**Draft ACP Policy brief for comments**
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# Biofuels: ACP's response to fossil fuel dependence

## *The role of Science, Technology and Innovation in supporting sustainable biofuel policies*

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***This article outlines various opportunities for using local biomass resources to reduce ACP countries' dependence on fossil fuels and to improve the competitiveness of traditional agricultural-based industries.***

### 1.0 Introduction

ACP countries with their biomass resource potential are well positioned to effectively deploy biofuel in helping meet their energy needs. The continued increase in the cost of fossil fuels coupled with the cut in prices paid for sugar exported to the EU have forced many ACP countries to seek innovative ways of meeting energy demands and agricultural diversification.

Biofuels are products from biological origin that are converted into liquid, solid or gas form, for energy production, depending on the raw material and the technology employed. Liquid biofuels can be used for transport, power generation, heating and cooking/lighting purposes. Raw materials include renewable plant matter e.g. trees, grasses or agricultural crops and also animal waste. Bio-ethanol and bio-diesel are the most common forms of Biofuels, in addition, pure plant oils are used in modified engines. Bio-ethanol is produced from crops such as sugar cane, corn, beet, wheat and sorghum. A new generation of 'ligno-cellulosic' bio-ethanol also includes a range of forestry products such as rotation coppices and energy grasses. Biodiesel is made from seeds such as rapeseeds, sunflower, soy, palm, coconut or jatropha.

Figure 1: Farmer harvesting cane for sugar and biofuel utilisation *(Source: Associated Press)*

An example of solid biofuels is bagasse, the fibre remaining when cane is crushed, to remove the juice, has been used for centuries for electricity generation at sugar mills and with greater emphasis on energy efficiencies and the implementation of new technologies and process optimisation, energy generated can be sold to the national grid. Gaseous biofuels include biogas, which is produced by digesting organic waste and can be used for cooking, lighting and power generation at the village level.

## 2.0 Why Biofuels?

Biofuels can provide an opportunity for ACP countries to utilise their own natural resources and attract the necessary foreign and domestic investment to achieve sustainable development goals. Promoting widespread use of biofuels would provide greater energy security, improved quality of life for both rural and urban populations, economic development, opportunities for job creation and poverty alleviation, especially in rural areas.

For example, the sugar cane plant which grows well in most ACP countries, is considered the most efficient species of the plant kingdom in terms of biomass production and can be further engineered to produce increased amounts of sugars and higher percentages of fibre. Sugar cane juice and molasses, a by-product of sugar production can be fermented to produce ethanol. Also vegetable oil sources such as palm, coconut and jatropha are increasingly viewed as alternatives to diesel imports in ACP countries. The energy output of these oily crops is up to 30 times their energy inputs. The production of biofuels using existing agricultural resources will not only provide alternative fuels for local consumption but can also be used to meet demands on export markets.

Biofuels from ligno-cellulosic sources such as wood, grass and bagasse are promising, however conversion technologies are currently uncompetitive, while the feedstock are in abundance. If this becomes competitive in the medium term, the conflict of food versus fuel would be lessened.

The biofuel sector has strong links and synergies with other agricultural industries through provision of raw material base in the form of agricultural by-product streams from livestock and fisheries. At the same time, many biofuel by-products can provide feedstock for these same agricultural sectors.

## 3.0 CHALLENGES

### 3.1 Feedstock

Despite the existence of a range of conversion technologies, the biggest challenge is the availability of feedstocks at reasonable cost and sufficient quantities. Although there is a long list of feedstocks available, economics of transformation are rarely competitive with current fossil fuel cost. In some cases, national feedstocks are not sufficient to satisfy technically acceptable blending ratios, such as 10% ethanol in petrol (E10).

### 3.2 Economics

Economics of production is crucial for successful implementation of biofuel development programmes. In this regard it is important that knowledge and capacity are available to select the appropriate technology and feedstock, which will yield production costs that are competitive with fossil fuel. For example, lessons can be learned from economic analysis undertaken for selected feedstocks in various countries (Figure 2, ethanol, Figure 3, biodiesel).

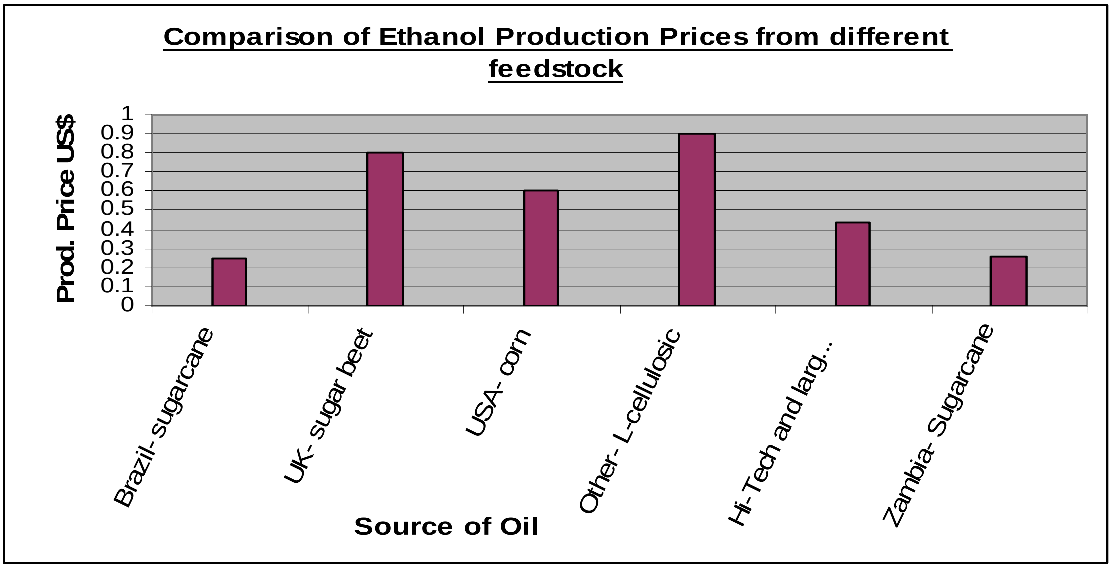


Figure 2: Production cost of ethanol in selected countries *(Source IEA Energy Outlook 2004, CEEEZ 2007)*

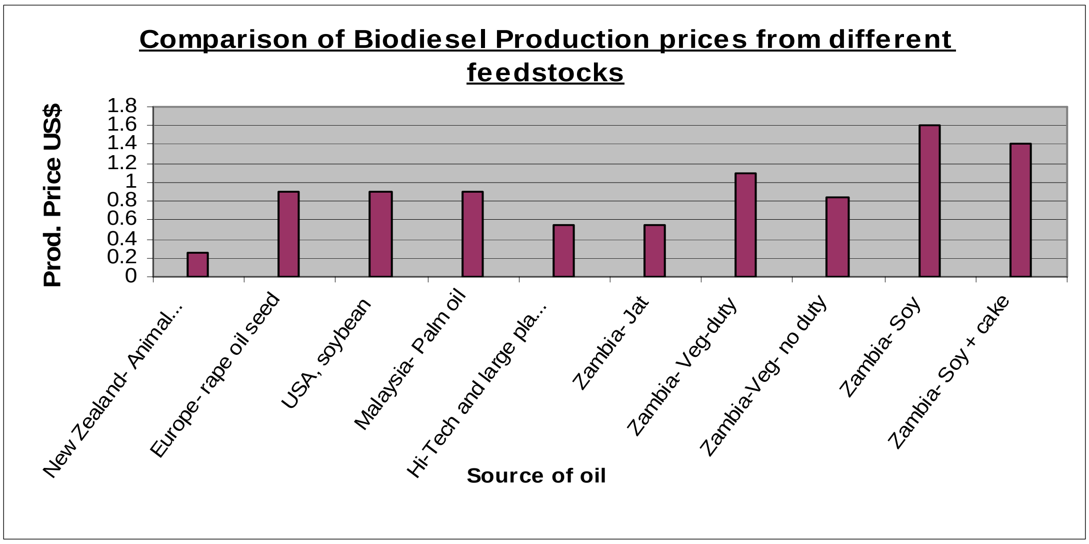


Figure 3: Production cost of Biodiesel in selected countries *(Source IEA 2004 Energy Outlook, CEEEZ 2006)*

On the other hand, biofuels from woody biomass and bagasse are highly competitive with the current price of fossil fuels and are increasingly applied in co-generation of steam and power.

## 3.3 Industry

### 3.3.1 Restructuring

With the pending implementation of the new EU sugar regime, industries started restructuring in an attempt to stay competitive. The common theme among all the restructuring plans was energy production through using bagasse more efficiently and diversifying into ethanol production.

### 3.3.2 Standards

In most ACP states, biofuels have not been standardised as a recognised fuel or fuel blend. This has its impact on the acceptability of biofuels by customers and car guarantees. This is unfortunate as most countries in the EU have established standards for the addition of both bio-ethanol and bio-diesel, which could easily be transferred or modified into ACP national standards, based on the EU experiences. Further work to establish standards for the quality of pure plant oils in adapted engines can also build on the existing German standard for vegetable oils as a fuel and use these even more competitive biofuels in for example stationary engines for power generation.

### 3.3.3 Blending

Biofuels can completely displace the fossil fuels in the corresponding equipment. if it is adapted to accommodate the new fuel, for example in 100% ethanol flex cars. To minimize the costs of switching 100% to biofuels, it is generally simpler to blend the proposed biofuel with the existing fossil fuel in proportions which will not require any modifications to the engine, such as E10, or B10 for diesel vehicles. Careful policies as to the correct level of biofuel blending are thus necessary for each particular occasion. To ensure that the correct infrastructure is in place to accommodate these blends, Oil companies need to invest, for which nationally appropriate incentives are required.

## 3.4 Trade

Bio fuels to be produced in ACP countries are preferably obtained from locally grown crops usually well adapted to the local conditions. Thus, in sugar producing countries, bio-ethanol will be obtainable from the sugar cane. On island countries, biodiesel can be produced from coconut oil; in other countries, palm oil, jatropha, may provide the necessary feedstock. The economies of such industrial initiatives are highly dependent on the current import price of fossil fuel to be displaced. Market volatility of both agricultural feedstocks and fossil fuel prices are therefore the main determinants of biofuel competitiveness. For example, under pressure of the EU biofuel mandate, vegetable oil prices have made a rapid increase, which decreases the viability of local oil sources for biofuel in ACP countries.

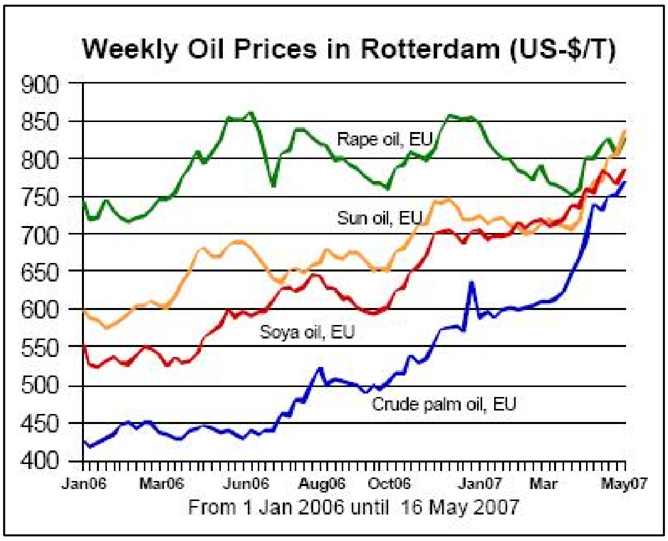


Figure 4: Vegetable Oil prices (source OilWorld, May 2007)

Other ways of financially securing the industrial proposals would be to increase the production capacity to satisfy both the local needs but also to compete with corresponding biofuels on the export market. Right sizing of the industrial complex is thus important to the long term success of the industry. In addition, when going on the export market, transport charges as well as import duties in the targeted countries must be closely examined to guarantee successful competitive prices at the delivery site.

## 3.5 Policies

Even though most ACP states have an energy policy, many are outdated and for example do not actively support the application of renewable energy. To support rural farmers, many countries subsidise the use of kerosene for lighting, cooking and other diesel for power generation and transport in remote areas. In addition, to support farmers, many ACP countries still have support mechanisms to stabilise the prices of farmer produce. These price mechanisms do not necessarily take into account the role that biofuels can play in remote places, substituting fossil fuels and therefore outdated energy policies pose a barrier on the more widespread use of biofuels.

The absence of policies supporting blending of biofuels and the absence of tax benefits to promote biofuels leads to stagnation in the development of the biofuel sector. New agro-energy policies need to address these issues in a more holistic way, so as to optimise on the total net benefits on a country/regional level.

### 3.6 Socio Environmental Issues

The production of crops for biofuels requires improved efficiencies and sustainability in the way land is used as marginal lands can be used. Stringent management must be carried out to achieve maximum yield and high productivity. Agronomic factors, e.g. the rapid increase in the price of fertilisers can negatively impact on the optimum application which will prevent the proper growth and development of the plant. Likewise, the harvesting and management of available water is equally important for maximum production of the crops. Removal of crop residues, such as leaves and stalks, for use in co-generation, can negatively impact on soil structure and promote erosion, thus affecting the eco-system. Therefore strategies for managing crop residues must be developed for sustainability.

There is a potential conflict between using land and water for growing livestock feed, aquaculture ponds, food for human consumption and biofuels. In addition, large-scale palm plantations have been leading to significant deforestation in the tropical regions of the world, resulting in loss in biodiversity.

### 3.7 The role of Science Technology and Innovation

To improve on the availability and quality of suitable feedstock suitable for local conditions, more research is required on the feedstock characterisation and optimisation of feedstock life cycle. In addition, economic analysis on feedstock suitability and appropriate technologies for conversion should provide direction towards cost-effective solutions.

As an alternative to biodiesel esterification, requiring imports of methanol, pure plant oil applications in adapted engines should be investigated further, as well as alternatives to esterification. Also, appropriate biofuel logistics and transport issues need addressing to ensure compatibility with the existing infrastructure. The use of GIS technology for resource assessment provides opportunities to identify feedstock availability in a comprehensive way. Harvesting and storage of the feedstock raw material requires improvement to compaction techniques to increase the energy density. Additionally, biofuel quality standards may require adaptation to suit local requirements.

To answer such questions, research and human and financial capacity is required, however this is often lacking in ACP countries.

## 4.0 OPTIONS

### 4.1 Power Generation

#### 4.1.1 Power Generation at industrial level

Burning solid biomass releases considerable amount of energy, which may to fire a high pressure steam boiler, to produce electricity using a steam turbine.New high pressure technology is now available with higher efficiencies of electricity generated per unit of biomass, thus allowing excess electricity to be sold to the national grid.

In addition, other biofuels such as woody biomass from fast growing species and agricultural waste, may also be used during the out of crop season.

Figure 5: CTSAV Bagasse / Coal Power Plant in Mauritius *(Source: Raymond Rivalland)*

## 4.2 Bioenergy for household and village applications

### 4.2.1 Biofuels

Remote areas in ACP countries can competitively use local sources of biofuels such as palm, jatropha and coconut to produce fuel for power generation at the village level. This requires incorporation of adapted generators and agricultural conversion equipment such as mills and filters into existing rural electrification programmes, which usually only feature diesel generators.

### 4.2.2 Biogas

It is possible to produce biogas from domestic and agricultural waste through anaerobic biogas digesters. The gas thus obtained can be used for cooking, heating both for households and light industrial applications and power generation. This requires cultural sensitivity analysis to ascertain its acceptability for use in the local context.

### 4.2.3 BioGel

BioGel is made from low-grade ethanol and mixed with a gelling agent that can replace wood for cooking, lighting and heating. Use of this fuel will contribute to reduction of forest depletion caused by firewood use.

## 4.3 Promotion Policies

The use of biofuel can be promoted with the rationale of improving the balance of payments, decreasing dependence on fossil fuels and improving the local air quality by including these externalities into the price of fossil fuels through taxation. In addition, duties on biofuel-related equipment, partial duty exemption for biofuel blends and investment subsidies have been shown to boost biofuel sectors in EU countries. Also, a target such as the 5.75% biofuels in 2010 has shown its merits in the EU and could be replicated in ACP countries.


Figure 6: Coconut Oil Retail in Vanuatu *(Source Tony Deamer)*

## 4.4 Biofuels for Transport

Blending ratios are determined by technical, economic and market considerations. For ethanol and biodiesel, up to 10% blending is possible without engine modifications. However, the final blending ratios are influenced by the market for conventional fossil fuels and availability of feedstocks. To obtain optimal blending ratios requires research in feedstock characteristics vis-à-vis environmental and socio-economic considerations. In order to support market development, national quality standards are imperative. Locally appropriate standards in adapted engines for pure plant oils can also be considered.

**Box 1: Success story: "Mauritius cane hub"**

Facing a most severe price reduction of 36% of its raw sugar , traditionally sold to the EU, the Mauritius sugar industry restructured its activities in order to add value to every product related to crystal sugar manufacture.
Cane biomass utilization – bagasse from the milling activities, and cane trash originally left over in the fields – are thus burnt in most efficient boilers in order to generate high pressure steam used in cogeneration to satisfy the factory requirements, and to produce electricity exported to the local grid. Cane biomass presently satisfies 50% of the country's electricity requirements during the crop season.
Molasses, the residue from the crystallization process, - traditionally exported for cattle feeding mainly – is now fermented and distilled to bio ethanol. Bio ethanol may be blended, as it is currently done in Brazil, up to 20% to gasoline for the transport industry. This brings substantial savings to the country's foreign exchange balance, avoiding the import of ever increasing petroleum products.
Raw sugar, traditionally exported to the EU for refining will now be refined locally in state of the art refineries working all year round and fuelled from the cogeneration power plant installed nearby on the cane hub complex. The country will thus benefit from from the refined sugar higher selling price as a partial compensation of the 36% raw sugar price drop.
In line with the success of the cane hub, the local research station (MSIRI), is currently breeding new high fibre canes which will ultimately practically set Mauritius as a self-sufficient energy producer all year round!

## 5.0 Policy Recommendations

### Implement National Biofuel Strategies

ACP Governments should formulate strategies aimed at addressing critical issues such as promoting local demand for biofuels as a share of the fossil fuel market, determine blending ratios; establish biofuel standards, recommend production modalities and consider environmental and social concerns; and providing appropriate incentives.

### Institute Legal and regulatory framework

ACP Governments to set up legal and regulatory framework aimed at guiding and regulating the biofuel industry. Enforce sustainable use of land and resources to avoid negative environmental impact of the biofuel industry.

### Promote integrated agro-energy farming policies

ACP Governments to take into account the interconnectedness of the biofuel industries with livestock, farming, fisheries, and the conservation of forests and watershed areas to ensure maximising national benefits and sustainable development. This integrated approach is also important for coherent and sustainable water and land management.

### Support ACP Biofuel Research

ACP Governments and the EU should support local regional research into suitable feedstocks; process and logistics optimisation; economic analysis for cost effective solutions; adapting and transfer of technologies, such as ligno-cellulosic conversion; searching locally appropriate alternatives to existing biofuels; resource assessment, including the use of GIS and support laboratory capacity for the analysis of biofuel produced to ensure compliance with quality standards.

**References**

Cloin, J. (2007) “Capacity Building for a Sustainable Biofuel Sector in the Pacific”

Dufey, A. (2007) “International trade in biofuels: good for development? And good for environment?”

Ravilland, R. (2007) “Meeting National Energy Needs from Cane Fibre / Cogeneration as an Option "

Steenhuijsen, B. (2007) “How sustainable are biofuels? – Between common curiosity and confronting interests”

Wilson, M. R., Caribbean: Status of Biofuels Research and Capacity Building

Wilson, M. R., (2007) “Biofuels – S&T strategic options for acp countries”

Yamba, F.D., (2007) “Research Needs and Capacity to Support Opportunities and Challenges for Biofuels Development –Southern Africa Perspective”