Bio-energy

Sector Overview

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Introduction

A Quick Scan is a short piece of research which is undertaken in a period of six days. This research was funded internally in order to make an inventory of the knowledge-gaps in the the bio-energy sector and to provide SOMO and others that are interested with an outline of the sector. An important focus of the scan is on potential critical issues with regards to the sector's environmental, ecological and social-economical impact and on Corporate Social Responsibility (CSR). The scan also provides an overview of the types and uses of bio-energy, the variety of regional activity and major companies involved. More specifically this Quick Scan attempts to answer the following questions:

- What is bio-energy made of? How is it used?
- What does the bio-energy market look like?
- What issues is the sector faced with? How does the sector respond?
- Where is the sector heading? What are the gaps in the current knowledge? What could be the focus of future research by SOMO?

The information in this Quick Scan report was obtained from websites, databases, international press and websites of relevant companies. Additionally various people and organizations from SOMO's network were contacted to provide information. This Quick Scan *does not provide a complete and detailed image of the sector* but is set out to serve as a starting point for possible further research and acquisition by SOMO.

Bio-energy

The term bio-energy refers to 'renewable energy made available from materials derived from biological sources'[1] produced from living, or recently living biological material for the production of fuels, electricity, heat and industrial products. This material includes crops grown specifically for this purpose, such as sugar cane, corn and palm oil, but also natural waste products, animal products and manure. In recent years, interest in bio-energy as a sustainable alternative has increased due to the 17 fold growth in global energy use in the last century[2]. It is estimated that known petroleum reserves will be depleted within the next 50 years. Consequently, alternative energy sources will become more valuable. The mention of biofuels in the State of the Union speech by US president Bush in 2005 is just one example of the increased awareness of the importance and potential of bio-energy for the world's energy consumption. Other examples include the EU incentives for its use in order to achieve the Kyoto protocol goals and success of ethanol in Brazil.

The market for biomass has grown considerably over the last few years. For example the market for biofuels for transport is currently growing with 15% per year[3]. In 2005, the production of biofuels equalled approximately 1% of the total world gasoline use[4]. The production of ethanol, one of the two main types of biofuel, has increased by 165% from 4.6 billion gallons in 2000 to 12.2 billion gallons in 2005. The other type of transportation biofuel, biodiesel, more than tripled during this period and was

1 Wikipedia website, "Bioenergy," no date, http://en.wikipedia.org/wiki/Bioenergy (15-02-07).
2 A. Demirbas, "Progress and recent trends in biofuels", meer gegevens? August 2006.
3 Biofuelwatch, "Biofuels: Renewable energy or environmental disaster in the making", no date, < http://www.biofuelwatch.org.uk/biofuel_paper.pdf>, (07-02-07).
4 WorldWatch Institute website, Press Room, News, "Report: Biofuels poised to displace oil," 07-07-06, <http://www.worldwatch.org/node/4079> (15-02-07).

up to 790 million gallons in 2005. For use, this is often mixed with regular diesel. A number of countries have set goals to further replace its fossil fuel use with biofuels. For example, the US is aiming to have 30% of their transportation fuel to be biofuel by 2030. In an EU Directive, the European Union has determined that its biofuel use should be at least 5.75% by 2010[5]. Numbers on the share of bio-electricity in the global electricity market are not readily available.

There are a number of economic, geopolitical and environmental factors that have triggered the trend of increased use of bio-energy. First of all, there is the rise in oil prices that created an interest for alternatives. It seems that interest in biomass is closely related to the price of oil. This can be seen in the development of technologies for bio-energy in the 1970s when oil prices soared. In the 1980s, when oil prices were very low, these technologies were neglected. The finite supply of crude oil, and the high current prices per barrel have encouraged recent research into the use of bio-energy. Governments, companies and motorists in various countries have partially turned to bio-energy as a cheaper alternative to fossil fuels[6]. The price of crude oil has a clear direct impact on this industry: stock prices of alternative energy companies rise and fall in line with oil prices[7].

Secondly the geopolitical issue of western dependency on foreign oil affects the demand for bio-energy. Bio-energy could be a locally produced alternative to imported oil that is currently used to meet the enormous energy demands of developed countries. For instance, the UK was motivated to use bio-energy because it would be less vulnerable to disruptions of supply due to changes in the political landscape or market forces[8]. In the US, the use of biofuels has been stimulated by the government. Some claim that the use of ethanol as fuel would decrease the dependency of the United States by approximately 1/3, or 80,000 barrels of crude oil per day[9]. Another political motivation to stimulate bio-energy is the boost to domestic agriculture, as well as the creation of jobs within the country. Reports have shown an additional 200,000 jobs in the Midwestern region of the United States[10] and 120,000 jobs in California[11].

Thirdly, environmental issues are deemed to be more significant than before due to the increased debate on global warming. The use of biomass is perceived to be more sustainable, as the total CO2 exhaust is much less than that of fossil fuels. Partially, this is because the CO2 that is released has recently been removed from the atmosphere, while the CO2 in the exhaust of fossil fuels has been stored for thousands of years[12]. Therefore, the use of bio-energy adds much less CO2 to the world's atmosphere. Many countries, including a number of EU members, are hoping to achieve the goals of the Kyoto protocol by promoting the use of biofuels as a replacement for fossil fuels[13]. As biofuels release less carbon than fossil fuels this would decrease their total emission of carbon and possibly be

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5 OECD, Directorate for Food, Agriculture and Fisheries, Committee for Agriculture, "Agricultural Market Impacts of Future Growth in the Production of Biofuels," February 2006.

6 "Biofuel Crossroads," Ward's Auto World, November 2006, p. 30.

7 I. Polyak, "Alternative-energy investing proving riskier than expected; Stock's fortunes are closely tied to volatile oil prices," Investment News, 23-10-06, p. 21.

8 ICC Keynote Market Report, "Renewable Energy," (November 2006; ICC Information Group Limited).

9 American Coalition for Ethanol website, "Energy Independence Benefits," no date http://www.ethanol.org/energy.html (07-02-07).

10 Regional Economics Applications Laboratory, Environmental Law & Policy Centre, "Job Jolt: The Economic Impacts of Repowering the Midwest: The Clean Energy Development Plan for the Heartland," Executive Summary, no date.

11 B. Heavner, B. Del Chiaro, "Renewable Energy and Jobs: Employment Impacts of Developing Markets for Renewables in California," Environment California Research and Policy Centre, July 2003.

12 J. Cushman, G. Marland, B. Schlamadinger, "Biomass Fuels, Energy, Carbon, and Global Climate Change," no date, http://www.ornl.gov/info/ornlreview/rev28_2/text/bio.htm (07-02-07).

13 EUROPA website, Rapid, Press Releases, "Promoting Biofuels as Credible Alternatives to Oil in Transport," no date, http://europa.eu/rapid/pressReleasesAction.do?reference=MEMO/07/5&format=HTML&aged=0&language=EN&guiLanguage=en (07-02-07).

a tool to reach their carbon reduction goals[14]. The OECD report mentions that studies have shown a net decrease of greenhouse gas emission ranging from 20% to 90%. However, the benefits of bio-energy are subject to strong debate. This will further be discussed in chapter 4.

Recent years have seen the development of so-called 'second generation' biomass technology. This entails the production of energy from lingo-cellulosic crops, such as grass, plants, wood and even algae. Through the processes of fermentation and thermo-chemical conversions, the energy that these products extract from the sun can be turned into electricity and fuel.[15] There are three main uses of biomass: fuel, electricity and industrial heat and products.

For usage as fuel, two main types can be distinguished; biodiesel and ethanol. Other examples, such as gas from biomass can also be converted into fuel. However, their use is relatively insignificant compared to the other two. One important benefit of both biodiesel and ethanol is that they can both be blended with fossil fuels and used without alteration to a car's engine. While most biofuels are currently produced from energy crops, such as sugar cane and corn, there are some initiatives to produce fuel from second generation feedstock, such as Fisher-Tropsch diesel[16] and biobutanol[17]. For usage as electricity, biomass is either directly combusted in a similar way to coal, or through a process of gasification to create methane that is used to generate steam engines[18].

[14] The Globalist website, "How Food and Fuel Compete for Land," February 2006, http://www.theglobalist.com/StoryId.aspx?StoryId=5077 (07-02-07).

[15] SenterNovem website, Energietransitie, Nieuws, "Verschillende Routes Mogelijk naar Meervoudig Gebruik van Biomassa," 13-12-06, http://www.senternovem.nl/energietransitie/nieuws/verschillende_routes_mogelijk_naar_meervoudig_gebruik_van_biomassa.asp (07-02-07).

[16] Wikipedia website, "Fischer Tropsch Process," no date, http://en.wikipedia.org/wiki/Fisher-Tropsch_process (07-02-07).

[17] Dupont website, "Biobutanol," no date, http://www2.dupont.com/Biofuels/en_US/ (07-02-07).

[18] Powerscorecard website, "Electricity from: Biomass," no date http://www.powerscorecard.org/tech_detail.cfm?resource_id=1 (07-02-07).

1. Types

This section describes the different types and usages of bio-energy. The types differ as they use different types of feedstock, and the process through which the bio-energy is generated also differs.

1.1. Biodiesel

Biodiesel is the type of biofuel that is generated primarily from vegetable oils and occasionally from animal fats. The oil is extracted from seeds, such as rapeseed and sunflowerseed in Europe, and soy in the United States. Other options include palm oil imported from Indonesia and Malaysia, jatropha, and used frying oil.

Box 1

Biodiesel from frying oil

There are several examples of initiatives to convert left-over oils and fats into biodiesel. In Amsterdam plans have been made to develop a biodiesel refinery that will use frying oils from fast-food restaurants as feedstock. It is expected to open in 2008. Other examples include a refinery in Oklahoma that turns leftover animal fat from slaughtering operations into biodiesel[1], and even the initiative of using human fat leftover from liposuction operations[1].

According to a study by the US Environmental Protection Agency, there are several environmental advantages of biodiesel over petroleum based diesel. For example the emission of several harmful chemicals responsible for local smog and ozone depletion, can be reduced when biodiesel is combined with new biodiesel technology[19].

The feedstock is turned into biodiesel through a chemical process, and the resulting product is often added to 'regular' diesel. For example, most diesel sold at petrol stations in Germany is mixed with a percentage of biodiesel as high as 10%. Europe is the global leader in the production of biodiesel, with Germany, France and Italy contributing for 80% of the global production in 2002. However, countries such as Australia, Brazil, India, Malaysia and the United States are also investing heavily in this type of energy. In many countries, the government provides incentives for plants that turn oils and fats into diesel, and offer tax breaks for producers and consumers. There are a number of downsides to the use of biodiesel, including the loss of biodiversity, an increased monoculture and socio-economic issues related to workers and indigenous tribes in the developing world. These issues are described in more detail in chapter 4.

1.2. Ethanol

Traditionally, ethanol is created by the fermentation of crops, such as sugar, wheat, rice, potatoes and corn. The largest feedstock for ethanol is sugar cane in Brazil, where a high percentage of cars are fuelled by ethanol rather than petroleum. In the United States maize is used to supplement the use of

[19] J. Agnese & C. Wood, Booming Grain Prices Hit Beef, Pork Producers, (December 2006: McGraw-Hill, Agribusiness)

fossil fuels. Other feedstocks used to make ethanol include sugar beet and wheat in EU[20], cassava and other similar crops. The process consists of a fermentation of the natural sugars into alcohol, which can then be the base for the fuel.[21]

The largest advantage of ethanol, besides the lower price than gasoline in some parts of the world, is the relatively low release of greenhouse gasses. However, the benefits of the corn-based ethanol, mostly used in the United States, is at the centre of an academic debate. A downside of ethanol is that the energy content is significantly lower than of fossil fuels. Some researchers have even claimed that the energy input is greater than its output, making it an unfeasible source of energy. In order to use ethanol as an alternative for fossil fuels, large agricultural areas are needed to grow the crops.[22] This has lead to the use of subsidies to promote the use of ethanol in many western countries, with the US having the highest subsidy budget. The only country where the fuel can compete with gasoline without being subsidized is Brazil, where low-cost sugar cane is widely available. At the moment Brazil is the global leader in the use of ethanol, with 22% of all transportation fuel coming from this source.

A recent trend has been the development of second-generation 'cellulosic' ethanol made from cheaper source materials such as plants, wood and forest residues[23]. One example is the use of switchgrass in the United States, a fast growing plant with a very high biomass output. The advantage of switchgrass compared to other crops is that the crop is resistant to poor soil conditions and harsh climates. It also has a higher energy output, and does not need any fertilizers or herbicides[24]. Many believe that this will solve the energy input dilemma that has been at the core of the recent ethanol debate. Another feedstock for second generation ethanol is agricultural and forest waste. This includes straws and leaves, as well as 'dead wood', excess small trees and municipal solid waste products like paper and cardboard[25].

1.3. Biomass for heat and electricity

Another use of biomass products is bio-energy for the generation of electricity. For this purpose, biomass is often a replacement of or an addition to coal. At least five types of feedstock for electricity generation can be identified[26]. Agricultural residues, such as wheat straw and corn stover, are generated after the harvest of commodity crops and are used for electricity generation. Energy crops are crops that are grown solely for the purpose of electricity generation. These include hybrid poplars, hybrid willows and the abovementioned switchgrass. Forestry residues include everything that is left over from forests that have been harvested for wood. Examples are dead wood, small pole trees and logging residue. Urban wood waste and milling residues, including pallets, construction waste, demolition debris and mill residue. And finally, manure, often used by farmers to provide their own electricity and process their biological waste in a sustainable manner[27].

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[20] "Advise on Wheat Growing for Fuel," The Journal (Newcastle, England), 24-08-06, p.44.

[21] OECD, Directorate for Food, Agriculture and Fisheries, Committee for Agriculture, "Agricultural Market Impacts of Future Growth in the Production of Biofuels," February 2006.

[22] Wikipedia website, "Ethanol," no date, http://en.wikipedia.org/wiki/Ethanol (07-02-07).

[23] "Biofuel Crossroads," Ward's Auto World, November 2006, p. 30

[24] Wikipedia website, "Switchgrass," no date, http://en.wikipedia.org/wiki/Switchgrass (07-02-07).

[25] UNCTAD, The Emerging Biofuels Market: Regulatory, Trade and Development Implications, United Nations (2006: New York and Geneva).

[26] Haq, Z., "Biomass for electricity generation," no date, < http://www.eia.doe.gov/oiaf/analysispaper/biomass/index.html> (07-02-07).

[27] SenterNovem website, Duurzame Energie, DE technieken, Mestvergisting, "Mestvergistingsinstallaties," no date, <http://www.senternovem.nl/duurzameenergie/DE-technieken/mestvergisting/Index.asp> (19-02-07).

Note that all of the abovementioned feedstock would be considered second generation types of bio-energy. At the moment, first generation crops, such as soy and palm oil are still widely used. In Holland, incentives were given by the government to electricity companies that would provide green electricity, such as from biomass. When a number of electric companies decided to import palm oil to use as the feedstock for its green electricity, they received criticism from various environmental groups. The issues related to the use of palm oil as bioenergy are discussed in more detail in chapter 4.

The process of turning biomass into electricity can be done in various ways. The most common practice seems to be through so-called 'anaerobic digestion' in a biogas power plant[28]. This entails the transformation of the biomass, including wood products and animal waste, into methane gas. This gas, in turn, can be transformed into electricity through gas turbines and used in households[29]. The same gas is used for the heating of residential and commercial buildings[30]. It is also possible to burn wood biomass to supply steam for the regular steam-driven generators that are also used for fossil fuels[31].

1.4. Bio-based materials

Biomass can also be used as the basis for a number of chemical products and materials that are currently produced by petroleum. The biomass can be converted in building blocks for a number of consumer goods, such as plastics, solvents, paints, adhesives and drugs[32]. At the moment such plant resources are used in paper manufacturing and as chemical feedstock, but according to the US Department of Energy, the growth potential for other purposes is immense. Bio-based chemical products include paint, ink and lubricants. Figure 2 lists a number of different products that can possibly be made from biomass.

Figuur 1: Some examples of biomass products[33]

Biomass Resource	Uses
Corn	Solvents, pharmaceuticals, adhesives, starch, resins, binder, polymers, cleaners, ethanol
Vegetable Oils	Surfactants in soaps and detergents, pharmaceuticals (inactive ingredients), inks, paints, resins, cosmetics, fatty acids, lubricants, biodiesel
Wood	Paper, building materials, cellulose for fibers and polymers, resins, binders, adhesives, coatings, paints, inks, fatty acids, road and roofing pitch

[28] Wikipedia website, "Anaerobic Digester," no date, http://en.wikipedia.org/wiki/Anaerobic_digester (07-02-07).
[29] Wikipedia website, "Biogas," no date, http://en.wikipedia.org/wiki/Biogas (07-02-07).
[30] Haq, Z., "Biomass for electricity generation," no date, < http://www.eia.doe.gov/oiaf/analysispaper/biomass/index.html> (07-02-07).
[31] Powerscorecard website, "Electricity from: Biomass," no date http://www.powerscorecard.org/tech_detail.cfm?resource_id=1 (07-02-07).
[32] U.S. Department of Energy website, Energy Efficiency and Renewable Energy, Biomass Program, "Products," no date, http://www1.eere.energy.gov/biomass/products.html (07-02-07).
[33] Energetics Incorporated, for the U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, Office of Biomass Program, "Industrial Bioproducts: Today and Tomorrow," July 2003, http://www.brdisolutions.com/pdfs/BioProductsOpportunitiesReportFinal.pdf (07-02-07).

2. Regions

Although bio-energy is used and developed in all regions in the World, there are clear differences in the types and scales of the bio-energy industries on different continents. This chapter looks at the production, processing and uses in various regions per type of bio-energy, citing examples from countries for which data was readily available.

2.1. Latin America

The feedstock for both ethanol and biodiesel is produced in Latin America. In Brazil, ethanol is generally made from sugarcane, and is mostly used for the domestic market. This has been encouraged via government incentives since the 1970s[34]. While numbers on the use of ethanol as transportation fuel differ, it seems to account for approximately 40% of fuel used by passenger cars[35]. This makes Brazil the biggest user of biofuel in the world, both relatively and absolute. It is also the largest exporter of ethanol in the world.

The organisation of sugarcane planters expect that the production of sugarcane for the use of ethanol as fuel will double within the next 10 years, to approximately 31 billion liters[36]. At the moment, the annual production is an estimated 16 billion liters. There are plans to transform grazing grounds into sugarcane fields, and to expand the number of ethanol producing factories.

At the same time Brazil is attempting to develop its biodiesel industry in order to lessen its dependency on foreign oil. Biodiesel plants based on tallow have been built in recent years[37], and subsidies are given for the family production of castor oil. Besides castor, soy will be used as a feedstock[38]. Brazil has set a mandatory standard for 2008, whereby all diesel should include a minimum of 2% biodiesel. It intends to lift this standard to 5% by 2013[39].

In Guatemala, the expenditure on petroleum has risen by 87% since 2002 as consumption levels doubled over the last 10 years[40]. Due to the increase of oil import costs, and the decrease of the agricultural products that it exports, the country has been forced into the development and production of biomass as an energy source. Guatemala has the largest and most fertile area for the production of sugarcane and the highest yield of Central America. The availability of molasses, a sugar cane by-product, would be sufficient in itself for meeting the target of blending gasoline with 10 percent biofuels.

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[34] OECD, Directorate for Food, Agriculture and Fisheries, Committee for Agriculture, “Agricultural Market Impacts of Future Growth in the Production of Biofuels,” February 2006.

[35] “Brazils Booming Agriculture Faces Obstacles,” Amber Waves, November 2006, p.28.

[36] UNCTAD, The Emerging Biofuels Market: Regulatory, Trade and Development Implications, United Nations (2006: New York and Geneva).

[37] “Brazil to Build New Tallow-Based Biodiesel Plant,” Alternative Transportation Fuels Today, November 2005.

[38] “Brazils Booming Agriculture Faces Obstacles,” Amber Waves, November 2006, p.28.

[39] Steenblik, R. (2006), "Liberalisation of Trade in Renewable Energy and Associated Technologies: Biodiesel, Solar Thermal and Geothermal Energy", *OECD Trade and Environment Working Papers*, 2006/1, OECD Publishing. doi:10.1787/358734455580

[40] UNCTAD, The Emerging Biofuels Market: Regulatory, Trade and Development Implications, United Nations (2006: New York and Geneva).

However, there is currently only one ethanol distillery in the entire country. This means that there is massive growth potential in the industry, and this has been noticed by Brazilian investors. Plans exist to develop three more plants, import technology, and to introduce the same flex-fuel cars that are used in Brazil. Biodiesel is not yet produced in Guatemala, but plans exist to develop jatropha plantations, as this crop would do very well in its climate. Projects have also been developed to use wood waste for electricity generation[41].

2.2. Europe

The European Union has general policies both on the use of biomass as a source of electricity and on biofuels. The policy on biofuels is defined in the Directive 2003/30/EC. This directive states that all member countries should introduce legislation and provide a framework to ensure a minimum percentage of biomass in the country's transportation fuel[42]. The goal was for 2% of all transportation fuel sold on the territory of member states is biofuel by December 2005. The goal is to raise this to 5.75% in December 2010. The 2005 goals were not achieved, as EU-wide only 1.4% of fuel was produced from biomass. The EU is now considering turning the indicative targets into law. The scenario envisaged to achieve the 2010 goal is that the EU will produce 50% of its needed biomass and that the other 50% will be imported.

According to the most recent figures found, the EU produced around 2.9 billion litres of biofuels in 2004. By far the largest share is biodiesel, with an estimated 2.3 billion litres in production, which makes the EU the largest producer in the world. Biodiesel in Europe is mostly produced from rapeseed, and its production takes up an estimated 27% of the EU's rapeseed crop. The largest producer of biodiesel is Germany, which produces over half of all biodiesel in Europe. Other countries heavily involved in this type of fuel are France and Italy. According to UNCTAD, biodiesel is only price competitive with oil when oil prices are above $72 a barrel, due to the higher production costs.

Ethanol is mostly produced from locally grown cereal and sugar beet. The production of ethanol is significantly lower than that of biodiesel, with a production of 620 million litres in 2004. This took up 0.4% of the EU's cereals production and 0.8% of sugar beet production. The most important producer of ethanol in the EU is Spain. One explanation for the lower interest in ethanol is the relative high price of sugar in Europe, which makes fuel from this feedstock not competitive with traditional fuel. UNCTAD calculated that bio-ethanol would be competitive at an oil price of $102 a barrel.

The bio-electricity policy was originally created in 2001, when the goal was set that the EU should have 21% renewable energy by 2020[43]. This not only includes electricity from biomass, but also for other renewable sources, such as wind and water power. More than half of the members of the EU were not even close to achieving this goal. Various legislative initiatives have been taken by various member states in order to achieve this goal. Most electricity is generated from wood sources, such as wood residues, timber waste and black liquor, a by-product of paper mills. However, some energy is also generated from imported energy crops, such as soy and palm oil. Finland is the EU's leader is the use of bio-electricity, using 87.1% biomass[44].

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41 International Utility Efficiency Partnership (IUEP) website, "Bio-Gen Power Generation Project Guatemala," http://www.iuep.org/portfolio/bio-gene-power1/execituve.html (07-02-07).

42 UNCTAD, The Emerging Biofuels Market: Regulatory, Trade and Development Implications, United Nations (2006: New York and Geneva).

43 Euractiv website, Energy Policy Section, ËU Renewable Energy Policy," no date, http://www.euractiv.com/en/energy/renewable-energy-eu/article-117536 (07-02-07).

44 Greenprices website, Europe, News, "Solid Biomass Production in Europe Increased Markedly," no date, http://www.greenprices.com/eu/newsletter/GPBE_34_061220/Barometer.asp (07-02-07).

2.3. United States

Biofuels have become a hot topic in political debates in the United States recently. It has received a lot of attention, mostly due to the fact that the issue was mentioned in the last two State of the Union speeches by president Bush. In 2006, the total production of biofuel was approximately 5 billion litres, and Bush aims to increase this to 35 billion litres in 2017.

The most prominent type of bio-energy in the United States is ethanol. The 3.4 billion litres of ethanol that was blended with gasoline in 2004 entailed 99% of all biofuel usage in the US, and the equivalent of 2% of all transportation fuel[45]. The ethanol used in the US is mostly produced from maize, and took up 14.4% of the maize crop[46]. However, maize is not the ideal feedstock, as it needs more CO2 input to produce and has a relatively low energy balance. In fact, there has been extensive debate around the net output of maize-based ethanol, with various scientists claiming that it needs more energy input than it generates output[47]. Another main feedstock is sugar cane, but this type of biofuel is mostly imported from Brazil. However, the US government has set up a number of protective measures, including a tariff of $0.50 per liter of imported ethanol[48]. At the moment there are 101 ethanol plants in the country, all owned by private companies. The top five companies account for 30% of all ethanol production, with most of the crops coming from the Midwest region.

Biodiesel use is still minimal relative to ethanol, but its use has more than tripled from 94.5 million litres in 2004 to 283 million litres in 2005. According to the McGraw Hill market report, these figures have risen to 400 million liters in 2006, and are expected to reach to 1.2 billion in 2008[49]. Two types of biodiesel used in the US can be distinguished; biodiesel made from vegetable oils, such as soy and canola oil, and also from recycled grease. While the increase in use of biodiesel is remarkable, it does not seem likely that biodiesel will eventually become a substitute for regular diesel. This is partially due to the high production costs of soy, and the limited availability of recycled grease from restaurants.

The US government has encouraged the production of bio-electricity through tax based incentives. Most biomass power plants are independent, commercial energy providers, rather than government owned utilities. Most electricity is generated through conversion of wood waste and municipal solid waste products, but it is also generated from landfill gasses. In the US, biomass is the biggest source of renewable energy in use today[50]. Interestingly, it seems that no biomass is imported for the generation of electricity, in contrast with the current situation in the EU.

2.4. South East Asia

South East Asia has very high production rates for palm oil, which is grown in large plantations in Malaysia and Indonesia. Palm oil is mostly used in various food products, but can also be the feedstock for biodiesel. Consequently, the attention in South East Asia is much more on biodiesel than it is on ethanol. In 2005 Malaysia developed its first biodiesel refinery that uses this crop as its

[45] A. Farrell, R. Plevin, B. Turner, A. Jones, M. O'Hare & D. Kammen, Ethanol Can Contribute to Energy and Environmental Goals, Ethanol Science, 27-01-06.
[46] UNCTAD, The Emerging Biofuels Market: Regulatory, Trade and Development Implications, United Nations (2006: New York and Geneva).
[47] Grist website, "The Balancing Act," 05-12-06, http://grist.org/news/maindish/2006/12/05/olmstead/index1.html (07-02-07).
[48] "Ambitieus plan VS voor bio-ethanol," NRC Handelsblad, 27-02-07, Sec. Economie, p.12.
[49] J. Agnese & C. Wood, Booming Grain Prices Hit Beef, Pork Producers, (December 2006: McGraw-Hill, Agribusiness)
[50] U.S. Department of Energy website, Energy Efficiency and Renewable Energy, Biomass Program, "Biomass Today," no date, http://www1.eere.energy.gov/biomass/biomass_today.html (07-02-07).

feedstock[51]. The biodiesel will not be used domestically, but is only exported to western countries. One minister explained that, at that time, the existing infrastructure of the Malay oil companies was not sufficient for blending with biodiesel. Most of the biodiesel will be exported to Germany. A more recent development saw the Malay government mandating the use of diesel that is at least 5% blended with biodiesel.

Indonesia is also an important producer of palm oil, and therefore seems to be in a similar situation as Malaysia. In fact, Malaysia and Indonesia mutually agreed to allocate 40% of their palm oil production for use in biofuels[52]. The government estimates that 6 million tons of crude palm oil will be used for biodiesel in the next year. This has attracted a number of foreign investors that partner with the large palm plantations for the production of biodiesel. The latest development, in 2007, has been a partnership between China National Offshore Oil Company and an Indonesian palm oil producer in an investment of $5.5 billion[53]. Domestically, it aims to have 10% of all transportation fuels to be biofuel by 2010[54].

The Philippines is one of the countries in the region that is more actively pursuing the use of biofuels domestically. According to UNCTAD, this is a means to increase fuel self-dependency, environmental stewardship and economic development[55]. The Philippines uses mostly coconut oil and jatropha for its biodiesel, and sugar cane for the production of ethanol. All gasoline needs to be blended with 5% ethanol in 2007, as mandated by the president.

Box 2

Jatropha

Currently the oil from *Jatropha curcas* seeds is widely used for making biodiesel fuel in India, and is being promoted as an easily grown biofuel crop in hundreds of projects throughout India and the third world. The rail line between Mumbai and Delhi is planted with Jatropha and the train itself runs on 15-20% biodiesel.
The plant can grow in wastelands, and it yields more than four times as much fuel per hectare as soybean, and more than ten times that of corn. A hectare of jatropha produces 1,892 liters of fuel. Also Jatropha is a one-stage conversion to biodiesel.

2.5. Africa

In Africa, most focus is on the production of ethanol, although the interest in biodiesel seem to be growing. In particular, the development of jatropha as a feedstock has gained much interest over recent years. Jatropha is a crop that fares very well in the dry and arid regions in Africa that are unsuitable for the production of other crops. No reports were found of electricity plants based on biomass, but biofuel is used in villages as the fuel for diesel power generators[56].

[51] Green Car Congress website, "Malaysia Building First Biodiesel Refinery," 24-04-05, http://www.greencarcongress.com/2005/04/malaysia_buildi.html (07-02-07).
[52] Green Car Congress website, "Malaysia and Indonesia Set Aside 40% of Palm Oil Crop for Biodiesel Production," 21-07-06, http://www.greencarcongress.com/2006/07/malaysia_and_in.html (07-02-07).
[53] Green Car Congress website, "Indonesia the Focus of Massive $12.4 Billion in Biofuels Investments: Signing Ceremony in Jakarta, 09-01-07, http://www.greencarcongress.com/2007/01/indonesia_the_f.html (07-02-07).
[54] Green Car Congress website, "Indonesia Targets 10% Biofuel Use in 2010," 24-07-06, http://www.greencarcongress.com/2006/07/indonesia_targe.html (07-02-07).
[55] UNCTAD, The Emerging Biofuels Market: Regulatory, Trade and Development Implications, United Nations (2006: New York and Geneva).
[56] UNCTAD, Challengens and Opportunities for Developing Countries in Producing Biofuels, (2006: United Nations).

South Africa is one of the few African countries that is actively attempting to develop its domestic biofuel market. At the moment, the biofuel consumption is mostly accounted for by ethanol, with a production of 390 million litres in 2005. Ethanol is mostly produced from sugar cane, but also from sweet sorghum and maize[57]. The government is currently in the process of mandating an 8% blending of ethanol with oil based fuels for all transportation[58].

No figures were found on the production and consumption of biodiesel. It seems that biodiesel is not as widely used as ethanol, but the country is in the process of further developments. The main feedstock used in South Africa is soy, and the use of jatropha as feedstock has stirred some debate. As jatropha is not a crop native to South Africa, there were fears of the environmental impacts that the introduction of this crop would have[59]. Although it is not certain whether the issue has been completely solved, it does seem that the South African government is open for jatropha in order to increase domestic biofuel production.

Malawi has a longstanding ethanol program that started in 1982. However, it only recently opened its second distillery, which indicates that the volume of ethanol produced has not been very large[60]. As in South Africa, the most important ethanol crop in Malawi is sugar cane. Malawi is very active in the development of technologies that would increase the domestic use of ethanol. One notable example of this is the development of a car engine that can run on 100% ethanol[61].

Malawi grows large amounts of jatropha for the use in biodiesel. At the moment, an estimated 200,000 hectares of arable land is used for jatropha in Malawi, most of which was previously used for the growth of tobacco[62]. Interestingly, the most important player in this recent surge in jatropha production is the British private company D-1 oils. This biodiesel processing company has leased land and trees to farmers for the production of the crop and encourages the use of land that is not suitable for other crops[63].

[57] UNCTAD, The Emerging Biofuels Market: Regulatory, Trade and Development Implications, United Nations (2006: New York and Geneva).

[58] Department of Minerals and Energy, Communications Chief Directorate, Draft Biofuels Industry Strategy, Press Release, 14-12-06, http://www.dme.gov.za/pdfs/media_release/Media_release_biofuels.pdf (07-02-07).

[59] Business Report website, News, “Plans to Bring Biodiesel to SA Brings Traction,” 29-05-05, http://www.busrep.co.za/index.php?fSectionId=561&fSetId=304&fArticleId=2537729 (07-02-07).

[60] UNCTAD, The Emerging Biofuels Market: Regulatory, Trade and Development Implications, United Nations (2006: New York and Geneva).

[61] OneWorld website, “Malawi Test Groene Auto,” 10-01-07), http://www.oneworld.nl/index.php?articleId=9909&articleType=Nieuwsartikel&page=1 (07-02-07).

[62] Biofuelwatch, Country Study 1: Green Gold for Southern Africa? Jatropha Plantations in Malawi and Zambia, no date, < http://www.biofuelwatch.org.uk/background4.php> (07-02-07).

[63] UNCTAD, The Emerging Biofuels Market: Regulatory, Trade and Development Implications, United Nations (2006: New York and Geneva).

3. Companies

The companies interested in bio-energy come from various sectors, such as agribusiness, processed foods, chemicals and petrol. An important aspect of this interest will probably be the expected economical potential of this emerging sector. Also, there are still a large number of smaller companies active, mostly in the refining process. They have not yet had to face the fierce competition of larger players. This fact makes the sector very interesting to look at, as it is unavoidable that a consolidation of players will take place in the near future, due to such factors as economies of scale, competition, vertical integration and strategic alliances.

No information was readily available on the scale of companies on a global level. Data was available for specific regions and countries, but this was slightly outdated. As it seems that the market has changed and developed very rapidly in the last few years, any information that is slightly older can only serve as an indication of the current situation. In 2002, the top four biodiesel producers in Europe were all subsidiaries of either Archer Daniels Midland (ADM) or Bunge, both large agribusiness multinationals[64]. In the United States, ADM is also the largest player in the ethanol and the biodiesel market.

3.1. Archer Daniels Midland

Together with Cargill and Bunge, Archer Daniels Midland (ADM) is one of the three largest agricultural companies in the world. The company is a worldwide leader in procuring, transporting, storing, processing and merchandising of agricultural commodities and products[65]. The company is divided in four segments; oilseed processing; corn processing; other food & feed ingredients; and agricultural services.

The oilseeds processing segment entails the processing of soybeans, rapeseed, palm oil and canola. The unrefined, crude vegetable oil is used in the production of biodiesel. The increasing demand for biodiesel has turned ADM's attention to the European market. It owns numerous oilseed crushing facilities, including a multi-seed crushing facility that is to open in The Netherlands in 2007[66]. It is also the largest producer of biodiesel in Germany, the largest biodiesel market in Europe, where it owns two biodiesel refining plants[67]. It recently announced its plans to also open a biodiesel refinery in the United States[68]

Within the corn processing segment, one of ADMs activities is the production of ethanol, besides producing for the food and feed industry. ADM is mostly involved in the ethanol industry in the United States, where it accounts for 40% of all ethanol used as fuel[69]. In 2005, ADM owned seven ethanol

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64 Market Share Reporter, Major Biodiesel Producers in Europe 2002, 2005.
65 Archer Daniels Midland, SEC filling, Form 10K, 2006.
66 "ADM Announces Plan to Add Rapeseed Crushing Capacity in The Netherlands," PR Newswire, 08-02-06.
67 Biodiesel website, Company, "Archer Daniels Midland Company (ADM)," no date, http://www.biodiesel.de/index.php3?hid=019&spid=2 (07-02-07).
68 State of North Dakota website, Office of the Governor, News Center, "Hoeven Announces New ADM Biodiesel Plant in Velva," 04-10-05, http://governor.nd.gov/media/news-releases/2005/10/051004a.html (07-02-07).
69 The Straight Dope website, "What's the True Story on Ethanol?," 28-11-03, http://www.straightdope.com/columns/031128.html (07-02-07).

refining plants in the United States alone[70], and it has announced an expansion with two more. The ethanol that ADM produces is almost exclusively from corn. The company is involved in two government funded projects to convert corn fibres into ethanol. Many of ADM's activities in the bio-energy sector are heavily subsidized[71].

3.2. Dupont

Dupont is a large and diversified science and technology company. It mostly focuses on the development of a wide variety of chemicals used in products for the automotive, agricultural, medical and electronic industries[72]. The company works in five fields: electronic and communication technologies; performance materials; coatings and colour technologies; safety and protection; and agriculture and nutrition[73]. After recent restructuring, the company's main focus is on biotechnology and safety and protection.

Last March, Dupont issued a press release in which it states its intentions within the biofuel industry[74]. John Raneiri, the Vice President, lists three fields of focus for the company. First of all, Dupont is involved in the production of genetically modified seeds designed to be used as ethanol. Through its subsidiary Pioneer Hi-Bred International, Inc. it owns the patent to more than 135 seed hybrids, that 'have special grain traits that improve the efficiency of the ethanol'. At the same time, Dupont is also developing a number of 'crop protection solutions', such as pesticides and fertilizers to this same end. It is not clear to what extent these are new developments specifically aimed at the bio-energy market, rather than a marketing approach of existing technologies.

Secondly, Dupont jointly funds, together with the US Department of Energy, a research program that attempts to develop technology to convert cellulosic material, such as corn stover, into biofuel[75]. This *BioRefinery* program would increase the amount of ethanol that could be produced per acre of corn as it would use leftovers from food harvests. One of the technologies that has been developed in this program makes use of a micro-organism that is usually found on the agave, a plant used in Mexico to produce tequila.

The third activity Dupont is involved in is a partnership with British Petroleum for the development of so-called bio-butanol, a second generation biofuel. Dupont will focus on the biotechnology and manufacturing aspects of the production, while BP focuses on the fuel technology. Biobutanol is said to be easier to blend with regular gasoline than first generation ethanol. It is expected to be introduced on the UK market first in 2007.

3.3. Royal Dutch Shell

Royal Dutch Shell is one of the largest companies in the world. It's a vertically integrated petroleum company, dealing with the exploration, production, transportation, refining and trading of oil. Besides

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[70] Renewable Fuels Association, From Niche to Nation: Ethanol Industry Outlook 2006, February 2006.

[71] Corpwatch website, "Green Fuel's Dirty Secrets," June 1st, 2006, http://www.corpwatch.org/article.php?id=13646 (21-02-07).

[72] Hoovers website, "E.I. du Pont de Nemours and Company," no date, http://www.hoovers.com/dupont/--ID__10487--/free-co-factsheet.xhtml (07-02-07).

[73] Wikipedia website, "DuPont" no date, http://en.wikipedia.org/wiki/DuPont (07-02-07).

[74] DuPont website, Media Center, News Releases, "Dupont Leader Outline's Company's Biofuels Growth Plans," 03-10-06, http://vocuspr.vocus.com/VocusPR30/Newsroom/Query.aspx?SiteName=DupontNew&Entity=PRAsset&SF_PRAsset_PRAssetID_EQ=103347&XSL=PressRelease&Cache=False (07-02-07).

[75] Dupont website, Government, News & Events, "News," 17-07-06, http://www2.dupont.com/Government/en_US/news_events/article20060717.html (07-02-07).

oil, Shell also trades in natural gas and chemicals, as well as the research and development of a number of renewable fuels. In total, it has five core areas of business; exploration and production; gas and power; downstream; chemicals; and trading and shipping[76].

Shell claims to be the largest distributor of biofuels in the world. According to its website, it sold 3 billion litres of biofuel in 2005, mostly in Brazil and the United States. This indicates that the large part of its operations are in ethanol, rather than biodiesel. It is also active in a number of European countries, Australia, The Philippines and Thailand[77]. Within Shell there seems to be an internal dispute regarding a comment made by one of its directors that the use of food crops for biofuels, as is the case in first generation biofuels, is morally unacceptable[78]. Shell later had to restate this comment[79].

In 2002 Shell initiated a partnership with the Canadian technology company Logen. This partnership was set up to develop the technology to produce cellulosic ethanol from straws through the use of enzymes. A demonstration plant was developed in 2004, but commercially available ethanol is not expected until 2009. This ethanol partnership seems to be extending, as the two companies are now in collaboration with Volkswagen to extend the market into Germany.

Also in Germany, Shell is active in a collaboration with Choren, in an attempt to construct 'the world's first commercial Biomass to Liquid (BTL) plant'[80]. This plant would also use second generation technology to convert wood chips and other feedstock into gas and finally into biodiesel. Shell has provided its knowledge in the last step to convert gas to liquid. The plant is expected to produce 15,000 tonnes of biodiesel per year[81].

[76] Wikipedia website, "Royal Dutch Shell," no date, http://en.wikipedia.org/wiki/Royal_Dutch_Shell (07-02-07).
[77] R-Squared Energy Blog website, "Who Supplies the Most Biofuel?," 16-11-06, http://i-r-squared.blogspot.com/2006/11/who-supplies-most-biofuel.html (07-02-07).
[78] Planet Ark website, "Shell Says Biofuels from Food Crops Morally Inappropriate," 07-07-06, http://www.planetark.org/dailynewsstory.cfm/newsid/37152/story.htm (07-02-07).
[79] Planet Ark website, "INTERVIEW- Shell Plans Cleaner Second Generation of Biofuels," 10-07-06, <http://www.planetark.org/avantgo/dailynewsstory.cfm?newsid=37164> (21-02-07).
[80] Shell website, About Shell, "Biofuels," no date, http://www.shell.com/home/Framework?siteId=aboutshell-en&FC2=&FC3=/aboutshell-en/html/iwgen/what_we_do/refining_selling/biofuels_17112006.html (07-02-07).
[81] The Energy Blog website, "Shell Invests in Choren BTL Technology," 28-08-05, http://thefraserdomain.typepad.com/energy/2005/08/shell_investmen.html (07-02-07).

4. Issues

The recent interest in bio-energy has been spurred by such factors as increased awareness of the role of fossil fuel consumption in climate change and sky rocketing oil prices. Many see development of a bio-energy sector as crucial to tackle some of these issues. However the debate over the legitimacy of this reasoning has just started. For one, as mentioned earlier, industrial large scale farming of feedstock for biofuels, for instance soy and palm oil, is known to have adverse impacts on the social-economical and ecological condition in southern producing countries. The recognition of these problems has also lead to a number of CSR initiatives. Below is a description of the discussion surrounding these issues and initiatives.

4.1. Environmental

Perhaps the most widely debated effects of the use of bio-energy are those related to the environment. The concern regarding the effects of CO2 emissions from transportation and electricity on global warming has urged the search for alternative energy sources. As mentioned in the introduction, one of the reasons for the recent interest in bio-energy is the attempt to decrease the CO2 levels caused by human activities. It is argued that there is no net increase when using bio-energy, as all the CO2 released from the burning of biomass has been recently extracted from the atmosphere. This is not the case for fossil fuels, as its CO2 has been stored for millions of years.

However, the lower CO2 emissions from bio-energy is at the centre of a fierce debate. There are multiple scholars and civil society organisations who claim that the cultivation, processing and distribution of bio-energy require a significant amount of CO2 that also needs to be taken into account[82]. The use of agricultural machinery, fertilizers and pesticides, as well as fuel used during the transformation from feedstock to fuel and its transportation all have negative effects on the total environmental benefit. In some cases, such as in the production of ethanol from corn in the United States, a scientific debate erupted about whether the total input and output of energy resulted in a net energy increase or decrease[83].

CO2 emissions is one of the major environmental issues that play a role in the production of palm oil, a crop also used for biofuel. The peatlands that are used for the plantation of oil palms are drained, and suffer annual fires. These peatlands contain a major source of CO2, that is released when these lands are drained or burned[84]. In fact, the amount of CO2 emmitted during the 1997-8 forest and peatland fires in Indonesia are estimated to be equivalent of 40% of all CO2 created by global transportation. Such fires are but one technique in which rainforests in South East Asia, as well as in South America, are cleared to make way for large oil palm and sugar cane plantations. With an increase in demand for bio-energy and the consequent increase in imports, it is likely that more rainforest will make way for the cultivation of feedstock such as sugar cane, soy and palm oil[85].

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[82] T. Juniper, “Fueling the Crisis,” The Guardian, 26-01-07.

[83] See for example “New Study Questions Energy Balance of Ethanol, Biodiesel,” Alternative Transportation Fuels Today, 25-07-05 & A. Farrell, R. Plevin, B. Turner, A. Jones, M. O’Hare & D. Kammen, Ethanol Can Contribute to Energy and Environmental Goals, Ethanol Science, 27-01-06.

[84] Palm Oil Is Not Green, Reproduced from Down to Earth: International Campaign for Ecological Justice in Indonesia, Newsletter No. 17, November 2006.

[85] European Environmental Bureau, Birdlife International & European Federation for Transport and Environment, Fueling Extinction? Unsustainable Biofuels Threaten the Environment, Press Release, 07-06-06.

Another serious negative consequence of the transformation of rainforests into monoculture plantations is the loss of wildlife and biodiversity. For instance, the increase in cultivation of oil palms in South East Asia has been linked with the decrease in numbers of orang-utans, already an endangered species. The case has also been made that intensive agriculture and the consequent loss of habitat has been partially responsible for the loss of bird and mammal life in Europe and the UK. Birdlife International states its concern regarding the loss of set-aside agricultural land that is vital for the European biodiversity[86]. In the US farmers opt for reduced biodiversity as well by changing their annual corn-soybean rotations to only corn[87]. In Brazil, the expansion of the sugar cane-based ethanol and soy production is a threat to areas rich in biodiversity, such as the Cerrado and the Amazon[88].

While some of the most important environmental issues can be related to the cultivation of soy and oil palms, there seem to be a number of environmental benefits to the so-called second generation biofuels. Examples of positive second generation techniques are the use of wood residues and waste for the generation of electricity[89]. The benefits include a reduction of emissions, a better use of limited resources, a better protection of habitat and landscape and a reduction and improvement of waste management. It should be noted that this relates only to locally produced electricity from second generation feedstock. However, this could mean that the development of second generation bio-energy has some major positive effects, while it also avoids some of the issues that are currently affecting the sustainability of bio-energy. Whether these positive effects only relate to small-scale production and whether production on a larger scale is still sustainable is something that needs to be further investigated.

4.2. Socio-economic and labour issues

The use of soy, sugar cane and palm oil as feedstock for bio-energy does not only create environmental hazards, but can have a number of adverse socio-economic effects as well. Most media attention is given to the consequences of the replacement of food agriculture with fuel agriculture. Without a change in food distribution, this can lead to more pressing issues of food insecurity for a large number of people.

Through campaigns by NGOs and other organisations, a lot of attention has been given to the effects of large plantations in South America and South East Asia on its indigenous people. For example, the Enawene Nawe Indians, in the Brazilian region of Matto Grosso, have seen large areas of their assigned land cleared to make space for soy plantations[90]. Plans also exist to build a large hydro-electric dam in this region, in order to provide energy to the plantations. A similar story emerges in Indonesia, where the development of oil palm plantations in the border region of Kalimantan has threatened the traditional livelihood of the Dayak tribe[91]. Large companies have deforested large areas and annihilated the customary rights land. Other issues that the indigenous tribes are faced with are increased food insecurity and deaths by malnutrition due to the expulsion from their farms or forests, pollution of fishing and drinking waters and displacement issues, such as urban poverty[92].

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86 Idem

87 J. Olmstead, "What about the Land? A Look at the Impacts of Biofuels Production in the US and the World," 05-12-06, http://grist.org/news/maindish/2006/12/05/olmstead/ (07-02-07).

88 CREM, Dutch Imports of Biomass: Producing Countries'Point of View on the Sustainability of Biomass Exports, November 2006 http://www.bothends.org/strategic/061211_Dutch%20import%20of%20biomass.pdf (07-02-07).

89 R. Sims & K. Richards, "Bioenergy for the Global Community," Renewable Energy World, January-February 2004.

90 Survival International website, "Brazil: 'Soya Is Killing Us' Says Amazon Tribe," 06-03-06, http://www.survival-international.org/news.php?id=1415 (07-02-07).

91 AIDEnvironment, The Kalimantan Border Oil Palm Mega-Project, April 2006.

92 S. van der Wal, Quick Scan Bunge, Somo, March 2006.

The destruction of the land, and the displacement of the indigenous tribes has caused a number of violent conflicts between the tribes and the plantation owners or the authorities. Many of these tribes are unaware of the Presidential Regulation allowing the government to clear any assigned piece of land out of 'public interest'. In practice, this gives the government the power to use military force to back the development of plantations in the habitat of indigenous tribes[93]. A report by Friends of the Earth International points out the very limited legal protection of these tribes and their vulnerability to abuse and suppression[94]. For instance when protesting against clearances in their native lands the Dayak tribe in Indonesia has seen two members arrested as they confiscated logging machinery. Mention has been made about deadly conflicts between farmers and Indians in the state of Matto Grosso in Brazil as well[95].

Research by the NGO Sawitwatch in Indonesia has looked at the effects of the expansion of the palm oil industry on local peasants and indigenous tribes[96]. It shows that the customary rights of the indigenous people, that are weakly protected by law, are under threat of policies made in the name of 'national interest'. Most of these policies favour the interests of large plantations, interests that are often in direct conflict with the needs and customs of the local people. The report makes points out that the indigenous people believe that they were lured into signing agreements, under false pretentions that stripped them of their land rights. Any protest or opposition is violently crushed down, leading to a large number of examples of human right violations.

The increasing volume of crops used for bio-energy also leads to a number of labour issues. At first this new industry seems to have a positive effect on job availability, as many new jobs are created in the process. In developing countries jobs are created at plantations for the production and processing, while developed countries will see extra jobs in research and development and often in the agriculture sector transforming from food to fuel. Researchers have calculated that the expected increase in ethanol production in Brazil over the next 20 years will give an economic boost to the GDP of 11,4% and create an estimated 5 million jobs[97]. Another important consequence is that most of the bio-energy jobs will be created in rural areas, thereby slowing down the process of urbanisation that is occurring in many developing nations. However, other academics have pointed out the loss of labour due to the increased mechanisation of production[98].

However, job creation in itself does not tell the whole story. Workers at plantations used for bio-energy can be vulnerable to very poor labour conditions. Often they have no choice but to accept low wages, long working hours and a hazardous working environment. In the soy plantations in the Amazon, often owned or directly linked to large agribusiness multinationals, child and bonded labour is occurring[99]. As these plantations are often in the middle of the jungle, workers have no choice but to accept poor

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93 AIDEnvironment, The Kalimantan Border Oil Palm Mega-Project, April 2006.

94 E. Wakker, Greasy Palms: The Social and Ecological Impacts of Large-Scale Oil Palm Plantation Development in Southeast Asia, Friends of the Earth, March 2004.

95 Truth Out website, Environment, "Tractors Crush Heart of a Nation," 10-07-05, http://www.truthout.org/cgi-bin/artman/exec/view.cgi/34/12556 (07-02-07).

96 M. Colchester, N. Jiwan, A. Siriat, A. Firdaus, A. Surambo & H. Pane, Palm Oil and Land Acquisition in Indonesia: Implications for Local Communities and Indigenous Peoples, Sawit Watch, no date, http://www.sawitwatch.or.id/index.php?option=com_content&task=view&id=45&Itemid=1 (07-02-07).

97 Scaramucci. J. A. and Cunha, M. P. (2006), "Bioethanol as basis for regional development in Brazil: an input-output model with mixed technologies". Presented at the International Conference on Policy Modeling (EcoMod2006), Hong Kong, June 28-30.

98 B. Wicke (2006), "The Socio-Economic Impacts of Large-Scale Land Use Change and Export-Oriented Bio-Energy Production in Argentina: Quantifying the Direct, Indirect and Induced Impacts of Agricultural Intensification and Bio-Energy Production with Input-Output Analysis". MSc. Thesis, Copernicus Institute, The Netherlands.

99 Greenpeace, Eating Up the Amazon, April 2006, <http://www.greenpeace.org/raw/content/international/press/reports/eating-up-the-amazon.pdf> (21-02-07).

housing and pay exuberant prices for their food. Friends of the Earth International mentions similar issues in the oil palm plantations in South East Asia, including low wages, illegal migrant labour, health hazards and housing issues[100].

4.3. Trade

At the moment global biofuel trade is still limited, with only significant amounts of intra-European trade in feedstock such as wood between Baltic and Scandinavian countries[101]. Currently, most bio-energy is produced locally, but a number of factors indicate that trade will increase within the next few years. First of all, the demand for bio-energy will likely increase in developed countries. Secondly, bio-energy can be produced more cheaply in the developing world, due to better climate conditions and lower working wages. This will likely lead to a larger dependency on imports in the United States and Europe.

There have already been a number of incidents and developments that are related to bio-energy trade. The EU has been in legal conflict with Guatemala and Pakistan, accusing them of dumping ethanol on the European markets. Due to lower tariff rates for both countries, their ethanol producers saw chance of exporting cheap ethanol to Europe. This caused a decrease in the price of ethanol in Europe, which caused problems for the local European ethanol producers.

The palm oil industry has been accused of purposely keeping the price of the crop low by the constant massive promotion of palm oil[102]. This is done in order for the trader to be able to compete with soy, but has negative consequences further down the chain. The producers of palm oil are not able to switch to other crops when palm oil prices are low, as the crop is perennial. The promotion of oil palm plantations in the developing world, including for the use as bio-energy, will mostly benefit the developed world. They will receive a constant supply of palm oil, while the fluctuation of prices will produce economic risks for the farmers, as well as the plantation workers, in the developing world.

The so-called 'tortilla crisis' in Mexico is an indirect consequence of the growth of the bio-energy sector. The sudden rise in corn prices in Mexico has led to a 60% price increase in the cost of tortillas which led to large demonstrations in Mexico city. The price increase can be traced back to the increased demand for corn as feedstock for ethanol in the United States, while that country has taken protective measures to keep foreign ethanol out. This has led to lower exports of corn to Mexico, while this country has been more and more dependant on cheaper subsidised corn imports due to the trade agreements from the 1990s[103]. The country now faces a shortage of food as it no longer produces sufficient amounts of corn locally.

While trade in biofuel is limited at present, expectations have arisen that this will increase greatly in the near future, due to the lower production costs of biofuel in developing countries[104], and the increasing demand from the developed world. As the developed nations are looking to expand their

[100] E. Wakker, Greasy Palms: The Social and Ecological Impacts of Large-Scale Oil Palm Plantation Development in Southeast Asia, Friends of the Earth, March 2004.

[101] Steenblik, R. (2006), "Liberalisation of Trade in Renewable Energy and Associated Technologies: Biodiesel, Solar Thermal and Geothermal Energy", *OECD Trade and Environment Working Papers*, 2006/1, OECD Publishing. doi:10.1787/358734455580

[102] World Rainforest Movement, the Bitter Fruit of Oil Palm: Dispossession and Deforestation, August 2001.

[103] C. Zoon, "Mexico Kan Zichzelf Niet Meer te Eten Geven," De Volkskrant, 01-02-07, http://www.volkskrant.nl/buitenland/article393038.ece/Mexico_kan_zichzelf_niet_meer_te_eten_geven (07-02-07).

[104] B. Wicke, The Socio-Economic Impacts of Large-Scale Land Use Change and Export-Oriented Bio-Energy Production in Argentina: Quantifying the Direct, Indirect and Induced Impacts of Agricultural Intensification and Bio-Energy Production with Input-Output Analysis, MSc. Thesis, Copernicus Institute, August 2006.

use of alternative fuels for the various reasons, the prospect is that they will be more reliant on imports from developing countries[105]. With a more global trade, it is likely that there will be some major players in control, and the question comes up who will profit from this trade. As agricultural products such as soy and palm oil are already traded heavily for food and feed purposes, it can be expected that some of the same names will control the biofuel trade, while the large oil multinationals will also take part. The question arises to what extent such developments will be beneficial to the developing countries where the crops are grown.

4.4. CSR initiatives

The growth of the bio-energy industry has lead to increased interest in CSR issues in this sector. Various stakeholders have set up initiatives and projects in order to address the critical issues of this sector. These initiatives have come from government bodies, the large corporations that are involved in this sector, and also from various civil society organisations.

The Roundtable on Sustainable Palm Oil (RSPO) is a multi-stakeholder initiative of agribusinesses, retailers and NGOs that seek to promote the growth and use of sustainable palm oil. A similar initiative exists for sustainable soy, the Roundtable on Sustainable Soy. Both initiatives attempt to stimulate the sustainability through cooperation throughout the supply chain and an open dialogue with its stakeholders. It should be noted that these are broad sectoral initiatives and not exlusive initiatives for the bio-energy sector as such. In addition, it is not clear whether producers that grow crops specifically for the bio-energy market are involved in the initiatives. Further research is needed to identify possible bio-energy crop producers, their relative size and their participation in CSR initiatives. It should be mentioned that the effectiveness and legitimacy of these initiatives is seriously doubted by NGO's.

There are two cases of electricity companies that have had to act on concerns regarding the sustainability of their feedstock. In both cases, with NPower in the UK and Essent in The Netherlands, the feedstock was palm oil, and in both cases the company decided to no longer provide electricity from this source. In the case of Npower, the issue of deforestation in South East Asia was cause for the company itself to cancel the plans to use this crop[106]. In the case of Essent, the company was criticized by the Dutch Advertising Code for unjustly labelling its palm oil-based bio-energy as 'sustainable energy', because of deforestation and human rights issues. Essent decided to temporarily suspend its palm oil activities and initiate research that should lead to an international system of certification[107].

The European Union has set up the European Commission's Biomass Action Plan in 2005. This plan calls for a requirement by which 'through a system of certificates, only biofuels whose cultivation complies with minimum sustainability standards will count towards the targets'[108]. The targets refer to those set in the EU Directive on biomass that determine the market share of biofuels as a percentage of the total transportation fuels. The certificates would count both for domestically produced biofuels and imports. It is hoped that this will indirectly lead to an improvement of the import quality, as traders in non-certified biofuels would find it difficult to sell their product.

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[105] "Biofuels on the Rise but Questions Remain," Designerdiesel, March 2006, p. 25-26.

[106] Palm Oil Is Not Green, Reproduced from Down to Earth: International Campaign for Ecological Justice in Indonesia, Newsletter No. 17, November 2006.

[107] "Even geen Palmolie bij Essent," NRC Handelsblad, 14-12-06.

[108] Steenblik, R. (2006), "Liberalisation of Trade in Renewable Energy and Associated Technologies: Biodiesel, Solar Thermal and Geothermal Energy", *OECD Trade and Environment Working Papers*, 2006/1, OECD Publishing. doi:10.1787/358734455580

5. Conclusions

Although the time span of this research was limited, the report gives an overview of the sector and lists a number of issues that the sector is faced with. The bio-energy sector is a relatively young but rapidly growing sector. It is a diverse sector as there is a large variety of types of feedstock, production methods and uses. While bio-energy crops are produced and used worldwide there are clear differences between different regions. Ethanol seems to be the most popular type in the Americas, while Europe focuses more on biodiesel and electricity generated from biomass. At the moment trade in biomass is still limited, and most bio-energy is produced locally. Due to the rapid developments in this sector, research on the market and its critical issues will quickly be outdated. For a good overview of the sector, research therefore needs to be kept up to date and often renewed.

Trade in biomass is limited, yet growing, but there have already been some issues and conflicts in the sector that are trade-related. As the trade in biomass is expected to increase, it is likely that more issues will come up that are comparable to the issues mentioned in this research. These issues will not only relate to the crops that are directly used for bio-energy, but also the indirect effects on the trade in food crops. Another outlook is that as the sector matures, a consolidation of players will occur that is likely to eventually create an oligarchy of the large companies involved. It is suggested that more complete research is conducted to identify the global leaders and the changes in their market shares over the next few years. A next step would be to analyze money flows, lobbying power and the benefits and downsides of such trading regimes on developing countries.

The sector is faced with a number of environmental and socio-economic issues, especially in the developing world. These issues are in conflict with the image that is portrayed of bio-energy as a sustainable source of energy. Only when these issues are addressed, can bio-energy become a good alternative to fossil fuels. The initiatives to develop sustainability certification systems seem to be a good development, but caution is needed here as well. It needs to be assured that all stakeholders, including populations in the developing world, are involved in the process of developing the criteria. Other critical issues include whether such regulations would be binding or voluntary, whether there will be independent monitoring, and what issues will be considered.

The development of second generation bio-energy seems to be a positive one. While crops such as soy and palm oil need large monoculture plantations, this is not the case for wood residues and municipal waste. When energy can be extracted from straws and other leftover from food crops, such as corn, this could also lessen the conflict of the replacement of food agriculture with energy agriculture. However, second generation feedstock for bio-energy is currently used and produced on a limited scale. That might be the reason why it isn't faced with as many problems as the production of first generation crops. If large scale supply of second generation feedstock is possible at all, it is uncertain whether this could still be done sustainably. This is also a field that requires further research.

In all, it seems that while there are some benefits to bio-energy as compared to fossil fuels, it is unlikely that it will become a sustainable replacement. Without a reduction in the quantity of energy consumed, no alternative will be truly sustainable.

Future (SOMO) research could focus on the following issues and questions:

- Updates of existing research: due to the rapid developments in this sector, research will quickly be outdated.

- The large players: identification of the market leaders, their behaviour, political influence and CSR policies.
- Benefits for developing countries: the increasing importance of bio-energy could potentially have beneficial effects for developing countries. These opportunities should be identified and critically analysed.
- Producers: who are the producers of bio-energy? What are the effects on small scale producers and rural economies? Where is bio-energy produced? Are there possibilities for regions with poor soil conditions?
- Environment: more research is needed on the possible adverse environmental impacts of biomass such as logging, urban pollution, monocultures etc.
- Government and trade investment: what is the role of governments with regards to trade regimes?
- The position of civil society organisations (CSO's) in the debate: a scan of CSO's involved and their position on the issues regarding bio-energy.
- CSR initiatives: identification and critical analysis of the relevant CSR initiatives.
- New technologies: research into the potential benefits and issues of second generation bio-energy and the transition debate from first to second generation bio-energy.