials purchased by EU firms. This has resulted in several of the EU's biodiesel firms (about 200) running below capacity.

Some examples of major industry entrepreneurship worldwide

Biofuels have been identified as one of the top 12 areas that will witness considerable scientific innovation and make commercial and social impact on consumers worldwide between 2008 and 2025.[29] Some examples of initiatives that biofuels companies across the world have made include the following.

1: Development of an algae-to-biofuels pilot plant in Hawaii

Europe's largest oil company, Royal Dutch Shell Plc together with HR BioPetroleum have announced that they will jointly be building an algae-growing plant to make vegetable oil for biofuel production.[29]

While biodiesel is currently produced largely from soybean in the USA and rapeseed in the EU, researchers are now studying using oil-rich algae as a source of biomass for biodiesel production.

The company, Cellana, will build a pilot-scale facility in Hawaii to grow native algae or other state-approved varieties in open-air ponds using proprietary technology.

2: Bulgaria attracts biodiesel investment

The Spanish group Coener Systems has unveiled plans to build a US$90 million biodiesel plant in north Bulgaria, by 2009. Company sources say that biodiesel produced here will be sold domestically and in Austria, Germany, Romania and Serbia.

An online article on the website World Energy Alternatives states that companies in the region Eko Petroleum, Papas Oil, Biodreams, Bulmarket, Kristera and Profex Bioproducts, and Spain's Green Fuel Corporación SA have also announced plans to build biodiesel plants in Bulgaria.[30]

3: Finnish Oil Moghul Building World's Largest Biodiesel Plant in Singapore

Finnish oil company Neste has already begun constructing what they claim will be the world's biggest biodiesel production facility. This plant is being built in with the company having invested about 550 million euros (about US$800 million). The capacity of the, the company says, will be 800,000 tonnes of biodiesel per year. Construction is expected to be completed by end 2010.

According to company sources, this facility will see the use of a second generation biodiesel manufacturing process which uses any kind of fatty acids as raw material. [31]

4: Biodiesel superplant to be built in Brazil

Petróleo Brasileiro (Petrobras), a Brazilian energy company headquartered in Rio de Janeiro, has announced it will build a 193 million gallons/year 'superplant' for biodiesel production that will make biodiesel straight from seeds. The new technology is currently being pilot-tested. An article in *World Energy* states that Petrobras is already constructing three smaller plants, each with a capacity of 15 million gallons/year. Total project investment for all four plants is projected to be US$300 million.[32]

5: Indian oil companies will invest in Brazilian ethanol projects

Indian state-owned oil companies have announced their intention to invest US$600 million in ethanol plants in Brazil, according to Indian daily newspaper *Hindustan Times*.[33] The investment will go towards the construction of several ethanol plants which have a combined capacity of 130 million gallons/year. Indian giants Bharat Petroleum, Hindustan Petroleum, and Indian Oil plan to invest equally in Brazil through acquisitions and new projects.

6: $330 million biofuel project planned for Kenyan company

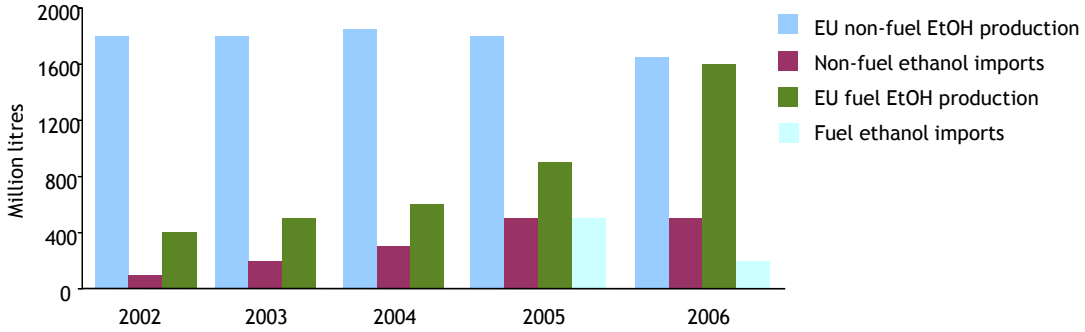
Mumias Sugar Company, a Kenyan-based sugar company is planning a US$330 million biofuel project, including an ethanol refinery and food processing plant. The company has also controversially announced that 20,000 hectares of sugarcane for biofuel production will be planted in the Tana river delta.[34]

Conclusion

The global growth of the biofuels industry, driven by regulatory support and improving economics, may see some fluctuating fortunes in light of the EU's apparent backtracking from its original goals. The European Parliament's environment committee, which favoured lowering the EU's goal of getting 10% of its road transport fuel from renewable sources such as biofuels by 2020, voted 36–0 on July 2008 in favour of amending the existing targets. However, underlying market drivers such as concern over CO_2 levels, energy security and agricultural support are vital supports for the industry.

Large-scale producers of biofuel such as Brazil are watching the commercialisation of biofuels in Europe, hoping to gain a new market. Europe has long been identified by analysts as the destination market for biodiesel: the buzz phrase within the producers' industry is that 'all roads lead to Europe'. Producers point out that realistically Europe was always going to be an importer in the age of global, international trade. The European biofuels market cannot supply the quantity it needs when the Biofuels Directive, which requires 10% bio-components in road fuels on an energy basis, comes into effect. In the past, up to 80% of European biodiesel demand was contracted locally in off-take agreement. However, for 2008, this is predicted to be below 50%, indicating that there will be a vast increase in the quantity of imports.

Figure 10. Europe's Ethanol Production and Imports (2002-2006)



Source: Ebio, Bioenergy Europe 2008, London

Sustainability standards are being developed by European countries for biomass to be used for bioenergy purposes. It is widely recognised by producers that unless the public see both reduction in GHG emissions, and other environmental benefits, there will be a likelihood of subsidies being withdrawn. It is predicted that these standards will soon pass into legislation. As developments in sustainability criteria take place, mandates will replace incentives. Only sustainable products will be able to sell at a premium, and discounts to non-sustainable products will cease, that is, only biofuels produced in a sustainable way may count towards the EU biofuel obligation and be eligible for tax exemptions and subsidies. Finally, the EU will make it obligatory to follow quality, not quantity, and the future market will place a high premium on carbon and sustainability credentials.

The biofuels market was a transaction market, and is now transforming into a traded market, maintains Kevin McGeeney, CEO of Starsupply Renewables SA, a leading brokerage firm in renewable energy. His presentation at the conference in London of Bioenergy Europe 2008 focused on how, by the end of 2006, major oil and agriculture businesses had set up biofuel trading desks. The biofuels market is a highly fragmented market. In 2007, there was an oversupply of biodiesel and it is currently very hard to make money in a non-taxation scenario, says Paul Bateson CEO of Greenergy. Growth in the EU biodiesel production would slow to no more than 10% in 2008, according to Raffaelo Garfolo, EBB, in *Bioenergy Business* (March 2008).

Research is ongoing into developing second-generation biofuels. The most favourable crop is currently sugarcane, which appears to have superior economic and environmental benefits. However, improved technologies under development for the production of ethanol from lignocellulosic biomass may become commercially available in 5–8 years.

- END -

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