BIOFUEL AND BY-PRODUCTS

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POTENTIAL MARKETS

The production of oil crops in Namibia will yield not only energy products such as biofuel, but also several other goods and services. Over and above the energy products, there is the added potential for environmental goods and services such as carbon gains and biodiversity conservation, as well as for the rehabilitation of degraded land.

Table 1 summarises a number of product markets into which crop-oil-energy goods and services may be sold, and demonstrates that the term ‘bio-oil-energy industry’ may create the misleading notion that products created through this value chain may be sold in energy markets only. Rather, it is important to realise that these products should be sold to markets that give highest value. A thorough market-sizing study is required to fully describe this type of market and its characteristics.

Table 1. Product markets in the plant-sector

<table>
<thead>
<tr>
<th>Product markets</th>
<th>Plant-oil pathway</th>
</tr>
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<tbody>
<tr>
<td>Cooking oil, protein*</td>
<td>Food</td>
</tr>
<tr>
<td>Liquid fuel - transportation</td>
<td>Mineral-diesel substitute and/or lubricity additive</td>
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<tr>
<td>Liquid fuel - household use</td>
<td>Bioparaffin</td>
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<tr>
<td>Electricity generation</td>
<td>Diesel generator</td>
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<tr>
<td>High-value products</td>
<td>Specialised biodegradable lubricants</td>
</tr>
<tr>
<td>Pharmaceutical</td>
<td>Glycerine</td>
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<tr>
<td>Sanitation</td>
<td>Soap</td>
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<tr>
<td>Seed-cake</td>
<td>Feed-cake (if detoxified), organic fertiliser, electricity</td>
</tr>
<tr>
<td>Other by-products</td>
<td>Glycerine</td>
</tr>
<tr>
<td>Auxiliary environmental markets</td>
<td>Carbon</td>
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</table>

* However, not in the case of Jatropha, which is toxic to humans and livestock.

The start-up of large infrastructure-based industries is greatly facilitated by, if not crucially dependent upon clients who anchor the business. Sales to anchor clients may not necessarily be highly profitable, but they ensure large volumes of sales and steady cash-flow, and therefore minimise the revenue and cash-flow risks faced by start-up businesses. Rapid growth of the crop-oil-energy industry is, therefore, dependent upon the existence of anchor markets. It is envisaged that the production of biodiesel for blending with mineral diesel and for generation of electricity can secure these anchor markets in Namibia.

Liquid fuel

Liquid-fuel consumption in 2005 was approximately 870 million litres, which is approximately 2% of southern African fuel consumption. Of this, 52% was diesel and 44% petrol consumption. The remainder consisted of paraffin, heavy fuel oil and jet fuel. Namibia currently relies fully on imports for these fuels, all of which are from South Africa. Liquid fuel is imported mainly via the Walvis Bay harbour and distributed through a system of fuel depots across Namibia. In the liquid fuel market, with a total consumption of 845 million litres of diesel, petrol and paraffin in 2005, there are three distinct segments:

- Firstly, the wholesale transportation market consists of a small number of multi-national oil companies, with strict product standards, offering prices not higher than the Basic Fuel Price (BFP) of approximately N$4.20 per litre, and distributing liquid fuel from 15 fuel depots across Namibia.

- Then, for biodiesel, there is a niche retail transportation market, located on farms and industrial sites, that includes mining companies, cargo and tour-fleet operators, farmers, cooperatives and others with somewhat less stringent standards requirements, and that offers prices at the retail fuel price of approximately N$5.95 per litre.

- Finally, households in Namibia consumed approximately 4.6 million litres of paraffin in 2005. This is a product with low specifications, that sells at a retail price of N$14 in Rundu (2006).

It is unlikely that fatty acid methyl ester (FAME – ‘biodiesel’) as a replacement for heavy-fuel oil would find a market off-take in large fishing vessels or blast furnaces. Due to crude-oil refinery deficiencies, heavy-fuel oil is in oversupply internationally, and in many instances sells for prices lower than the crude-oil price.

At a national level, an anchor market may be created by imposing a compulsory B5 diesel blend (5% biodiesel to 95% mineral diesel). This, however, will have to be done in consultation with NAMCOR, the Namibian Oil Industry Association and TransNamib, as there will be implications for product cost, product quality, depot infrastructure and transport infrastructure. It is also likely that the blend to
be sold in Namibia will be no different from that of the fuel imported from South Africa. In other words, the enforcement of a compulsory B5 blend in Namibia would be complicated by the fact that in future imported mineral diesel will already contain additives. However, as an indication, a B5 FAME diesel blend in Namibia would imply a market for 22.7 million litres of plant oil per year.

Electricity generation

There is a growing awareness worldwide that the global energy economy should move steadily from its present excessive dependence on fossil hydrocarbon energy to hydrogen energy and other forms of renewable carbon-neutral energy with, ideally, zero emissions. The imperative motives for this obligation include:

- limited life of fossil-fuel stocks;
- security of energy supply;
- volatility of international fossil-fuel prices;
- environmental legislation to reduce polluting emissions;
- improvements in energy efficiency;
- advances in science and technology.

Namibia has a highly energy-intensive economy, despite having a small population that results in modest energy requirements relative to other countries in the southern African region. Namibia’s peak electricity demand is approximately 400 MW, which is approximately 1% of that of South Africa. Namibia imports more than 50% of its electricity from South Africa. Other electricity supply sources include the 120 MW coal-fired Van Eck power station near Windhoek, a 250 MW hydroelectric plant at Ruacana, and the 24 MW Paratus diesel generator (using heavy-fuel oil) at Walvis Bay. A new transmission line to connect to the regional grid via Zambia is due to be commissioned in 2006. Another 9 MW of diesel generation capacity exists across the country, with 2 MW capacity at Katima Mulilo and the rest on commercial farms.

Although the electricity grid is well developed, it does not yet fully serve the rural population. The Rural Electrification Master Plan identifies a substantial requirement for off-grid electricity generation to serve local communities and services. Furthermore, the second National Development Plan (NDP II) identifies a number of sites for small-scale power generation in rural areas, about 11 in all for the Caprivi and Kavango Regions together. There is huge potential for these generators to be run on biodiesel. In addition, electricity generation projects based on diesel replacement lend themselves excellently to Clean Development Mechanism (see below) fuel-switching approaches.

Off-grid electricity generation projects, therefore, coupled with CDM, may provide anchor markets on which to base a biodiesel industry. With future grid extensions in mind, consideration may also be given to hybrid systems that will primarily deliver off-grid power, but may also sell electricity to the grid at peak times.

Soap

Although the soap market may never provide the anchor market described in the section above, it may provide small niche markets for microbusinesses. One of the greatest household needs in the rural north, as identified by the Philadelphia Orphans NGO, is soap for household use. In communities where soap is not available or is too expensive, this cottage industry will develop quickly. The experience in both Zimbabwe and Mali of the early *Jatropha* oil production was that the women of the area ‘commandeered’ it for soap-making projects. Laundry and bath soaps are made for their own home use and for sale to local shops. Many of these projects have continued to the present day.

Inputs, apart from the oil, consist of caustic soda (sodium hydroxide), water and personal effort. The caustic soda can be successfully replaced by lye, from wood ash soaked in water, to create a liquid soap. In India a major commercial soap manufacturer is using *Jatropha* oil in place of animal tallow. In Zimbabwe the major soap manufacturer (Olivine Industries), after carrying out trials with *Jatropha* oil, confirmed that this oil could replace animal tallow if the supplied quantities and quality of the oil could be assured.

Anecdotally, *Jatropha* soap exhibits skin care properties far better than most commercial/super-market soaps. Users frequently claim that *Jatropha* soap is particularly good on sensitive skin, in cases of psoriasis and eczema and in the skin problems experienced by AIDS sufferers, while common commercial soaps tend to aggravate the condition. A simple cold-mixing process allows for all the basic ingredients of the oil to be retained, including the glycerol fraction (which is removed in commercial hot processes).

Actual profit margins at village level would need to be calculated using each village’s own input and return figures, which will vary according to distance from and means of supply, and other factors. However, as a rough guide, the profit from selling basic soap in the village should be in the region of N$5 to N$10 per litre of oil used. Assuming every person in Namibia would use one bar of soap per month, and every visitor to Namibian tourist overnight facilities would use one soap bar per visit, Namibia could have a demand for approximately 25 million bars of soap per year.

The tourism industry is the third-largest economic sector in Namibia, and may provide an excellent niche market for indigenous soap products. With the simple inclusion of one or more of the essential oils (e.g., lavender, tea-tree, citronella, lemon grass, etc.) in the soap mix, and/or colourants and exfoliation ingredients, the tourist market can be accessed with ‘a handmade, pure *Jatropha* soap’. Nature-based tourism being Namibia’s third-largest source of foreign revenue (with mining and fisheries in the lead), eco-labelled fuel and soap present interesting marketing opportunities.
Lubricants

Plant oil is a high-quality biodegradable lubricant that may be used, for instance, in the forestry and garden maintenance industry to lubricate chainsaws. In the commercial forest industry in particular, environmental standards such as those dictated by the Forest Stewardship Council (FSC) encourage the use of biodegradable products in forestry.

Seed-cake

By-products obtained from the crop-oil-energy generation processes produce important revenue streams. In the case of biodiesel especially, these include seed-cake that remains after the seed-extraction process. The revenue received from seed-cake will contribute significantly to the feasibility of crop-oil projects. This effect will be more pronounced for annual crops, such as soy, with a lower oil yield.

Seed-cake is essentially a source of protein. These markets, therefore, include animal-feed (if seed-cake is detoxified, in the case of Jatropha), fertiliser markets and electricity generation, including on-farm use.

Glycerine

Other by-products include glycerine, which forms during the trans-esterification process and may be sold to pharmaceutical markets.

Substitution for fuel wood

Namibia has a large rural population that is extremely reliant on fuel-wood energy. It is estimated that 520 000 tons of wood is used for this purpose annually, and that 63% of all households in the country rely on fuel wood.

THE CARBON MARKET

The Clean Development Mechanism (CDM), as an avenue to access the international carbon market, is available to Namibia as a signatory to and Non-Annex I country (meaning that Namibia qualifies as a potential seller of carbon-offset certificates) under the Kyoto Protocol. CDM is a market-based instrument to promote carbon-emissions control and yields a saleable certificate known as Certified Emissions Reduction (CER). Ancillary carbon markets, such as the European Union Emission Trading System (EU ETS) and a number of other country carbon-trading exchanges (in the UK, Australia, USA, South Africa) have also developed. Furthermore, a voluntary carbon market is emerging, with buyers such as FIFA (during the past World Cup) and other large conference organisers, and specialist funds at the World Bank, World Food Programme and governments. These organisations purchase carbon-emission reduction certificates, known as Verified Emissions Reduction (VER), as a means of social responsibility or as a donor-funding mechanism.

In either case, the trade is based on a verified and audited proof of carbon gain or offset according to the Kyoto Protocol and Marrakesh Accord rules, which are contained in a limited set of instruments called CDM methodologies, each being different for different kinds of projects. The window for CDM-based carbon trading will last until 2012, at which point the United Nations and signatories to the Kyoto Protocol are expected to reassess the effectiveness of the various carbon-market instruments. Although it is widely expected that there will be a market after 2012, no guarantees currently exist on which to base project financing beyond this period.

CDM holds tremendous promise for Namibia as a means of foreign direct investment and technology transfer, but it is also fraught with risk and uncertainty. There are various CDM methodologies that may be applied to earn CERs. The process is extremely complex, demanding and expensive. Simple CDMs, for which approved methodologies already exist, may cost between N$300 000 and N$600 000. In cases where the development of new methodologies is required, the transaction cost may be three times as high. It is estimated that there is a 10% success rate for eventual registration of potential CDM projects with the CDM Executive Board. Methodologies that have had the highest CDM success rate have been mostly for various power-generation, fuel-switching projects. The methodologies with the lowest success rate have been for reforestation and afforestation projects.

Although CDM methodologies may be applied to various segments of the processing chain in the plant-oil-based industry model relevant to this Roadmap, the earning of CERs for more than one methodology in the same value chain is not permitted. For instance, where Jatropha is planted under an afforestation regime and the oil used as a mineral-diesel replacement in power generation, it is not possible to earn CERs for both methodologies, because this would result in double accounting. In such a case, the best is to apply a fuel-switching, power-generation methodology: this is easier to apply and is a methodology with a higher approval rate than that of the afforestation methodology. The benefits of the CDM may then be passed backward into the value chain, through transfer-pricing. Clearly there are no hard and fast rules for CDM application, and each project should be designed and approached on its own merits.

A critical aspect of CDM is the requirement for Additionality. According to the United Nations Framework Convention on Climate Change, a CDM project is additional if anthropogenic emissions of greenhouse gasses are reduced below those that would have occurred in the absence of the registered CDM project activity. This may have the following practical implications: it is ideally targeted at projects that are not feasible without CER-derived income; and, if project implementation were to start before CDM Executive Board approval, it could stand the risk of failing the Additionality criterion.

By 2012, Namibia could earn at least N$4.5 million in CDM revenue. This could be realised by commissioning twelve B100-diesel generators of 1MW capacity, each requiring about 2 million litres of fuel per year. In total, 24 million
litres of FAME, produced from 24 000 ha of *Jatropha* plantings, can replace the equivalent of 61 000 tons of fossil-fuel-based carbon emissions, according to IPCC guidelines. At a current price of about N$70 per ton of carbon, this equates to N$4.5 million in CDM revenue, or N$375 000 additional income per generator. This revenue may, of course, be received every year from project commissioning. The situation after 2012 is uncertain.

**MARKET CONSIDERATIONS AND RISKS**

The nature of market segments to which crop-oil-energy products may be sold requires a thorough market-sizing exercise, as purchasers in these market segments have unique product standard, price and logistical requirements.

**Distance from the market**

The areas with high agricultural development potential in Namibia are far removed from the large domestic markets around Windhoek, Swakopmund and the port at Walvis Bay. Bio-oil-energy products lend themselves to a number of avenues to address this. Firstly there are both existing and new local markets for liquid-fuel consumption, household products such as soap, and the potential development of secondary transport hubs around Rundu and Katima Mulilo as part of the Trans-Caprivi Corridor Project. Secondly, diesel may be used as a power-generation source, to be fed into the national electricity transmission grid, thereby accessing the national power market without the burden of prohibitive transport costs.

**Price**

Globally, the supply chains of both the power-generation and the liquid-fuels industries are controlled by governments via their institutions, and large multi-national corporations. Vertical integration is thus strong in these supply chains, which operate at very large economies of scale and are subject to transfer-pricing mechanisms. Hence prices are firmly regulated.

In both the electricity and the liquid-fuel markets, the commodity prices of the main raw materials used (coal, crude oil) and the final products are linked, meaning that a rise in the raw-material prices leads to a corresponding rise in the final product price. However, agriculture-based raw materials have different commodity cycles, so there is the risk of a price squeeze in cases where rising crop prices may coincide with falling crude-oil prices.

Countries that have successfully implemented biofuel strategies have managed to find ways of countering this risk. A new crop-oil-energy industry in Namibia, therefore, requires the government to administer pricing mechanisms that provide incentives for new initiatives and protect these initiatives from external price shocks.

**Standards**

A characteristic of the formal energy market worldwide is that it is strongly regulated. In addition to price regulation, there are other regulatory tools, such as numerous quality standards (ASTM, BS, DIN, EU, and SABS) for petrol and diesel fuels. These standards align closely, usually differing only according to geographical considerations (e.g. colder northern hemisphere climates). The blending of FAME into diesel requires adherence to these standards. FAME has to be manufactured to particular standards, therefore. The South African Bureau of Standards (SABS) has recently developed standards for FAME for SA (SANS 1935:2004), which specifications may also pertain to Namibia.

Some market segments may be satisfied with products of lower specification, but this would depend on the application of the fuel, i.e. in what type of vehicle it is used or whether it is used for power generation. It must be noted here that poor product standards or poor product control may be severely damaging to a new crop-oil-energy industry. In Australia in 2002, reports of high bio-ethanol blends causing various vehicle-performance problems dented consumer confidence and set the Australian ethanol industry back by an estimated three to five years.

**Fuel blending and storage**

Quality control in the blending of FAME into mineral diesel is much easier than it is for ethanol into petrol. Splash-blending of FAME into mineral diesel is performed with relative ease. FAME has a somewhat higher specific gravity (±0.88) than mineral diesel (±0.85) and should therefore be splash-blended on top of the mineral diesel. Biodiesel blends do not separate in the presence of water, and may be stored in standard diesel-storage tanks.

**Technology warranties and tolerance**

Engine manufacturers design, develop and standardise vehicle engines and generators according to specific fuel standards. Therefore, the warranty conditions of the particular technology supplier must be carefully considered, as these conditions may be limiting factors in the development of a crop-oil-energy market in Namibia.

In the liquid-fuel market, diesel-fuel-injection manufacturers usually refuse to warrant the use of FAME blends exceeding B5 unless the engine has undergone slight modifications. This allows for a rough estimate of the biodiesel wholesale market in Namibia to be approximately 22.7 million litres per year (454 million litres mineral-diesel consumption x 5%). Perkins and Caterpillar generators do not recommend the use of FAME blends exceeding B30, because of possible problems with filter clogging. However, some vehicle manufacturers, most notably John Deere, produce vehicles warranted for B100, pure biodiesel.

**Environmental standards relevant to fuels**

Various environmental standards regulate the negative impact of fuels on the environment, as concerns air and water pollution. Such legislation has boosted the large-scale use of catalytic converters, unleaded petrol and low-sulphur
The numerous potential product markets for crop-oil-energy products (and specifically for FAME products) are new and undeveloped, and consequently entail risk for entrepreneurs. The government, through the NABEC, has a large role to play in reducing market risks to acceptable levels. This may be achieved by means of a number of policy instruments, which include:

- **Budgetary assistance**, for instance, by dedicating large GRN vehicle fleets to biodiesel consumption;
- **Economic incentives**, such as fuel or other tax exemptions, grace periods or concessions;
- **Price protection**, for example through an Equalisation Fund against falling crude-oil prices; and
- **Market regulation**, such as fast-tracking of processes to remove market barriers;
- **Formalising quality standards**. It is anticipated that FAME quality standards may be based on the existing RSA standards.

These policy instruments should have two goals: establishment of anchor markets to secure off-take of plant-oil products, and opening of other plant-oil products markets.

The establishment of anchor markets is crucially important. At this stage, there are three possibilities that require immediate investigation:

- Compulsory blending of FAME into mineral diesel up to a B5 level may be considered. Such an initiative should, however, be conducted in consultation with NAMCOR, the Namibian Oil Industry Association, and TransNamib, as there will be implications for product cost, product quality, depot infrastructure and transport infrastructure. However, imported fuels from South Africa are likely, anyway, to have a B4 or B5 blend in the near future.
- Namibia’s rural electrification plan may act as an anchor, with biodiesel being used to fuel diesel generators.
- Another opportunity may materialise from the development of the Trans-Caprivi Development Corridor, in which the Walvis Bay Corridor Group is planning the development of secondary transport hubs at Katima Mulilo and Rundu. Within these developments, markets for FAME products may be created.

CONCLUSIONS AND IMPLICATIONS

There are several requirements for **CDM implementation**:

- The government of Namibia must ensure that the regulatory processes for CDM are in place and properly capacitated. A Namibian Designated National Authority (DNA) must be established and empowered through legislation, in order to certify certain issues as an Executive Board prerequisite for registration of any CDM project. Procedures for evaluation of environmental impact assessments (EIA) and sustainable development criteria must also be in place. Private investors should be encouraged to be as innovative and entrepreneurial as possible in developing projects. It should be left to these entrepreneurs to decide which CDM route they prefer, if any. A functional DNA will regulate these CDM applications.
- The government may actively participate in carbon-trade projects through bi-lateral agreements with countries such as Germany and Holland. Such agreements may be based on either CDM or voluntary transactions, and may yield foreign direct investment to Namibia, which investment may be put towards project financing or fund underwriting.

Clearly there are no hard and fast rules for CDM application, and each potential project should be designed and approached on its particular merits. However, it is worth noting that lower transaction costs, shorter lead times and higher probabilities of success may be achieved if existing, widely applied CDM methodologies are used. This means that fuel-switching projects might be easier to register with the CDM Executive Board than those, such as afforestation projects, at the primary production end.

It is inadvisable to make the carbon market an end goal; it would be wiser to regard it as an option that may turn marginal energy development projects into feasible projects.