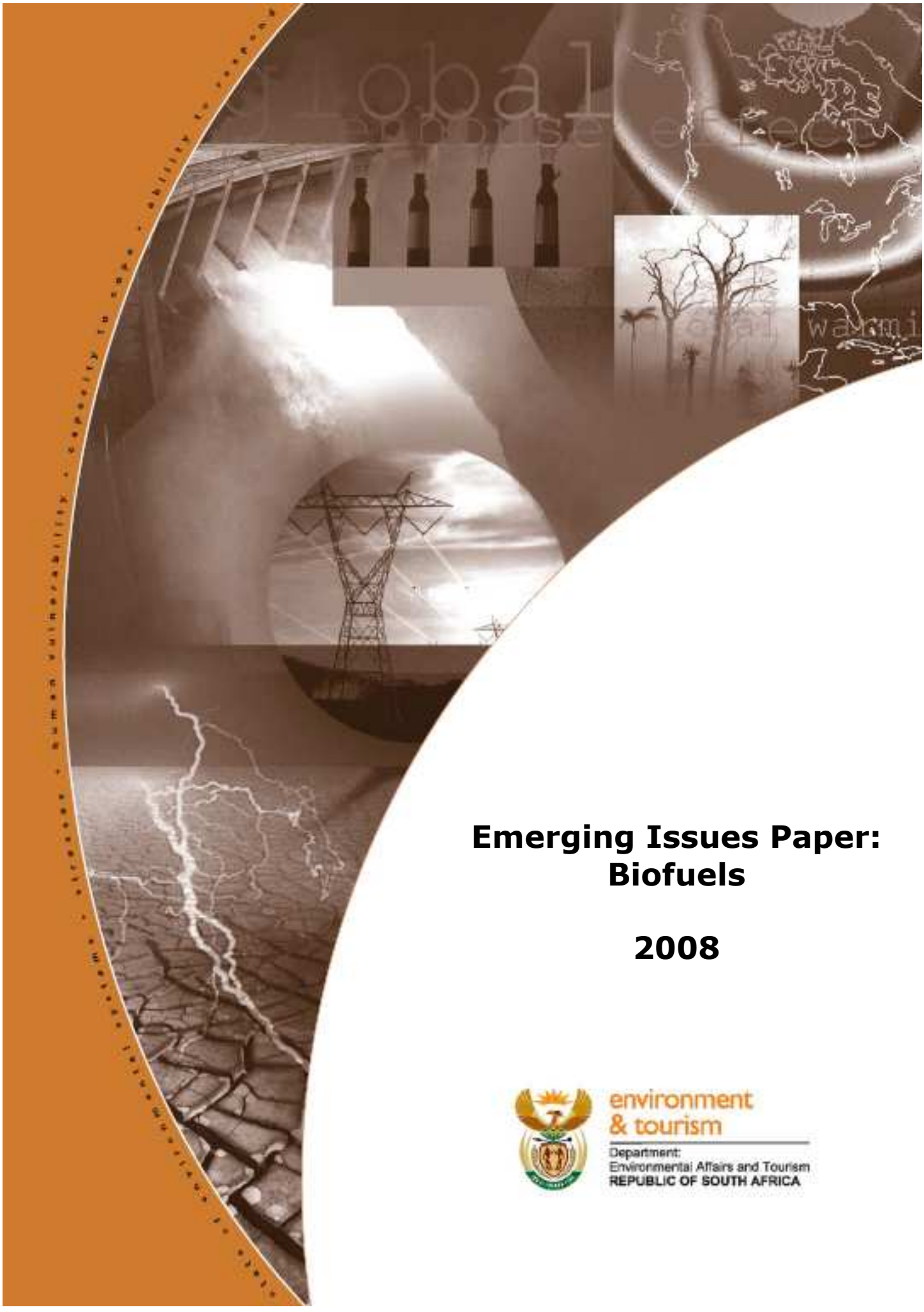

Emerging Issues Paper: Biofuels

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THE EMERGENCE OF A 'GREEN FUEL' IN SOUTH AFRICA - BIOFUELS: A CONSIDERATION OF KEY EMERGING ISSUES THAT MAY IMPACT THE STATE OF THE ENVIRONMENT

This document provides information on emerging issues that may affect the future state of the environment. The purpose of this paper is to draw attention to issues in preparation for the next state of environment reporting cycle.

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Introduction

Petroleum is the largest single source of energy consumed by the world's population, exceeding coal, natural gas, nuclear, hydro and renewable energy sources (Energy Information Administration, 2005). It is predicted that by 2025 the global demand for petroleum will have increased between 40-50 % (Rooney et al, 2007, Johnston and Holloway, 2007). The associated rise in oil price, questions about energy security, and the threat of global warming have sparked worldwide concern within the energy sector to rapidly address the replacement of conventional fossil fuels with alternative energy sources.

Biofuel is widely seen as one possible alternative to achieve this replacement. This essay discusses the production and use of biofuels, and advocates for a sound understanding and management of the potential, and unintended, side-effects of this energy source should it be employed widely in South Africa. Many of these consequences are not yet fully understood.

By manipulating the cellulose, hemicellulose, starch and lignin found in biomass (from all types of plants, residues of agriculture and forestry, and the organic component of municipal and industrial waste sites) through thermal, biological and mechanical conversion technologies, biomass can be converted into commercial fuels suitable for transportation, heating and electricity generation. The basic fuel products that these technologies produce include bio-oil, fuel gas, heat, ethanol, bio-gas and vegetable oil. Figure 1 provides a simple illustration of the conversion processes, products and applications of biomass.

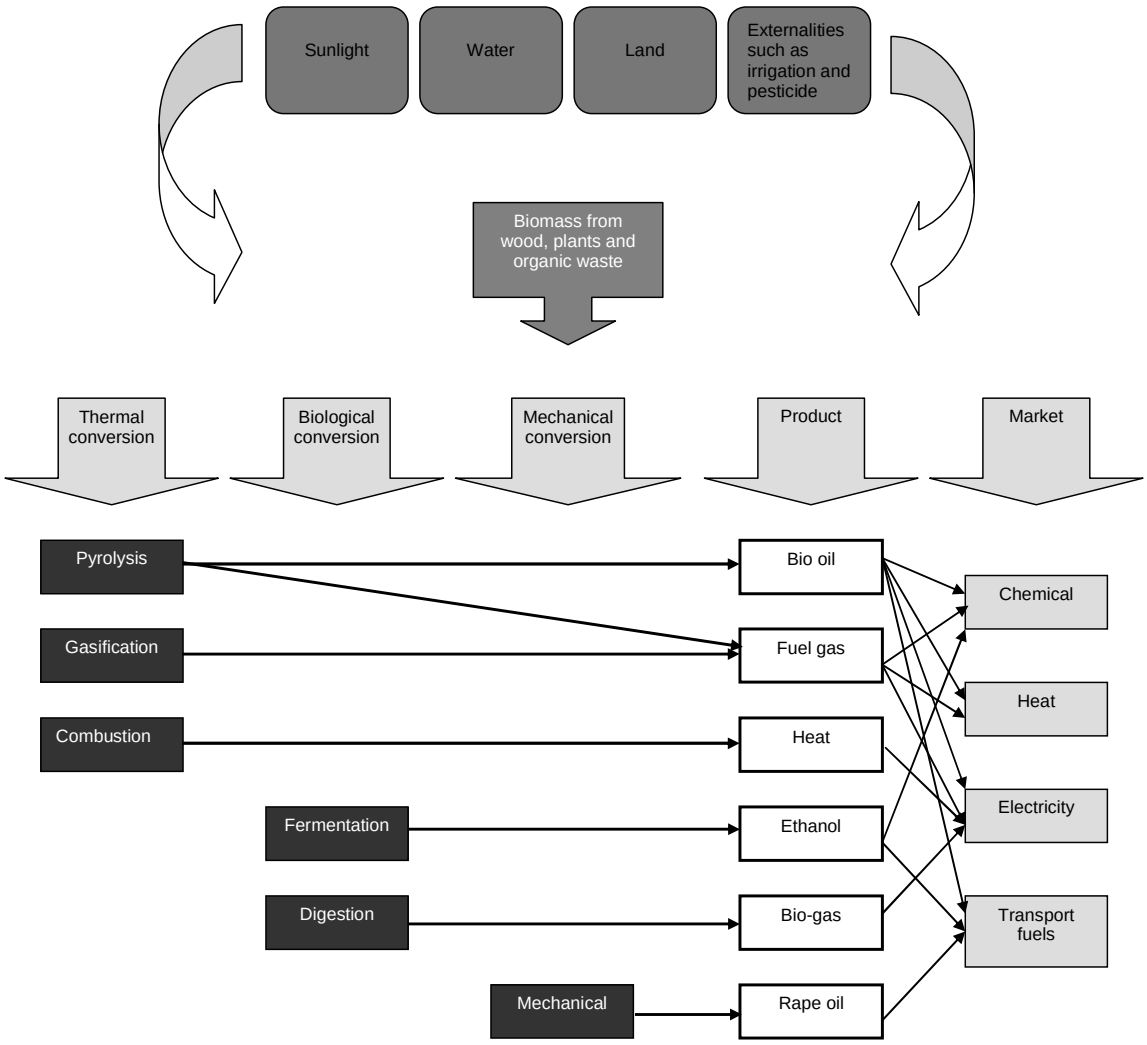

Figure 1: Representation of the conversion of biomass into products and their appropriate applications (Adapted from Demirbas, 2002 and Bridgwater, 2006)

Bioethanol and biodiesel are the most commonly produced biofuels. At present, they are mainly derived from food crops such as corn, soybeans, wheat, sugar cane and sorghum. These are referred to as first generation biofuels. Bioethanol is produced by fermentation of sugars and starch and blended with petroleum in varying percentages as a replacement to petrol in petrol driven engines. Biodiesel is produced from oils or fats and can be used in any diesel engine when mixed with mineral diesel according to automobile manufacturing standards.

The technology of converting biomass into a fuel product has been hailed as a 'green revolution'. Biomass-based fuels are perceived to be carbon

neutral; thereby not contributing to climate change. Plants capture the energy from the sun by photosynthesis, and the carbon dioxide that they release during combustion as a biofuel is offset by the carbon that the plants absorb from the atmosphere while they growing. The net emission of carbon dioxide will be zero as long as plants continue to be replenished for biofuel purposes. Apart from reducing greenhouse gas emissions, biofuels are generally considered as offering many other benefits related to sustainability such as regional development, improved social structure, and security of supply (Demirbas and Demirbas, 2007).

The carbon truth

Unfortunately, biofuels are not necessarily carbon neutral. Reasons for this are that firstly large amounts of energy are needed to produce biomass feedstock from the agricultural crop for biofuel production, and in most instances this energy comes from traditional fossil fuels. Secondly, the growing of biofuels requires fertilizers, which have large energy inputs in their production. The use of fertilisers also results in increased levels of nitrous oxides being released from the soil and these have a potential impact on climate change of higher magnitude than carbon dioxide. Thirdly, farming activities such as harvesting and irrigation also require energy for the operation of agricultural machinery. In addition, energy is consumed during the conversion of biomass to biofuel through the milling and fermenting of starches for bioethonal, and in the oil extracting and transestificaiton of biodiesel. Fourthly, non-carbon greenhouse gasses also result from the growing of biofuels. When the above factors are considered, the net overall carbon emission from biofuels is in most instances marginally lower than that from fossil fuels.

Biofuels are currently being produced in large volumes in the United States of America, the European Union (EU), and Brazil (Stein, 2007). The EU has set targets of 5.75% biofuels in vehicles by 2010 (COM, 2006), while the United States of America has called for the displacement of 17% of projected US petrol consumption by biofuels by 2017 (Wahenga Brief, 2007, Boddiger, 2007). Since it is unlikely that Europe or the United

States of America will be able to produce enough biofuels to meet these targets, developing nations are seizing the opportunity to enter these growing markets (Boddiger, 2007). Developing nations, however, already face challenges including poverty alleviation, and food and water security. With a large and rapid expansion of the biofuel market, food prices in both domestic and international markets will certainly be affected, due to the allocation of acreage among crops and fluctuations in exports and imports. As more food grains will be used to produce first-generation biofuels, it is foreseen that food grain carryover will remain tight and average grain prices will increase (Dong, 2007).

Discussion

In late 2007, the South African Cabinet approved and released a biofuels strategy for the country. The strategy proposes that South Africa actively participate in biofuel production in order to achieve a 2% penetration level in the national liquid fuel supply (Department of Mineral and Energy, 2007). The main driver for the strategy is that of economic growth especially amongst rural communities, to enhance food security and alleviate poverty by creating income-earning opportunities. The strategy envisages that the biofuel industry will create 25 000 jobs predominantly within rural areas, thereby increasing economic growth in the country by 2.5% (Department of Mineral and Energy, 2007). It is believed that this is achievable utilising the country's potential for surplus agricultural capacity on arable land currently not being used, especially in the former homelands (Department of Mineral and Energy, 2007).

South Africa covers an area of 121.9 million hectares; 80% used for agriculture activities with only 11% having arable potential, the remainder is primarily used for grazing (Department of Environmental Affairs and Tourism, 2006). South Africa is reliant on what is globally considered to be low to marginal potential soils, which require extensive inputs such as irrigation and fertilisers. With the slow and growing impact of climate

change, as predicted by climate change models for South Africa, parts of the country will be become dryer and others wetter, with more extreme events in all regions (Wahenga Brief, 2007). There is therefore much uncertainty related to future food and water security in South Africa (Department of Environmental Affairs and Tourism, 2006; Wahenga Brief, 2007). This uncertainty is an important consideration as the biofuel industry emerges, due to its (current) reliance on conventional food crops. Brent *et al.* (in press) highlight the potential negative consequences for areas that are already water stressed, since biofuels like ethanol are water intensive to produce. In addition, this industry will need to pay attention to links with biodiversity, most notably genetically modified (GM) food crops and invasive alien species.

As greater areas of bioproductive land are likely to be required to grow bioenergy crops, land currently supporting biodiversity may need to be converted to monoculture crops. Conversion of previously natural lands has been noted to disrupt ecosystem services and increase the input of pesticides in an area, ultimately impacting on the livelihoods of rural populations and biodiversity. Brent *et al.* (in press) note that expansion of cropland could encroach on wetlands, riparian areas and other areas of high biodiversity importance. If higher numbers of biofuel crops are grown, these areas may also have an increased demand on water resources. This could be problematic, considering South Africa is considered water scarce (Varis, 2007). Water extraction for crops is likely to therefore have an impact on other water uses within catchments. At present, agricultural irrigation accounts for about 63% of South Africa's total water requirement and the potential to increase irrigation is low (Department of Environmental Affairs and Tourism, 2006).

In addition, the agricultural industry has engaged in technologies that modify and manipulate plant genes in order to boost the growing potential of food crops. Genetically modified (GM) foods are potentially a concern, as environmental and health risks associated with them remain uncertain (Sims et al, 2006). Similarly, the introduction of alien species to countries as a source of biomass feedstock is considered as a risk, because of the

possibility that such species may become invasive, resulting in a further impact on biodiversity (Rooney et al, 2007).

What biomass feedstocks should be used?

The global press around the maize to ethanol production suggests that it may seriously impact food security and global food prices. South Africa has withdrawn from the use of maize as a feedstock for bioethonal production due to concerns around the ability to produce surplus at the national level. Indeed, the estimated crop yield for 2007 is not thought to be enough to meet South Africa's annual consumption (Sugrue and Douthwaite, 2007; in Brent *et al.*, in press). The South African government thus needs to create a market for any energy crops that increase the medium-term local demand to that of the actual agricultural potential of the country. This increase in demand should ensure that the country's full agricultural potential is exploited, which should contribute to food security by encouraging food price stability (Makenete et al, 2007).

The above highlights two important considerations for the biofuel industry in South Africa; firstly, the biofuel industry cannot be solely dependent on maize and sugar but rather on a multi feedstock approach, especially if food production is not to be jeopardised. Secondly, it emphasises the need to utilise the countries marginal to low agricultural land to the benefit of rural communities; alleviating poverty and building the economy of the country while at the same time not detrimentally impacting on the natural resources that are important to the country.

Growing energy crops on bioproductive agricultural land currently underutilised in rural areas will create upliftment opportunities for rural communities. These areas include land in the former regions of Transkei, Ciskei, Bophutatswana, Venda, Lebowa, KwaNdebele, Kangwane, Gazankulu, KwaZulu and Qwa-qwa (Makenete et al., 2007). These areas should be cultivated with biomass feedstocks best suited to the climatic conditions of the area. Communities must also be collaborated with to ensure the biofuels industry advances using a precautionary and adaptive management approach, so that learning about reducing known negative

impacts (including those highlighted in this essay) is shared. In addition, as Brent *et al.* (in press) highlight, a clear strategy for sustained employment must be developed, including plans for maintaining capacity and income security.

Conclusions

Biofuels offer much potential as a 'green fuel' of the future. However, measures must be successfully undertaken to ensure sustainable agricultural practices and sustainable biofuel production practices. If this is not done, no matter the technological advancements this industry may cause ecological and social damage despite the envisaged benefits. It is also important to note that with current technologies biofuels can only, at best, substitute a small amount of the global fossil fuel needs. There is simply not enough land to produce sufficient biofuel for all mankinds' liquid fuel needs. Therefore, proper consideration and management of the potential negative effects of the biofuel industry is required, to ensure benefits outweigh any ecological, economic and/or social costs. A strategic life cycle assessment approach is one way to enable better informed decision making and implementation of biofuels in South Africa (see Brent *et al.*, in press).

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