GreenCape

Biofuels:
from viability to pilot projects

Overview Report

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Acknowledgments

Project funding:

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The contributions from the steering committee throughout the year is much appreciated. Details of the steering committee members are provided below.

Name	Organisation
Lise Jennings-Boom	Department of Environmental Affairs and Development Planning
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Anthony Williams	Independent (former Biiofuels Project Manager)
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Overview

The *Biofuels: from viability to pilot projects* project was commissioned by the Department of Economic Development and Tourism (DED&T) to determine the potential for biofuels from various feedstocks in the province; particularly from waste resources (including agricultural residues) and non-food crops.

The objectives of the project were as follows:

- To confirm the general viability of biofuels from wastes and non-food crops in the Western Cape to help establish an expanded and diversified agriculture and agro-processing sector in line with the Western Cape's Green Economy Strategic Framework
- To assess the contribution of biofuels in the reduction of the Western Cape's carbon footprint
- To quantify the number of jobs that can be created in the biofuels industry.

To achieve these objectives, the project had two deliverables:

- **Deliverable 1: evaluate alternative biofuel production options, identifying preferred and credible options based on a multi-criteria analysis approach**, incorporating the criteria of local feedstock production capacity, local market demands for biofuels, economic viability, socio-economic benefits (expansion of agriculture and job creation) and environmental benefits (GHG reduction potential).

- **Deliverable 2:** Prior work had identified triticale-based bioethanol production, combined with animal feed production, as a preferred option for the Western Cape Province. The second deliverables aimed to **build new and detailed process simulations for triticale-ethanol production**, taking into consideration process options not previously considered, while also reworking economic models, taking into account newer legislation on ethanol pricing and blending, as well as the market values of animal feeds.

The first deliverable was completed in-house in GreenCape, while the Process Engineering Department of the University of Stellenbosch was commissioned to complete second.

Deliverable 1: Overview and Key Findings

Three biofuels were considered: bioethanol, biodiesel and biogas. For each, the viability was considered according to project scale: small, medium and large. For the liquid biofuels these divisions were as follow large >60 million litres (ML), medium (1.2 - 60 ML) and small (<1.2 ML).To provide detailed insights for investors, projects that showed significant potential were investigated in detail. The following were considered as having potential for further consideration: large and small scale bioethanol, as well as large and small scale biogas.

For large scale bioethanol, the viability of a 160 million litres/year facility utilising the following grains was explored: triticale, sorghum and low grade wheat. Triticale-based bioethanol emerged superior. However, for viability, triticale would still require a subsidy, primarily due to the low basic fuel price (BFP). The government procurement process for large scale ethanol (and other biofuel) is under review – the work thus forms a basis for investors considering bids in any new large scale bioethanol production processes. It is likely that only one such large scale facility would be set up in the Western Cape.

Small scale bioethanol facilities using agricultural residues (e.g. fruit pomace) of up 1.2 million litres/annum in total may be economically viable. These merit more detailed investigation particularly due to the potential to extract high value compounds from the residues prior to ethanol production.

The bioethanol work has been supply-side focused. It is recommended that opportunities on the demand side merit further consideration i.e. the use of bioethanol in innovative ways, e.g., as a cooking fuel in stoves that can operate on E50 (50% ethanol: 50% water) or ED95 diesel replacement engines (currently produced by Scania)

For biodiesel, large and medium scale generally not viable given lack of feedstock, current fuel price and regulatory framework. Canola grown for the purpose of biofuel production has some potential, but faces competing demand in the food value chain as well as challenges in terms of the food versus fuel dilemma.

For biogas: in the Western Cape, there is significant potential to generate energy from waste streams via anaerobic digestion (small, medium and large scale) in the province. An estimated 1000-1600 MWth (up to 500 MWe) can be generated, most of which would be from the animal husbandry sector. Wastewaters and "organic fraction of municipal solid waste" (OFMSW) could contribute approximately 25% to the estimated potential. The biogas area merits investment support (especially to the animal husbandry sector) as the current energy crisis, energy price increases and a potential demand for green energy are strong drivers for the development of this industry in the short term.

The diagram below summarises the key findings discussed above, categorised into immediate, medium and long term opportunities.

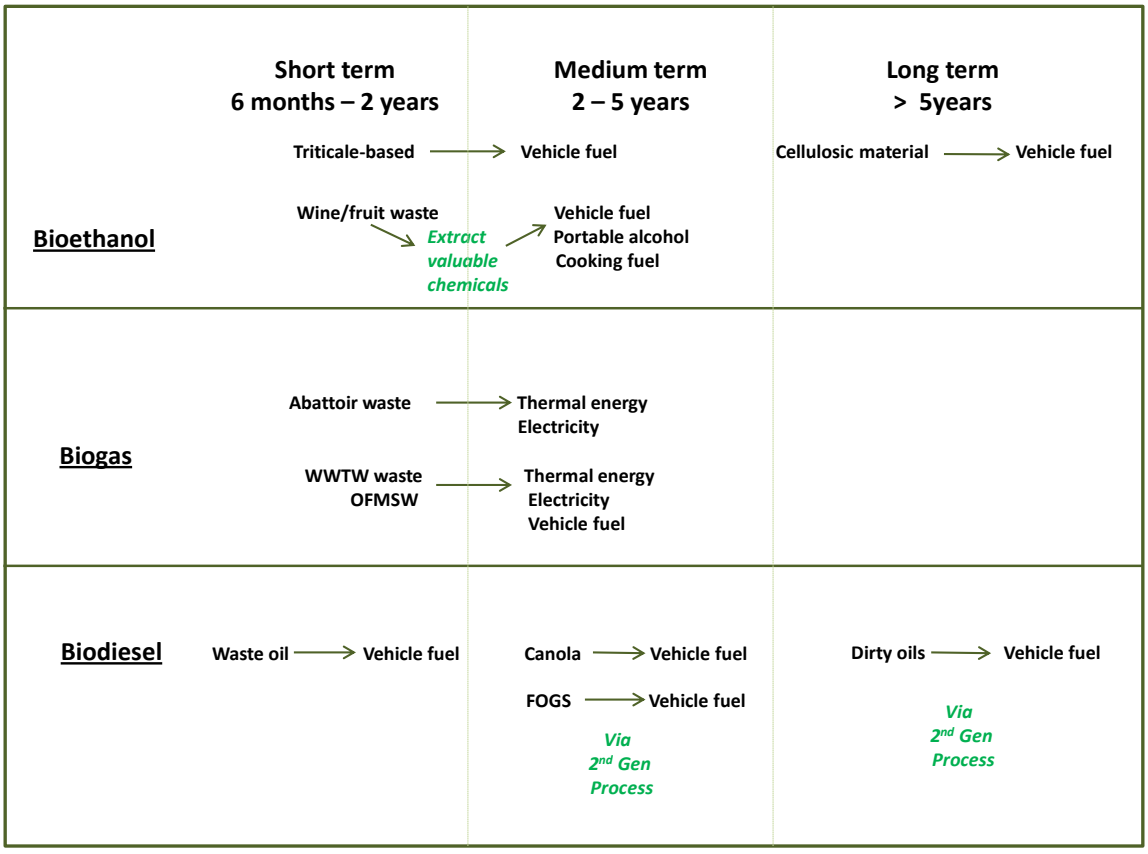

Figure 1: A snapshot of opportunities and relevant timelines for exploitation

Deliverable 2: Overview and Key Findings

The impact of process technology selection for triticale-ethanol production on conversion efficiency, profitability and environmental impacts (greenhouse gas emissions) was examined. Triticale is particularly attractive as a bioethanol feedstock as it has benefits in terms of improving soil quality as part of a crop rotation cycle and can also be grown on marginal land. Three alternative process technologies were compared through detailed modelling of process steps, energy balances, economics, CO_2 emissions and water requirements. The three processes are:

(1) the conventional dry grinding process with higher temperatures in mashing ("warm" process)
(2) the conventional dry grinding process with lower mashing temperature ("cold" process),
(3) processes with dry grinding that include pre-fractionation for removal of the hull from triticale prior to fermentation (pre-fractionation processes).

Details of the sensitivity of the economics to fuel price and feedstock price as well as the trade-offs inherent in the selection of the various processes described in detail in the full deliverable report. The work demonstrates the merits of the pre-fractionation process as this produces a valuable by-product, dried distillers grains and soluables (DDGS), with a high protein content that can be used for animal feed. The work highlights the importance of using a non-fossil energy source if the process is to have a net benefit in terms of greenhouse gas emissions. The use of biomass (e.g. alien invasive plants) merits consideration and should be pursued actively as an energy source in parallel to the development of the bioethanol industry in the Western Cape.

Future Work

Going forward in 2015/2016, the work will build on the insight gained from these two deliverables. In the short term, support will be given to biogas project developers, particularly in the animal husbandry sector to assist them in progressing their projects (e.g. through technical support, assistance with the understanding the regulatory environment and overcoming other known barriers, identifying potential sources of project finance). Work will also be done to identify barriers to the utilisation of biogas at waste water treatment works. The insights from the detailed triticale based ethanol production can also be used to support investors in this area to understand the implications of different technology choices and to provide some of the key insights gained in terms of economic, environmental and social benefits and trade-offs into the national policy framework for the large scale production of bioethanol for blending purposes.