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# BIOFUELS – THE ENVIRONMENTAL CONTEXT

## ABSTRACT

The issue of biofuel has been growing in importance worldwide in response to the growing seriousness of the problem of climate change in general and global warming in particular. It is increasingly being recognised that, due to the use of greenhouse gas-emitting fossil fuels over the past century-and-a-half, global warming has developed into one of the twenty first century's most acute environmental problems. It is within this context that renewable energy sources is being put forward as a viable alternative to dirty, polluting fossil fuels such as coal and oil.

However, while renewable energy sources such as wind and solar energy are regarded as environmentally friendly alternatives to fossil fuels, environmentalists have pointed out that biofuels are not, in fact, carbon neutral. On the contrary, it is increasingly being realised that, because of the intensive and destructive cultivation methods used in biofuel production (particularly in countries such as Brazil, Indonesia and Malaysia), biofuels have the potential to unleash negative environmental (habitat loss, animal and plant species loss) and socio-economic (higher food prices) impacts which are so serious that they may offset the benefits of biofuel. Accordingly, the United Nations has urged that investments in biofuel should be carefully managed at the national level in order to avoid these impacts, which could have irreversible consequences.

Biofuels *do* offer benefits, but these should be accessed as an integral element of a holistic approach to energy security and as one part of an overall strategy on renewable energy and energy efficiency. Given the potential negative impacts of biofuels, South Africa needs to proceed with caution on this issue.

## 1. INTRODUCTION

Motivated by concerns around climate change and global warming, biofuels such as ethanol are increasingly being proposed as an opportunity to promote an alternative energy source, as well as a valuable short-term mechanism to reduce global warming while simultaneously creating jobs, especially for the rural poor.

**What is Climate Change?**

Climate change is a general term, used to denote warming or cooling of the global climate. This can occur naturally, such as the cooling which occurred during the Ice Ages. However in recent years, climate change, mainly in the form of global warming,[1] has been rapidly emerging as a serious global problem affecting all countries.

[1] The term, 'global warming' is thus a specific case of the more general term, 'climate change'.

**What is Global Warming?**

Global warming refers to the increases in the average temperature of the Earth's atmosphere and oceans that have been observed in recent decades.[2] Greenhouse gases (GHGs) intensify the greenhouse effect of the atmosphere and can cause long-term climate change.

**What is the Greenhouse Effect?**

While GHGs form naturally, many human activities, such as heating and cooling buildings, using energy, driving vehicles and powering industrial processes, add additional GHGs to the atmosphere. Radiation from the sun enters the earth's atmosphere, and greenhouse gases then act like the glass of a greenhouse to block this heat from escaping back to space.

This research paper will examine the issue of biofuel production within an environmental context, evaluating the viability of biofuel as a sustainable alternative energy source, and a possible answer to the problem of global warming.

## 2. BACKGROUND

### 2.1 What is biofuel? [3]

Biofuel is any fuel that is derived from biomass, i.e. recently living organisms, such as plant matter. Biofuels are made from corn, palm oil, sugar cane and other agricultural products. It is a renewable energy source, unlike other natural resources such as petroleum, coal and nuclear fuels.

Like coal and petroleum, biomass is a form of stored solar energy. The energy of the sun is captured through the process of photosynthesis in growing plants. One advantage of biofuel in comparison to most other fuel types is that it is biodegradable, and thus relatively harmless to the environment if spilled. Biofuels are seen by many as a cleaner and cheaper way to meet the world's soaring energy needs, than the use of fossil fuels which have significant negative social and environmental impacts.[4]

### 2.2 What is renewable energy?

Renewable energy sources are those sources of energy arising from natural sources that are regularly replenished by natural processes. Renewable energy is sustainable in that it allows the needs of the present generation to be met without compromising life support systems for future generations. Renewable energy sources include:

[2] www.en.wikipedia.org
[3] This section has been extracted from: Biofuels – http://en.wikipedia.org
[4] For example, coal-fired plants produce pollution which impacts heavily on the health of surrounding communities as well as the environment.

- Solar power
- Wind power
- Biomass

Solar energy has long-term potential to supply power to populations living in remote areas without access to the national grid, as well as potential for bulk grid supply. Solar energy may be tapped through: the use of photovoltaics that convert solar energy directly into electrical current using solar cells; solar thermal techniques that drive generators using fluid heated directly by the sun; and solar passive techniques, such as water heating and cooking.

Wind energy is one of the fastest growing renewable energy sectors that currently supplies over 32 000 megawatts (MW) worldwide, enough power to meet the electricity needs of 40 million people in a developed country. Wind energy is generated using wind turbines that can be situated *en masse* on 'wind farms'.

Biomass (that is, the use of plant matter and the capture of gas produced by decomposing biomass as an energy source), is a renewable energy source if the material used is harvested in a sustainable way and does not contribute to land degradation.

### 2.3 The advantages and disadvantages of renewables

#### 2.3.1 The advantages of renewables

Generally speaking, renewable energy sources have lower social and environmental costs (viz. their environmental impact) compared to other forms of energy such as fossil fuels and nuclear energy. Fossil fuels emit the greenhouse gases that intensify the greenhouse effect of the atmosphere and can thus cause long-term climate change – primarily a rise in temperature. The six main GHGs are: carbon dioxide ($CO_2$); methane ($CH_4$); nitrous oxide ($N_20$); hydrofluorocarbons (HFCs); perfluorocarbons (PFCs); and sulphur hexafluoride ($SF_6$). Nuclear power, which is promoted by its proponents as an environmentally friendly alternative to fossil fuels as it does not emit greenhouse gases, in fact produces extremely dangerous waste at nuclear power plants (far greater than that produced by coal-fired plants). Moreover, this waste, which remains radioactive for thousands of years, would have to be stored and guarded for thousands of years at taxpayers' expense.

The main advantages of renewable sources of energy may be summarised as follows:

- The cost of renewables is usually very competitive once sufficient and equitable national resources have been spent on research, development and implementation (see text box below).
- Renewable energy sources have significant long-term commercial potential.
- Renewable energy technologies are labour-intensive, directly producing more jobs than fossil fuel or nuclear development.
- Renewable energy is sustainable.

**The issue of equitable investment in renewable energy**

South Africa provides a clear example of the distorted energy situation which develops when the development of renewable energy technology has been neglected. In this country, the nuclear industry has benefited from decades of research and funding support, while the renewable sector has, by contrast, been seriously neglected. It may further be noted that the parastatal, Eskom, has spent about R2 billion (much of this public money) on the proposed Pebble Bed Modular Reactor project.[5]

Recently, Eskom has reached a 25-year deal with the Canadian aluminium-smelting company, Alcan,[6] providing the company with electricity (for its project in Port Elizabeth) at a time when many parts of the country are affected by blackouts as a result of Eskom's inability to supply sufficient electricity to the nation. This deal will very likely result in the construction of more coal-fired electricity plants in an effort to ensure that sufficient electricity is available.

### 2.3.2 The disadvantages of renewables

There are still barriers to using renewable energy sources for bulk electricity generation, for example, the issue of high costs. The high costs of renewable energy in many countries reflect the low levels of investment which those governments have made in this field. In addition, there is the challenge of lack of capacity – in this regard, proponents of nuclear and coal-generated electricity have expressed doubts about the capacity of renewable sources to ever supply more than about 30% of the country's electricity needs.

## 2.4 The environmental impact of biofuel

Environmentalists have warned that the intensified production of biofuel can do as much, if not more damage to the environment as fossil fuels.[7] Some of the environmental impacts that have been identified thus far include the following:

- Ethanol produced from crops such as sugar cane, sorghum and maize, has been criticised as the enormous amount of land and water needed for the cultivation of these crops, utilises valuable natural resources needed for food production and drinking purposes and could result in higher food prices, as well as food insecurity and water scarcity. The socio-economic impacts of higher food prices and water scarcity on the poor (particularly in developing countries) will be severe, possibly triggering political problems those countries can ill afford.
- It has been claimed that biofuels have a positive impact on the environment as they are carbon neutral – that is, vehicles running on biofuels would not emit $CO_2$ as these vehicles would produce only the carbon that the plants had absorbed from the atmosphere. Environmentalists have pointed out that biofuels are not, in fact carbon neutral and are probably carbon positive.[8] While in one sense it is true that biofuels only emit the carbon originally absorbed by the plants, this does not take into account the enormous amount of energy needed for biofuel production in the first place (viz. the fuel used to plough, harvest, pump irrigation water, produce fertilisers, pesticides and then transport the product). The most optimistic estimates s have it that ethanol fuel produced by maize yields only 30% more energy than is

[5] Gosling, 2006.
[6] Yeld, 2007b.
[7] This is a concern reflected throughout a recent report on bioenergy issued by UN-Energy, a consortium of 20 United Nations Agencies – See UN-Energy, 2007.
[8] For example, botanist Mark Botha - Gosling, 2007b.

consumed in its production, while at the end of the scale, it is estimated that final energy output is actually less than 80% of that used in the production of the fuel.[9]

- Forest clearance for biofuel production could result in deforestation, soil erosion and ecosystem degradation.
- Old growth forest and peat land play a vital role in regulating climate change. Forest and peat land clearance could result in changes in the carbon content of soils and carbon stocks in forests and peat lands, thus releasing emissions even higher than that caused by fossil fuels. The draining and burning of peat lands sends huge amounts of carbon emissions into the atmosphere. These practices would offset some or even all the benefits of a reduction in GHG emissions achieved by the use of biofuels.
- Use of large-scale monocropping in the cultivation of biofuel crops could result in soil erosion and ecosystem degradation, which would further threaten biodiversity. These are existing problems which are already heavily impacted by development.
- As a result of habitat loss, a number of animal species are threatened with extinction. With non-agricultural land increasingly coming under cultivation, this is a problem set to increase in the future.

## 3. BIOFUELS IN THE GLOBAL CONTEXT

Agricultural products specifically grown for use as biofuels include:

- Corn and soybeans, primarily in the United States.
- Flaxseed and rapeseed, primarily in Europe.
- Sugar cane in Brazil, where ethanol fuel produced from sugar cane is used as automotive fuel.
- Palm oil in South-East Asia.

### 3.1 The United States of America (USA)

The USA, spurred by the record high prices of oil, is working on a proposal that would increase production of biofuels by seven times by 2022.[10] This is of concern with regard to the issue of food security as the contribution of the US biofuel industry, has already led to the doubling of the world maize price.[11]

### 3.2 Europe

Spurred by government subsidies over the past few years, European countries have enthusiastically adopted the use of biofuel. Some European leaders have decided that at least 10% of fuel will come from biofuels like ethanol by 2020.[12] However, much of the biofuel has come from South-East Asia, notably countries such as Indonesia and Malaysia. Recent exposès of the serious environmental costs incurred in the wake of forest clearance and the overuse of fertilisers however, have led to a re-examination of the use of biofuel. The Netherlands is leading the way in the reviewing process, highlighting the need to distinguish the biofuels production processes which are environmentally sound enough to achieve a significant reduction of GHG emissions.[13] Increasingly, there is agreement over the need to source sustainable, environmentally biofuels for European markets.

In Europe itself, it is mostly local rapeseed and sunflower oil that is used to make diesel fuel.

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[9] Botha, 2007.
[10] *Cape Argus*, 9 May 2007.
[11] *Cape Times*, 28 March 2007.
[12] *Cape Argus*, 9 May 2007.
[13] Rosenthal, 2007.

### 3.3 Brazil

Biofuel production in countries such as Brazil has resulted in the clearance of large tracts of rainforest. This has negative consequences not only for biodiversity and ecosystem degradation, but also on greenhouse gas (GHG) emissions. The impact of such levels of deforestation within a country has been calculated for 1997, when it was estimated that the felling of huge numbers of rainforest trees in Indonesia released such enormous amounts of carbon that it equalled the world's consumption of fossil fuels for that year.[14] The impact of deforestation on Brazil's rainforests would be equally severe. As the most biologically diverse country in the world, Brazil is endangering this status through habitat loss as a result of rainforest clearance.

### 3.4 South-East Asia

The destruction of tropical forests could result in emissions that are even higher that those caused by fossil fuels. The cheapest biofuel globally is that produced from palm oil in South-East Asia. The demand for palm oil is being driven by rich nations attempting to meet their greenhouse gas reduction targets. However, the development of palm oil plantations is wreaking havoc in those countries producing it. In Malaysia for example, an estimated 87% level of deforestation has taken place.[15] A similar situation is developing in Sumatra, Borneo and Indonesia, where forest clearance is resulting in ecosystem degradation, threatening biodiversity and placing a number of animal species under the threat of extinction. The orang-utan is likely to become extinct and there is a possibility that other species, such as the Sumatran rhino could follow.[16]

Indonesia is under particular threat from the environmental impact of biofuel production as it already has the highest deforestation rate, with almost two million hectares destroyed annually for the period 2000 and 2005. While the country has already lost more than 72% of its intact ancient forests, much of the remaining forest areas are threatened by commercial logging and clearance for palm oil plantations.[17] As a result of forest clearance and the burning of peat lands, huge amounts of carbon have entered the atmosphere, resulting in Indonesia becoming the world's third leading producer of carbon emissions, ranked after the US and China.[18] There is great concern for the future as Indonesia plans to expand its palm oil production 43-fold, thus threatening most of its remaining rainforests and peat lands.[19] As the second most biodiverse country in the world, Indonesia has a lot to lose.

## 4. SOUTH AFRICA AND BIOFUELS

The Government of South Africa has taken a decision to accelerate ethanol production, as a key renewable energy source and a major element in the country's future growth strategy.[20] The Cabinet recently approved a draft National Industrial Biofuels Strategy.[21] The Strategy calls for the mandatory inclusion of 4,5% of biofuels in

[14] Monbiot, 2006, p.160.
[15] Monbiot, 2006, p.159.
[16] Monbiot, 2006, p.150.
[17] *Cape Times*, 4 May 2007.
[18] Rosenthal, 2007.
[19] Davie, 2007.
[20] Davie, 2006.
[21] Gosling, 2007a.

road transport by 2013.[22] This decision paves the way for a multibillion rand biofuels industry that will create jobs by harnessing under-utilised land in the economically depressed former 'homelands' (black rural areas). It has been estimated that 55 000 jobs could be created by this industry which could also see about three million hectares of fallow land in the former homelands being utilised.[23] It is also expected that the biofuels industry will revitalise the stagnant rural economy, offering hope to small-scale and emerging black farmers. This, however, will largely depend on the careful targeting of government subsidies to ensure that these do not primarily benefit large-scale and commercial farmers.

South Africa's ethanol programme is focusing on the production of E10 for vehicles – a fuel mixture requiring only 10% ethanol to be mixed with petrol. In addition, petrol engines will be able to run on E10 without any modification. Construction has already begun on the country's first ethanol plant, which will convert maize to ethanol – the first of eight such plants.[24] An ethanol production plant using sugar beet is also planned for the Eastern Cape, where partnerships between established and emerging farmers will produce crops for the plant.[25]

The country's ethanol programme, however, has not been without its problems. Recently, the Government rejected an application from a seed company to cultivate genetically modified maize for the biofuel industry, on the grounds that the crop could become mixed up with crops grown for food and also, that the crop had not been shown to be safe as a food or as animal feed.[26] Meanwhile, the costs of the country's first ethanol plant in Bothaville has risen by 25% to almost R1 billion, as a result of a rise in the steel price.[27] There has also been criticism of the Government's decision to plant three million hectares of biofuel crops in the former homelands on the grounds that: [28]

- The scale of the operation is huge. This may be contextualised against the fact that the country's entire commercial timber industry consists of plantations on only 1,5 million hectares across the country.[29] In contrast to this, the three million hectares of biofuel cultivation will take place in only one part of the country, the Eastern Cape.
- There has been no meaningful consultation with the communities affected by the planting of these crops.
- There has been no adequate investigation into the impact on biodiversity, food security or water scarcity in the area.
- Most of the three million hectares is grasslands, a vast natural resource which has a whole range of ecological values, the most important of which is water production. Grasslands are "water factories" which store water and release it into rivers during dry spells.[30] The loss of such a valuable resource will thus be significant for the region and will require an environmental impact assessment before the planned biofuel project goes ahead.
- There is, as yet, no biofuel strategy in place.

[22] Department of Minerals and Energy, 2006.
[23] Gosling, 2007a.
[24] Salgado, 2006.
[25] Hollands, 2006.
[26] Gosling, 2007c.
[27] Salgado, 2007.
[28] Gosling, 2007d.
[29] Yeld, 2007b.
[30] Yeld, 2007b.

Environmentalists in South Africa have pointed out that, while biofuels have their place in a renewable energy strategy, they are only a small part of the answer to reducing GHGs.[31] The most important element in reducing GHGs in the transport sector, to use less fuel. This requires that the issue of sustainable public transport has to be urgently addressed and the issue of fuel efficiency needs to be rigorously enforced. Furthermore, it has been pointed out that biofuel production requires huge amounts of land[32] and water for crop cultivation, which could contribute to food price rises and water scarcity in an already water-scarce developing country in which poverty is widespread. This can only exacerbate the acute socio-economic pressures South Africa already faces.

With specific regard to South Africa's Draft National Biofuels Industrial Strategy, environmentalists have drawn attention to the following shortcomings,[33] viz. that the Strategy:

- Pays scant attention to sustainable development concerns.
- Misses an opportunity to build rural livelihoods and local economic development.
- Encourages big industry to entrench itself in the alternative and renewable energy sector.

## 5. CONCLUSION

It should be acknowledged that biofuels have many positive uses: they could certainly help the millions of people all over the world who lack access to electricity; they could create jobs for the rural poor; provide an alternative energy source for poor countries, many of which have to spend more on importing oil than on the basic needs of their citizens; and they could help reduce global warming. However, as UN-Energy has recently made clear,[34] biofuels have the potential to unleash negative environmental, social and economic impacts which are so serious that they may offset its benefits. It is within this context that UN-Energy has urged that investments in biofuel at the national level must be carefully managed in order to avoid these impacts, which could have irreversible consequences.[35] As a developing country, South Africa would do well to heed this advice.

### 5.1 Recommendations

Given the context outlined in Section 5.1, the following steps are recommended for South Africa. The country should:

- Move with caution on the issue of biofuels, taking into account all the potentially negative environmental, social and economic impacts.
- Incorporate the use of biofuels into a carefully planned, holistic sustainable energy strategy, of which biofuels form only one (short term) element.
- Identify and implement strategies to consume less fuel (for example, through the national implementation of a safe and efficient public transport system).
- Identify and implement ways to consume fuel more efficiently.
- Place greater emphasis on the development and implementation of renewable energy technologies.

[31] Yeld, 2006.
[32] It has been estimated that South Africa will require up to three million hectares of land to grow the crops for the biofuel industry – *Cape Times*, 11 January 2007.
[33] Yeld, 2007a.
[34] UN-Energy, 2007, p.43.
[35] UN-Energy, 2007, p.43.

sources of energy.

- Initiate more intersectoral projects on renewable energy and energy efficiency.
- Create the conditions required for the large-scale implementation of renewable energy technology and energy efficiency campaigns.
- Initiate more joint projects aimed at promoting sustainable energy use.
- Initiate more co-operative projects on technology transfer (especially relating to renewable energy sustainable energy projects.

As part of its oversight function, the Portfolio Committee on Environmental Affairs and Tourism can help to ensure that the steps outlined above are taken, by taking the following actions:

- Act as a catalyst in bringing the issue of sustainable energy use to the forefront of the parliamentary agenda.
- Provide input to the biofuel debate in order to ensure that environmental concerns are taken into account and that a responsible and well-informed biofuel strategy is developed.
- Collaborate with other parliamentary committees (such as Agriculture, Transport, Minerals and Energy) in holding joint meetings in order to receive information and monitor progress reports on such issues as:

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