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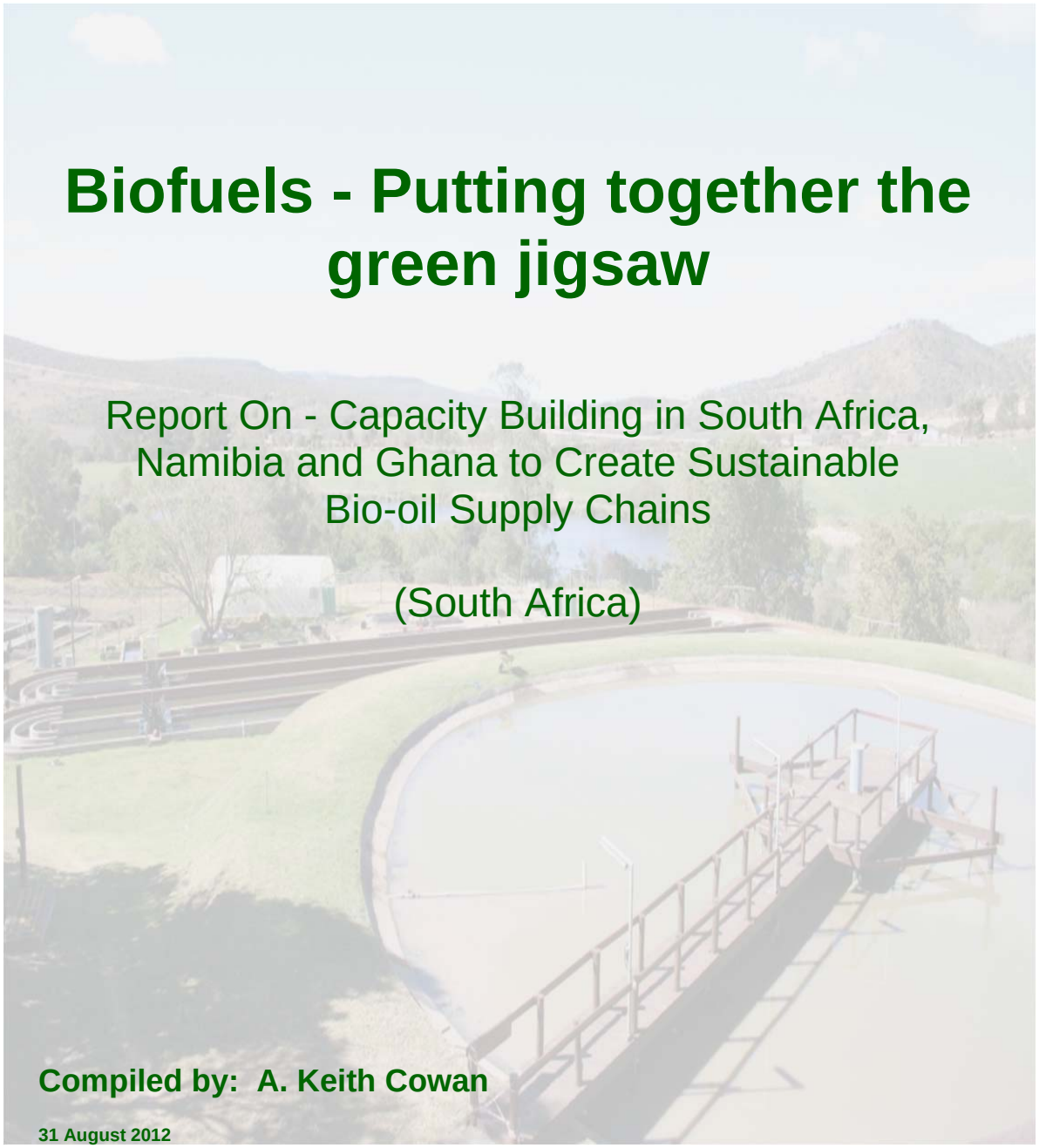


Biofuels - Putting together the green jigsaw

Report On - Capacity Building in South Africa, Namibia and Ghana to Create Sustainable Bio-oil Supply Chains

(South Africa)

Compiled by: A. Keith Cowan

31 August 2012

The Institute for Environmental Biotechnology
Rhodes University
E B R U

1. Preamble: The aim of the investigation is to interrogate case studies that have been aimed at either supporting or adopting biofuel technologies or the biofuel supply chain in order to assess:

1. Impact on jobs, women in society, wealth creation
2. Impact on agricultural practice
3. Contribution of stakeholders (government, local authorities, regulators, other) in the biofuel supply chain.

The context of the investigation is: biofuel supply chains (see Fig 1) in both Africa (Ghana, Namibia and South Africa) and Europe (Italy and the UK).

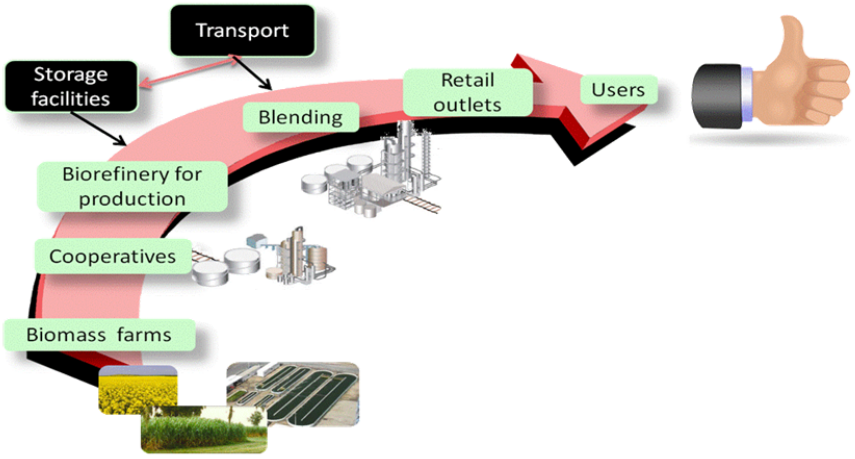


Figure 1 Elaboration of a generic biofuels supply chain

A minimum of five biofuels companies previously identified by Turner & Townsend and in collaboration with University of Greenwich, formed the basis of the study. Following identification of postgraduate student volunteers and training (provided by Merita Wickens of Turner & Townsend) each selected his/her case study and embarked on background research. The accumulated information sourced from the press, internet, company web sites, email contact etc. was used to design appropriate interview templates prior to stakeholder interviews. Thereafter, interviews were conducted either per telephone (Skype) or face-to-face and the interviewers tasked with compiling written reports based on audio recordings/interviewer notes detailing outcomes of discussions from each of the interrogations. Copies of the five reports are included as part of the document.

Interviewers were then debriefed in an exit interview which was aimed at determining the value of the training, the interview exercise, and an overall assessment of the support for adopting biofuel technologies and the associated biofuels supply chain with emphasis on 1) impact on job and wealth creation, 2) agricultural practice, and 3) the contribution of governments, local authorities, regulators etc. in the biofuel supply chain. What follows is a description of the activities carried out and an evaluation of the findings.

2. Scope of work: As set out in the quotation submitted to the University of Greenwich the Evaluation of Biofuel Case Studies in South Africa was carried out according to the Terms of Reference (ToR) of the African Caribbean & Pacific Group of States (ACP) Science & Technology Programme – Sustainable non-food sources of oil – and it was agreed that The Institute for Environmental Biotechnology, Rhodes University (EBRU) would conduct the data collection and reporting as follows:

1. One day training provided by Turner & Townsend (at EBRU);
2. Interviews scheduled and carried out included Ethanol Plant (Caddock, Eastern Cape Province), Three Crowns Community Biogas (East London), PhytoEnergy (Cape Town, Western Cape Province, per telephone), Mabele Fuels (Bothaville, Free State Province, per telephone), Algae-to-Energy System (Grahamstown, Eastern Cape Province);
3. Debriefing of reporters and compilation of final report;
4. Submission of report to University of Greenwich/Turner & Townsend by 31 August 2012.

3. Selection of student reporters & training: As specified in the terms of reference (ToR) student volunteers were selected based on their willingness to be trained in the relevant techniques, their level of qualification and experience, and skills competence in written and verbal communication. Following an introduction to the project (presented by Prof AK Cowan) and discussions with prospective candidates on the training and task ahead the following candidates were selected;

Ms Lerato Sekhohola – PhD student – Research field: Bioremediation of waste coal (yr. 3)
Ms Prudence Mambo – PhD student – Research field: Waste water treatment (yr. 1)
Ms Lwazi Madikiza – MSc student – Research field: Microbial solubilisation of coal (yr. 2)
Mr Dirk Westensee – MSc student – Research field: Biological polishing of waste water streams (yr. 1)

Mr Westensee was included as an alternate in the event that another student was for whatever reason unable to fulfill their obligations.

All candidates attended the one day training provided by Merita Wickens of Turner & Townsend at EBRU offices in Grahamstown on Friday 15th June 2012 and received instruction and electronic and hard copies of the "Business Support Training for Biofuel Sector Training" manual.

4. Selection of case studies & background information: Of the six case studies for analysis in South Africa student reporters elected the following;

Algae-to-Energy Grahamstown, Eastern Cape Province
Biogas for Community Electricity, Eastern Cape Province
Biodiesel from canola, Eastern Cape Province
Ethanol Plant, Eastern Cape Province
Mabele Fuels, Free State Province

Each was tasked with conducting a background search to compile a basic information sketch of the biofuels project to be scrutinized, identify the key role players, and determine contact details. The background information thus obtained was provided to Turner & Townsend upon request and is presented below for completeness.

4.1 Algae to Energy Systems - The algal waste water treatment demonstration scale system, which is based on the pilot plant found at the Institute for Environmental Biotechnology – Rhodes University (EBRU) in Grahamstown in the Eastern Cape Province, will manifest at the Alice Waste Water Treatment Plant. The demonstration scale system (0.7-1.0 ML/d) will use the high rate algal pond system to treat wastewater for the Fort Hare Agricultural Park which with its piggery, dairy and vegetable production will produce sufficient food to prepare 55 000 meals per day for school children in the region. As part of the food production system energy is required for vegetable dehydration and storage and at present this is sourced from the national grid. It is intended that with wastewater treatment sufficient algae biomass will be available for use as feedstock for anaerobic digestion to biogas and that biogas will replace the need for electricity from the national grid. The project will be carried out in collaboration with Royal Haskoning/DHV (previously DHV-SSI) and funding has been provided by the Dutch funding agency, Partners for Water. Fort Hare University who own the Alice WWTP is the client in this project and they too have contributed financially. Project initiation is scheduled for 1 October 2012.

Stakeholders and individuals to be contacted: EBRU, Prof Keith Cowan (a.cowan@ru.ac.za); Royal Hass Konning/DHV, Jan Theron (jant@ssi.co.za), Jaap Butter (jaap.butter@rhdhv.com), Frans Horjus (frans.horjus@rhdhv.com); University of Fort Hare, Alan Shaw (ashaw@hyperlink.co.za)

4.2 Three Crowns (Integrated biogas for rural schools) - Three crowns is a school in Lady Free district. Peoples Power Africa was appointed by Coastal Environmental Service to design and implement a pilot integrated biogas system for rural schools as part of the Development Bank of South Africa (DBSA)-funded Chris Hani District Municipality environmental support programme. The DBSA funds helped to build a biogas digester powered with wind energy. The system was designed specifically to support and complement the existing Wildlife and Environment society of South Africa (WESAA) school garden and feeding programme in the district. The pilot biogas system was built to provide robust low maintenance sanitation for the 170 staff and pupils at Three Crowns school, co-digestion of the associated kitchen waste (17 kg/day), renewable energy in the form of biogas for cooking, nutrient recycling in the form of pathogen free algal biofertilizer and recycled pathogen free water for irrigation of the school gardens. The programme demonstrates the viability of the integrated biogas technology as an appropriate technology/system for roll out at rural schools and as an effective sanitation system. It also demonstrates practical life science laboratory that teaches through the practical demonstration of important sustainability concepts and technologies such as: zero waste, environmental biotechnology, renewable energy production, resource recovery, recycling and support and integration to climate resilient local agro-ecological food production systems. The social and ecological impacts are predicted to include: improved school attendance, staff motivation and loyalty, improved public health due to improved sanitation and nutrition for children in the community, savings in cost for LP gas (including transport), the increased security of supply of energy, nutrients and water. There are also employment opportunities for supervision of the system, reduction in economic outflows to oil and petro chemical companies, increased food gardening, energy production and tourism (the school and community could be benefit financially from tours of the system).

Stakeholders and individuals to be contacted: WESSA, DBSA, Chris Hani District Municipality, ESKOM (energy and sustainable programme), Department of Education Lady Frere office, Peoples Power Africa (Mark Wells, mark@forestvale.co.za, 0835006276), Finishes of Nature, Department of Economics and The three Crowns School.

4.3 Biodiesel from Canola - Phytoenergy was established in 2004 and consists of a group of companies, mainly from German and South African project developers. A company like this consists of many experts within their field of study, which include cultivation specialists, life scientists, financial advisors, agronomists, energy market macroeconomists, system engineers, plant engineers, CPA's and lawyers. This company is in close cooperation with provincial and national administrators for the planning and implementation of a biofuel industry in South Africa. The company's main aim is to develop a project/initiative for implementation of a 400 000 ton/ per year biodiesel plant in South Africa. It aims to secure feedstock of canola (rape seed) under a unique sustainable agrarian model, which is supported by the national Department of Agriculture, Forestry and Fisheries, and which also provides guidance for industrial scale energy crop and food crop production in the Eastern Cape Province. Phytoenergy is in close cooperation with BEE (Black Economic Empowerment) development programme that is responsible for capital costs (R 3.5 billion). This biodiesel refinery was built in the East London development Zone which was completed at the end of 2011. Phytoenergy is a worldwide company with projects in the Ukraine and India and therefore part of the European Phytoenergy Group. Agreements on long-term supply have been protected in Europe. The Phytoenergy Group have been collaborating with various South African and German financial institutions for future funding. The Eastern Cape has a number of projects with regard to producing biofuels. This company is trying to avoid criticism from various other companies with regard to canola cultivation. Canola is a winter crop and cultivation would be in rotation with wheat and maize, which are summer crops. The rotation of the crops is expected to increase food crop yield by 25%, therefore this group supports the technology. Canola (rapeseed) is the principal oil used for biodiesel in Europe; mainly because of its winterization properties (it does not become viscous in winter) (Musango et al, 2010). This project also has a tremendous influence on the Mass Food Production Programme for the Eastern Cape Province. This project aims to benefit local communities in the area by creating 350 jobs for the biodiesel plant, BEE (Black Economic Empowerment), skills development, empowerment of local farmers and food security improvement. Biodiesel industry development is a new agrarian transformation plan for the Eastern Cape and this project is under the Accelerated and Shared Growth Initiative for South Africa (Asgi-SA). Asgi-SA is a government strategy aimed at boosting economic growth to reduce unemployment. Most of the biodiesel produced from the canola oilseeds will be exported to the European markets. The EU Biofuels Fuels Directive needs a 5.75% volume use of biodiesel by member countries. They also set an objective of 20% of energy resources to be substituted by 2020, which includes biofuels, hydrogen, natural gas and other alternative fuels. The reason why the project is in South Africa is because there is a shortage of land for cultivating suitable crops in many European countries; therefore they rely on imported biofuels feedstock (Musango et al, 2010).

Musango JK, Amigun B, Brent AC. 2010, Understanding the implication of investing in biodiesel production in South Africa: a system dynamics approach. Council for Scientific and Industrial Research (CSIR), Stellenbosch, South Africa. URL: http://www.systemdynamics.org/conferences/2010/proceed/papers/P1198.pdf

Stakeholders and individuals to be contacted: Charles Warren Hansen (KPMG) – 011 0835 053 or 083 440 8239, Erich Schmollgruber – eschmollgruber@phytoenergy.org, Jochen Schwaiger - jschwaiger@phytoenergy.org (overseas), Klaus J. Eichhorn - keichhorn@phytoenergy.org (overseas), Dr. Gerald Danner, Managing Director - gdanner@phytoenergy.org (overseas), Mr. Petrus Fouche - Phone & Facsimile: +27(021)8538004 Mobile: +27(082)7791609 pfouche@phytoenergy.org

4.4 Ethanol Plant (Sugar Beet RSA) - This bio-ethanol project will be implemented at Cradock in the Eastern Cape Province by the Agrarian Research and Development Agency (ARDA) formerly known as Sugar Beet RSA. The project concept has already been proven at pilot scale and construction of a commercial plant is anticipated to commence by the end of 2012 and is expected to be fully operational in 2014. The plant is expected to produce approximately 2 million litres of ethanol annually from sugar beet and sorghum grain which will be used as feedstock. The project is estimated to cost $258.5 million and has been funded by the government of South Africa. As part of the project an estate has been established for irrigation in the Great Fish River Valley,

with the support of the National Department of Rural Development and Land Reform. Small scale farmers will be involved in planting of sugar beet and sorghum.

Stakeholders and individuals to be contacted: Sugar Beet RSA/ARDA, Mr Zingisa (zingisa@ardasa.co.za), Mr Thabo Kekana (ThaboK@idc.co.za), Ascot Office Park 1, Ascot road, Port Elizabeth, Tel: 048 881 2778; National Department of Rural Development and Land Reform, Mr Mthetheleli Gengele (MEGengele@ruraldevelopment.gov.za) 11th Floor Caxton House, East London, Tel: 043 700 7000

4.5 Mabele Fuels - Mabele Fuels Pty (Ltd) is a registered company of the Republic of South Africa that manufactures fuel grade ethanol from grain sorghum for sale to the South African biofuels market. The company was founded and incorporated in 2005. Eventually the company will produce 153 million litres of fuel grade bio-ethanol per year and will come online in the second quarter of 2014. Emerging farmers and the Noble Group will be responsible for ensuring a constant supply of feedstock to the plant. The South African government supports this initiative and this was published in the Draft strategy regarding the blending of biofuels with petrol and diesel termed the Accelerated and Shared Growth and Investment Program (ASGISA). Mabele Fuels is located at Bothaville in the north western Free State. The town hosts one of the biggest agricultural festivals in the world NAMPO. Bothaville is also the location of the head office of Grain South Africa.

Stakeholders and individuals to be contacted: Management, Philip Bouwer- (BA. LLB. UCT), Asogan Moodaly- (Eng (ECSA)), Leo van Niel- BSc (Chem. Eng.) MSc. MBA. Corporate Partners, Standard Bank, Rockbury, Noble Resources, Sterling Waterford Holdings and Lampets. Empowerment Partners, Emerging Farmers Trust, Tarsimark Investments.

5. Interrogation, reporting and debriefing – On the basis of the information sourced as background and after initiating communication (either by telephone and/or email) the student rapporteurs were tasked with evaluating the prescribed questionnaire in relation to their respective case studies and determining whether additional specific questions might be needed to address any aspects peculiar to the biofuels case that had been selected. Once finalized, appointments were made to conduct the necessary interrogations. For two of the case studies the contacts were remote from both project site/offices and in these instances (i.e. Mabele Fuels and Phytoenergy) interrogation was by conference call. For the remaining three cases, person-to-person interrogation was possible and these were conducted in Cradock (Bio-ethanol plant), Grahamstown (Algae-to-energy) and East London (Community biogas). All interrogations were for a minimum of one hour, conducted by two student reporters, and recoded using digital voice recorders (purchased by Turner & Townsend).

Case background information, all additional case information, and the questionnaire used by each student interrogator is located at the URL which was supplied under separate cover, a virtual private network (VPN) set up to access this information. In addition, audio files of each interrogation (five) and copies of the reports (five) are located at this address.

6. Case study reports – Copies of the reports prepared by the student rapporteurs follow. These reports are the outcome of each student's analysis of the interview and recorded material, background research, and any additional information obtained. Drafts of each report were submitted for scrutiny and corrections, comments and suggestions provided to each rapporteur during the exit interview.

Case No. 1	***IAPS-to-Energy (EBRU/Fort Hare Univ)***

Name of reporter: Prudence Mambo

Contact details: pmambo@gmail.com

Time period of interrogation: Approximately 1 h 4 minutes 30 seconds

Methods used in interrogation:

- Voice recorder
- Template Questions in Appendix 2
- Interview was conducted in person
- Group interview: Lerato Sekhohola (sekhoholalerato0@gmail.com), Lwazikazi Madikiza (lwazikazimadikiza@gmail.com) and Prudence Mambo (pmambo@gmail.com)

Stakeholders interviewed - **Professor A. K. Cowan**
Professor and Director of the Institute for Environmental Biotechnology at Rhodes University
Email Address: a.cowan@ru.ac.za
Physical Address: Institute for Environmental Biotechnology
Rhodes University
P.O. Box 94
Grahamstown, 6140
South Africa
Mobile Phone Number: +27 799022 457
Telephone Number: +27 46 6222 656

There were no permissions or restrictions on the use of information

The Biofuel/energy supply chain

Biomass feedstock

- The biomass/ feedstock for the plant is wastewater generated by the Alice community combined with effluent from the digesters at the Agripark at Fort Hare University. The effluent is channelled directly to the Integrated Algae Pond System (IAPS) for remediation and biomass generation.
- The algae biomass generated as a by-product of the IAPS at the Agripark will serve as a co-feedstock for the anaerobic digester (piggery/dairy). The algae biomass is nutrient rich and is generated in copious amounts by the system.

Transportation Methods to Ship the Biomass to the Processing Units

- The feedstock is currently channelled directly to the remediation facility through the Alice and Agripark system.

Key Technologies Used in Bio-refinery

- Anaerobic fermentation during wastewater remediation is utilized to generate methane gas. The biogas generated is passively purified while passing through the water column above the anaerobic digester. As methane gas very sparingly soluble in water, it is estimated to make up 75 % of the biogas found in the headspace.

Retail Outlets and Consumers

- Consumers utilizing the products of the IAPS will be determined by the commissioners of the technology. The technology will however be of particular appeal to municipalities.

- The Agripark in Alice will use the methane gas generated by the plant to power drying ovens utilized for the preparation of dehydrated foodstuffs, soups, and meals for school learners.

The case study

Overview

The basis of the Alice demonstration scale plant is the Integrated Algae Pond System (IAPS) plant. The pilot IAPS based in Grahamstown, is primarily utilized for the remediation of 75 $m^3.d^{-1}$ of wastewater produced by the Grahamstown community. A by-product of the normal functionality of the system is methane gas. Methane gas is generated in the anaerobic digester. The anaerobic digester which is a component of the IAPS releases methane gas following the anaerobic degradation of suspended solids in wastewater. Thus a component of the system can in effect deliver an energy stream in addition to treating wastewater. Biogas generated by the IAPS can be used for heating, cooking, electricity production or as a gas to fuel some municipal buses and trucks as in some first world countries. The IAPS also generates a consistent quantity of algae biomass which can also be converted into methane gas following anaerobic fermentation. It is vital to capture the methane gas generated by anaerobic fermentation as currently methane is estimated to be between 23- 71 times more hazardous to the environment than carbon dioxide gas. The infrastructure required for the successful implementation of an IAPS is in varying stages of development around South Africa, thus the channels required to transport wastewater to the remediation plant may not be constructed depending on the proposed area of implementation. This infrastructure needs to be acquired by the consumer. Funding is problematic in South Africa thus the municipal development fund may be required to fund the sanitation requirements of the community.

Size of Operation

Originally the demonstration plant was designed to remediate 1 $ML.d^{-1}$ wastewater for the Grahamstown community in Makana district. However, the project had to be relocated to Alice. The current demonstration scale IAPS plant, to be constructed at Alice will only remediate 0.7 $ML.d^{-1}$ of wastewater. The downscaling was due to the inability of the Makana municipality to commit to the project between 2009 and 2011. Capital costs increased while the scale of the project declined. The project will downgrade further to 0.5 $ML.d^{-1}$ wastewater if DHV-SSI and EBRU consortium is unable to secure the remaining funding requirements.

The Business Model

The Institute for Environmental Biotechnology at Rhodes University (EBRU) is an academic institution that was approached by the company Royal Haskoning/DHV (previously DHV/SSI) to set up a consortium to market the IAPS as a standalone technology. Currently, approximately 75 % of the funding has been secured from Partners of Water (Netherlands) and Department of Education and Training (DET; grant to University of Fort Hare for establishment of the Alice AgricPark) for the construction of the demonstration scale plant. The IAPS is capable of generating methane gas and a clean water stream. The major investment would be in implementing a hood to capture the biogas generated by the anaerobic digesters. The commissioner of the technology could then sell this methane gas, rendering it available to the municipality. The municipality may then convert the gas to energy for downstream utilization by the municipality or the community in Alice. The Agripark in Alice where the technology is to be implemented will use the methane gas to power drying ovens. The client therefore harvests the gas generated by the IAPS and utilizes it for their specific purposes.

System Initiation

The research institute began work on the IAPS in 1994. The EBRU facility with the pilot IAPS was officially opened in April 1997. The pilot system has therefore been operational for approximately 15 years as a wastewater treatment facility. However, the methane generation and capture project will be conducted in Alice at the WWTP using in partnership with Royal Haskoning/DHV and Fort Hare University in 2012/3.

Drivers

The pollution and general deterioration of water bodies around South Africa resulted in the implementation of the IAPS. However it was later realized that the anaerobic digester, a component of the system was generating copious amounts of methane gas as a side effect of fermenting the suspended solids in wastewater. Consequently, it was estimated that the methane generated by the IAPS could potentially be lucrative and supply much needed energy for community utilization. As yet however, the system has not been utilized for this function.

- The demonstration scale plant will provide remediated water as well as energy for the

Agripark in Alice. The Agripark will be able to utilize the energy generated by the IAPS to provide approximately 55 000 school meals per day for learners in that region of the Eastern Cape. Three additional AgricParks are currently under development.

- Currently the efficiency of the IAPS to generate gas and to remediate wastewater has not been proven. However after a year of data collection and analysis, tangible evidence will have been produced to advocate the use of this particular technology in its current configuration for the abovementioned processes. This sound data can further be utilized to attract investment.

- The size footprint of the technology is significantly negated following the harvest of methane gas for energy, thereby resolving any environmental concerns. Disinfection during the remediation of the wastewater results in the removal of pathogenic microbes.

- As an artificial wetland the system retains the aesthetics of the area where it is implemented, while improving the biodiversity of the area by essentially providing a clean watering hole for wildlife.

The IAPS is therefore a perpetual passive system; it will continue to function indefinitely if it remains undamaged. This system can thus be sold as a commodity once its efficiency has been proven. The technology can be implemented virtually anywhere provided there is enough land available as well as an effluent stream.

Support

- Due to unforeseen delays caused by the inability of the Makana municipality to commit to the project (2009 to 2011), the project capital costs have increased to R 8.7 million. This could have been avoided had Makana municipality been decisive upon being approached by the EBRU-DHV-SSI consortium.

- Investors in the technology have thus far been private, government and non-governmental organizations (NGO).

- The funding for the methane harvesting project will be provided by the Dutch Funding Agency, Partners for Water (R 4 million), the Department of Energy and Training (DET) at the University of Fort Hare (R 2.5 million) and the shortfall may be covered by South African initiatives like the Technology Innovation Agency (TIA). However if TIA cannot provide the shortfall, the project will be downscaled to 0.5 $ML.d^{-1}$ in the short-term and expended once additional funding is sourced.

Jobs

The IAPS is inexpensive in terms of maintenance, low skills are required to operate the system and there is no need for supervision of the system on a day to day basis, that is, post optimization

by the relevant consultant engineer.
There are many niches that will develop as the IAPS is designed, constructed and implemented for methane fermentation. Many jobs will be created in order to supply the needs of the plant. Currently job creation has however been minimal due to the fact that the IAPS is still to be constructed, however once the system is in operation there will be job creation in order to supply the demand for the optimal functionality of the technology.

Business targets and wealth creation.

Achievements of the IAPS have been:

- The demonstration of an alternative to conventional wastewater remediation strategies
- Disease mitigation
- The remediation of water and generation of energy in a cost competitive manner
- Its integration into existing technologies
- Companies are also easily able to invest in the technology and adapt it to suit their particular needs, thereby giving the technology commercial appeal

Training

Wastewater treatment is a uniform process, that can however be packaged differently. Any operator knowledgeable in remediation processes would be able to operate an IAPS. However once the system has been coupled with biogas fermentation further training may be required. The system can easily be implemented by consultant engineers. During the transfer period operators can easily be trained to operate the system.

Local community stakeholder groups

To date there have been interactions with consultant engineers who are able to act as private agents and marketers of the technology. These people are able to adapt the technology to fulfil a niche in their particular industry. The institution has also engaged with various policy makers, municipalities both district and local all over the Eastern Cape while assisting community development projects such as the People's Power Africa.

Impact on agricultural practice

The Agripark located in Fort Hare will be positively impacted by the introduction of the IAPS as the effluent generated by the dairy located at the Agripark will be remediated, the water generated by the system will be utilized for crop irrigation and the methane generated by the

system will be utilized to power the drying ovens for the dehydration of food, facilitating the production of dried meals for school children

Future growth plans and recommendations

Once the project has been successfully implemented, it is hoped that the technology will be further utilized around the Eastern Cape specifically in Port Shepstone, Alice and result in the proliferation of more self-sustaining Agriparks around the country.

DHV-SSI will then utilize the demonstration scale IAPS to advertise the IAPS technology for global application.

References

Rose, P. D. (2002) Salinity, sanitation and sustainability: A study in environmental biotechnology and integrated wastewater beneficiation in South Africa. Volume 1: Overview. Report to the WRC. WRC Report Number: TT187/02. ISBN**:** 186845884.

Rose, P. D., & Boshoff, G. E. and Molipane, N. P. (2002) Salinity, sanitation and sustainability Volume 3. Integrated algal ponding systems and the treatment of domestic and industrial wastewaters. Part 3: Mine drainage waters, The ASPAM Model (Report 6). Report to the WRC. WRC Report Number: TT 192/02. ISBN: 186845889.

The manual for the implementation of the Integrated Algae Pond System (IAPS) is available from the Water Research Commissions (WRC) publications \

Case No. 2	***Community Biogas (Three Crowns School)***

Name of reporter: Lwazikazi Madikiza

Contact details: +27786775678

lwazikazimadikiza@gmail.com

Grahamstown, Rhodes University,6140

Time period of interrogation: 1h40

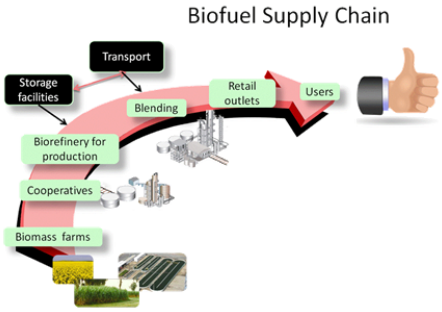
Methods used in interrogation: **Digital voice recording and Email correspondence**

Stakeholders interviewed- title, position in organisation **MR Mark Wells, Peoples Power Africa, PO Box 171, Chintsa East 5275**

Fax :0866222044 Email.markwells@forestvale.co.za

Any permissions / restrictions on use of information **There was permission granted to use information**

The Biofuel/energy supply chain



With reference to fig 1, give an overview of the full biofuel supply chain that the case study forms a part, both as it exists now and/or as is planned.
Include details of
a) Biomass feedstock – locations of biomass farms,
b) transportation methods to ship biomass to processing units;
c) key technologies used in biorefineries / blending operations;
d) Retail outlets and end-users, including any international export markets involved.

g 1

The Three crowns project is located at Three Crowns Primary school in Lady Frere,Eastern Cape,South Africa. Peoples power Africa was appointed by the Coastal Environmental Services to design and implement a pilot integrated biogas system for rural schools as part of a programme by the Development Bank of South Africa funded by Chris Hani District Municipality's environmental support programme. The Three Crowns School was selected as the location of the pilot as this school was a success model for the existing Wildlife and Environmental Society of South Africa school garden and feeding programmes. The technology that was used in this system is an anaerobic digestion which it was installed for the purpose of producing biogas and bio fertilizer. In the form of methane and algal extracts respectively. The feed stock that is used in this system is primarily food, garden waste and digestate and the storage units are onsite in the local school where the anaerobic digester was commissioned and built. Transportation of the food waste is handled manually and the sewage is transported by a

piping system over a short distance from schools toilet to the anaerobic digester. There are two additional piping systems that connect the methane that is produced as the product of anaerobic digestion to the schools kitchen. The second piping system transports the liquid digestate to the AIPS system for the production of biofertilizer (algal extract). The end user is the school, who the production of methane cooked meals are served for the school and nutrition from the digestate for garden is acquired in the form of algal extracts.

The case study. *Give a brief overview of the case study, its size of operation, the business model, when it was initiated and by whom, and how long it was/has been operational for. Indicate the sources of funding, any written or contractual agreements with suppliers of either equipment supplies, or of biomass sources as relevant.*

The system was built and commissioned by People power Africa (PPA). As creators providing raw materials and equipment to assemble the system. The digester was funded by Development Bank of South Africa (DBSA) and is powered by wind energy. As distributors of the system PPA are not part of the day to day running of the process but rather the school caretaker was appointed to supervise and maintain the operation. PPA continues to be available if there are queries or technical problems that might arise which the caretaker cannot resolve. The project was created as a pilot to demonstrate energy and nutrient beneficiation by providing robust low maintance sanitation for the staff and students of Three Crowns Primary School. Three Crowns school was one of the schools that was a beneficiary of the pit latrine sanitation system. Pit latrine now called ventilation improved pit toilets allow the urine to drain off enabling the faeces to dry up and decompose slowly. The urine is separated into a different pot and through a piping system underground it fertilizes the soil. This system was unsuccessful in Three Crowns Primary school, flies began to breed in the toilets such that students could not come to school. The smell coming from the toilets in summer made it immensely difficult for the students to study comfortable thus the attendance was minimal.

The co-digestion of the kitchen waste provides renewable energy in the form of biogas for cooking, nutrient recycling in the form of pathogen free algal bio-fertilizer and recycled pathogen free water for irrigation for the school gardens. Asset transfer agreement from the municipality (sponsor) to the school was done as a written agreement this will help the school to own and maintain the system while under supervision of the caretaker.

The system was commissioned in July 2012 and the structure components used to build the system include piping system, algal ponds, sanitary accessories, anaerobic digester and the bioprocess is part of the school premises as a permanent fixture. The intellectual property is that of the adopted technology of the integrated Algae Pond System (AIPS) the current configuration of the system is owned by the Institute for Environmental Biotechnology Rhodes University (EBRU) and by the Water Research Commission. A variation of this technology is currently

being commissioned in collaboration with Royal Hass Konning DHV. Finishes of Nature is the contractor that were retained to plan, construct and ensure that the system run and is operational.

Drivers. *Describe any external drivers that were important for initiating the case study and for its forward progression e.g. government mandates, subsidies, tax exemptions, legislation, local pressure groups. Analyse the data to highlight the enabling and constraining factors. Describe how these may have influenced the way in which the project has developed.*

Describe any relevant technology drivers for example, was established technology adopted, was local or internationally-led technology adopted?

Indicate knowledge and attitudes to the concept of an environmental footprint
Project was financed by private investors and non government organizations such as Peoples Power Africa, Finishes of Nature and Development Bank of South Africa. The difficulty was that the funding needed for roll out needed to be based on a business case, i.e. the value of the energy and nutrient services to the school as well as the value of flush sanitation over the standard pit latrine.

The anaerobic digester needs 15kg of food waste a day and 1000 liter of waste water from sanitation per day. From this system 150 students benefit with an annual turn over of R12 000 in energy, R10000 in nutrients and R350 000 in investment money. Government subsidy's were important for the initiating the project together with government mandate this has helped in the forward progress of the project.

The AIPS system does not emit any greenhouse gases the carbon dioxide is utilized by the algae during photosynthesis and the methane that is produced during digestion is utilized as energy. The digestate is used a feedstock for the AIPS system. The water is reused by recycling through the AIPS system for irrigation of the school gardens.

Support. *Describe any support (or lack of support) from Investment Promotion Agencies, export promotion agencies, trade associations, government agencies etc that has had an impact on the sustainability of the case study. Include here any impact that this may have had on the way the business plan evolved.*

Government agencies continued to be a very important support to the sustainability of the project and had an impact in the way the project has evolved. The DBSA Development Fund has been assisting Chris Hani District Municipality with a suite of environmental management tools over the past 4 years. These include an Environmental Management System, an Environmental Management Plan, an Integrated Waste Management Plan, and a series of Environmental and Climate Change Awareness and Training programmes. The conceptualization and planning of two pilot projects were an integral part of the above initiatives. The first pilot explored creative

ways to address solid waste, sewage from waste water treatment plants and manure from piggeries in an integrated manner. The second was to support an existing Eco-school programme in a remote rural area near Lady Frere. The DBSA funds helped to plan and build a biogas digester, powered with wind energy. It is the first of its kind in South Africa. These pilot projects will help inform a roll out programme to address environmental and health issues in the District The Lady Frere district office of the Department of Education (DoE) has used the environmental initiatives as a platform for all schools in the district to be able to visit the school/community of Three Crowns in order to learn about energy efficiencies and be able to replicate similar projects within their own schools. Thus the project soon began to expand and a similar project will be assembled in Chintsa in The Amathole District municipality, Eastern Cape South Africa. Wildlife and Environmental Society of South Africa's had started the schools gardening and nutrition programme.The benefits relating to ongoing monitoring and support by WESSA through their long term commitments and support of their support schools programme in the district tis created strong foundations for the development of the Integrated algal system and biogas production.

Jobs. *Describe the case study expectations in terms of jobs planned/created, and how far these expectations have been met from initial position. Include details of the percentage of jobs that required training, and percentage of jobs and nature of these jobs given to women. Describe whether the mix of paid and unpaid activities changed after the project began*

The project in its nature does not require intensive high skilled supervision no high increase in job employment was expected. From the project 30 short terms jobs were created and 1 long term goal with a possibility of expansion of one more as the garden is expected to expand and grow. There were jobs awarded to women. The jobs were all paid jobs with all 30 being short term jobs. After completion of the project there was only on paid job left and that is of the caretaker who is already employed by the school.

Figure 2.Pit latrine system that was installed in Chintsa Primary School,Eastern Cape ,South Africa that will be soon to be replaced by Integrated Biogas and Algal biogas system.

Business targets and wealth creation. *Describe the case study expectations in terms of business targets and wealth creation, and how far these expectations have been met from initial position*
The project has managed to provide energy access to poor communities, life science laboratory to school children, improved garden production and health benefits relating to school nutrition. The project has also demonstrated that 'integrate biogas technology' for roll out at rural school as an effective sanitation system. As a proof of the effectiveness of a system there is a school currently under the Amatole District Municipality that is being assessed by People power Africa for the installation of the same technology in Chintsa, Eastern Cape, South Africa. The project has a potential to grow and eliminate the need of the pit latrine system in all 800 schools where they have been installed already figure 2.

Training. *Describe how knowledge of the processes involved was gained and then communicated to employees, and whether expert opinions were sought.*
New skills were needed to be adopted in this technology such as an ability to operate and use biogas, operate algal ponding system and utilizing algal extracts as fertilizer. The project was under the management of industrial engineers ad sustainable construction. There were 150 students were trained to use the technology. Among the people that were trains 55% of those were women and a manual was adopted for the design and operation of the technology.

Local community stakeholder groups.
Describe the stakeholder groups that the case study engaged with, the order of engagement and whether the stakeholder groups changed with time, and if so, explain why.
Describe the methods used to engage with stakeholders and the representatives chosen, for example whether women were actively involved, whether communities were represented by their tribal chief, or by democratically elected leaders etc.
Describe how frequently case study operatives engaged with community stakeholders.
Explain whether there were any conflicts along the way, describe what they were and how they were resolved if at all.
Describe the perceptions of surrounding communities about what the project would bring and what perceptions the stakeholders had over their rights and whether this coincided with current legislation.
Describe whether there were any notable unintended consequences, for example, whether women's access to land water and fuel and household access was affected, and whether long-term income increases were enough to compensate all households for reduced access to land and increased prices

Local community stake holders that were engaged in order of importance were school governing body, municipality, regulators and policy makers .The interaction with the school governing body was in group meetings once every 3 months and the other stake holders interactions were

fairly frequent, policy making was conducted in group meetings and personal visits and the regulators were contacted via email. The stake holders haven't changed and there were no conflicts that occurred throughout the process of commissioning building and operation of the system except for delays in service delivery that were attributed to the change in governance within the municipality.

Impact on agricultural practice

Describe whether the availability and type of food on local markets changed after the project began and whether there was any impact on localised supply of or demand for food and fuel and if there were any credibly attributable impacts on prices

Describe whether there were any changes in land use as a result of e.g. new biomass farms being established.

The availability of food at the local school was changed after the project was implemented because of uninterrupted supply of clean methane gas for the cooking of the food daily. The quantities are not known and this aspect is still under evaluation and investigation. The issue of gas shortage and transportation that is needed to provide the gas has been eliminated. This also alleviates the responsibility of women carrying heavy LPG gas cylinders to and from the school for cooking purposes as they are responsible for the cooking. There was no change in the type of food on the local school nor on food price but there is a visible increase of food gardening.

The project impacted the school positively. The school saves on food as the garden provides the vegetables that are needed for the feeding scheme and thus the school expenses are reduced. The biogas that is produced by the system reduces the money needed for the purchase of gas and this also reduces the expenses of the school. The excess money can be used to improve the facilities of the school and general maintenance of the school.

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Future growth plans and recommendations. *Describe what the future growth plans of case study are, if any, and what the perceived opportunities and threats might be for future growth.*
The availability of food at the local school was changed after the project was implemented because of uninterrupted supply of clean methane gas for the cooking of the food daily. The quantities are not known and this aspect is still under evaluation and investigation. The issue of gas shortage and transportation that is needed to provide the gas has been eliminated. This also alleviates the responsibility of women carrying heavy LPG gas cylinders to and from the school for cooking purposes as they are responsible for the cooking. There was no change in the type of food on the local school nor on food price but there is a visible increase of food gardening.

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The recommendations for future implementation of similar project are to insist on a budget to be drawn up to quantify all social, environmental and monetary benefits, including Life Cycle Analysis.

In conclusion the project achieved its objectives and that is to: improve public health due to improved sanitation and nutrition for children in the community, savings in cost of LPG gas including transport, increase security of supply of energy nutrients and water, employment opportunities for supervision of the system and increase food gardening

Case No. 3 ***Biodiesel from canola (PhytoEnergy)***

Name of reporter: Dirk Westensee

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Email: dirk_westensee26@hotmail.com or g12w6263@campus.ru.ac.za

Time period of interrogation: 45 min

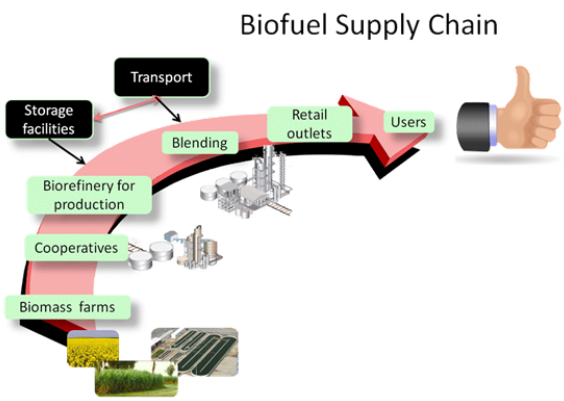
Methods used in interrogation: Telephone and Voice Recorder

Stakeholders interviewed: Mr Charles Warren- Hansen

Project Manager of *PhytoEnergy* in the Eastern Cape, South Africa *PhytoEnergy* of Southern Africa (Proprietary) Limited

This information must not be disclosed for public viewing as no permission was provided

The Biofuel/energy supply chain



Canola crops will be grown in areas close to Butterworth and Idutywa, Eastern Cape and also widely planted throughout the Free State area on various commercial farms. The amount of land used will eventually be about 550 000 hectares will be used for the cultivation of canola. When the canola has been harvested, they will be transported to 9 large silo's, with 4 in the Eastern Cape and 5 in the Free State. These silo's will be aligned and in close proximity with the growing areas as well as the railway system. The canola will then be transported via the railways to the biodiesel plant based at Coega Harbour, Port Elizabeth. The canola is then crushed at the plant and turned into biodiesel, which will be exported to Europe as a final good.

This project is viewed as a "green project" and according to the company, the process will be amongst the first carbon neutral plant in the world. They will use agricultural activities that are apparently sustainable, will make no use of genetically modified organisms, use conservational agriculture as a principal to cultivate the crops and work hand in hand with the community. It was reported that the project will be amongst the greenest projects in South Africa at the COP17 event in Durban. The plant will not use electricity, but instead use glycerol, which will be combusted to

provide the electrical energy required and this, will therefore be the basis on which the plant provides its energy requirements.
On completion of the biodiesel plant, the canola oilseeds will be exported to the European markets (such as Shell Petrol Company) and therefore need to meet their legal biodiesel requirements. None of the canola produced will be used in South Africa.

The case study

PhytoEnergy was established in 2004 and consists of a group of companies, mainly from German and South African project developers. The company's main aim is to develop a project- initiative for and an implementation of a 400 000 ton/ per year biodiesel plant in South Africa. The project is about 1 year away from building the plant. A BEE partner/firm has been found for this project and their stake within the company is very significant (Protected Info). They have worked in close cooperation with *PhytoEnergy* over the years and have helped them financially. Large amounts of funds have been raised for the development of equity and debt funding by private equity houses. Investors however cannot be named but there seems to be a mix of investors from across South Africa and they have invested much more than what is required with regard to the budget.

Drivers:

PhytoEnergy is a worldwide company but have particularly established in the Eastern Cape and Free State. The Eastern Cape is a vast area for growing canola during the winter season. The area provides a cooler temperature which is suitable for canola cultivation and the soil is particularly rich and full of nutrients. Canola is a winter crop and cultivation would be in rotation with wheat and maize, which are summer crops in this region. The rotation of the crops are expected to increase food crop yield by 25%, therefore this group and government supports the canola cultivation technology. Canola (rapeseed) is the principal oil used for biodiesel in Europe; mainly because of its winterization properties (it does not become viscous in winter) (Musango et al, 2010). The Eastern Cape also presents a major opportunity for skills development and the creation of jobs. Agriculture in the Eastern Cape has been ailing for many years and hopefully with this project, it is able to kick start the agricultural sector within the Eastern Cape.

Support

It aims at securing feedstock of canola (rape seed) under a unique sustainable agrarian model, which is supported by the national Department of Agriculture, Forestry and Fisheries and the Department of Trade and Industry, which both provides guidance for an industrial scale energy crop and food crop production in the Eastern Cape Province and parts of the Free State. The *PhytoEnergy* Group have been collaborating with various South African and German financial institutions for future funding.

Jobs

The plant itself will produce and train around 200 workers and within the crop fields, around about 25 000 field workers, all from local communities, therefore creating large opportunities. The emerging farmer mentorship programme has aimed to improve employment rate throughout the Eastern Cape.

The biodiesel industry development is also a new agrarian transformation plan for the Eastern Cape and this project is under the Accelerated and Shared Growth Initiative for South Africa (Asgi- SA). Asgi- SA is a government strategy aiming to boost economic growth and reduce unemployment in the country.

Business targets and wealth creation

The company's main aim is to develop a project- initiative for and an implementation of a 400 000 ton/ per year biodiesel plant in South Africa. The EU Biofuels Fuels Directive requires membered countries to use 5.75% volume use of biodiesel which had to be transported by 2010. They also set an objective of 20% of renewable energy resources to be substituted by 2020, which include biofuels, hydrogen, natural gas and other alternative fuels. They also expect local tribes to be financially secure.

Training

PhytoEnergy comprises of many experts within their field of bio-oil/bio-diesel, which include cultivation specialists, life scientists, financial advisors, agronomists, energy market macroeconomists, system engineers, plant engineers, CPA's and lawyers. This company works in close cooperation with provincial and national administrators for the planning and implementation of the biofuel industry in South Africa. There are 2 components to this project: the industrial component and the agricultural component. With regard to the agricultural side of the project, it's not going to be world class, it will be a simple procedure of growing a crop and nothing sophisticated will be applied. The industrial plant however needs qualified and experienced people, such as engineers, biochemists etc. These people in particular should be from South Africa and if the company can't find what they are looking for, they will source skills abroad.

PhytoEnergy will employ a general contractor to build the plant. As part of the building contract, there will be a clause which will state that engineers from the supplying company will need to train the industrial staff, of which will be trained abroad on similar biodiesel plants. The agricultural staff will also be trained on other agricultural farms. The contractor will have to provide a warranty. This contractor will be a well renowned contractor worldwide and who has built infrastructures like this before.

Local community stakeholder groups.

PhytoEnergy is in close cooperation with BEE (Black Economic Empowerment) development programme that are responsible for capital costs (R 2.7 billion) but they are still in a project development phase and therefore cannot be BEE rated.

This project also has a tremendous influence on the Mass Food Production Programme for the Eastern Cape Province. It aims to benefit local communities in the area; such as creating large numbers of jobs for the biodiesel plant, Black Economic Empowerment, skills development, empowerment of local farmers and food security improvement.

The Eastern Cape has a number of projects with regard to producing biofuels. This company is trying to avoid criticism from various other companies with regard to canola cultivation. In terms of conflicts with the surrounding companies and communities, no conflicts have emerged. The company follows a social mobilization process. If the company is properly managed, there will not be any conflict. They have dealt with tribal communities about how the land will be used and how much opportunity they will receive. The local community tribes will also have a stake in the plant.

Impact on agricultural practice

All the canola will be transported to Europe and therefore will be no impacts on localised supply of or demand for food and fuel. With regard to land use, nothing has been established as of yet and therefore information cannot be provided.

Future growth plans and recommendations

Not made available

Reference:

Musango, J.K., Amigun, B., Brent, A.C. 2010. Understanding the implication of investing in biodiesel production in South Africa: a system dynamics approach. Council for Scientific and Industrial Research (CSIR), Stellenbosch, South Africa. URL: http://www.systemdynamics.org/conferences/2010/proceed/papers/P1198.pdf

Case No. 4 ***Bio-ethanol Plant***

Name of reporter: Lerato Sekhohola

Contact details: Institute for Environmental Biotechnology – Rhodes University (EBRU)

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Cell: +277 8444 6415

Time period of interrogation: 1 hour 30 minutes

Methods used in interrogation: 1) Use of publicly available literature (internet)

2) Contact with stakeholders by e-mail and one-on-one interview

Stakeholder interviewed: Mr. Zingisa Somlotha

Position in organisation: Strategic Support Manager at Agrarian Research and Development Agency (ARDA), South Africa

Contact details: 24 Hospital street, Cradock – Eastern Cape, South Africa

E-mail: zingisa@ardasa.co.za

Tel: +274 8881 3663

Cell: +278 3534 1014

Place and Date of interview: ARDA office at Cradock, Eastern Cape, South Africa

Stakeholder contacted: Mr Thabo Kekana (ThaboK@idc.co.za)

Position in organisation: Industrial Specialist at Industrial Development Co-operation (IDC) of South Africa

Any permissions /restrictions on use of information: no restrictions on use of information.

The Biofuel/energy supply chain

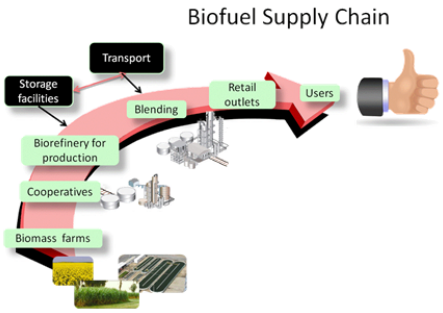

Fig 1

With reference to fig 1, give an overview of the full biofuel supply chain that the case study forms a part, both as it exists now and/or as is planned.
Include details of
a) Biomass feedstock – locations of biomass farms,
b) transportation methods to ship biomass to processing units;
c) key technologies used in biorefineries / blending operations;
d) Retail outlets and end-users, including any international export markets involved.

The project aims to produce fuel grade bio-ethanol from a commercially viable and sustainable process plant using sorghum grain and sugar beet as biomass feedstock. There are three types of land that will be used for cultivation of the feedstock: 1) communal land in the Eastern Cape region and other parts of the country where sorghum will be grown without irrigation, 2) land privately owned by farmers and land reform beneficiaries located in the Great Fish River Valley and surrounding area where sorghum and sugar beet will be produced under irrigation, and 3) Core Estate land with 6000 hectares of irrigation system and adjacent grazing land in the Great Fish River Valley which has been purchased by the National Department of Rural Development and Land Reform for production of sorghum and sugar beet. The commercial farmers and land beneficiaries will be involved with production and storage of the feedstock assisted by ARDA as a strategic partner. Sugar beet will be grown within a 70 – 100km radius of the ethanol plant to minimize transportation costs since it is a bulky product compared to sorghum grains.

Sorghum will be used as primary feedstock during phase 1 of the project while sugar beet will be used in phase 2. Mature sorghum will be harvested once the grain is of certain moisture content ideal for processing (therefore no need for further drying before storage) and will be stored in local *silos* near the cultivation sites. The grain will be transported by a contractor, either by rail or road (trucks), to the ethanol production factory. In the case of insufficient local supply the feedstock will be imported from elsewhere including other countries that have still to be identified. Processing of sorghum grain will include milling, mashing, cooking and liquefaction followed by fermentation, distillation and rectification as well as dehydration. Sugar beet processing will start with beet treatment followed by juice extraction, fermentation, distillation and rectification, and dehydration. Produced bio-ethanol will be transported to refineries in South Africa and depending on production scale some of it may be exported.

The case study

Give a brief overview of the case study, its size of operation, the business model, when it was initiated and by whom, and how long it was/has been operational for. Indicate the sources of funding, any written or contractual agreements with suppliers of either equipment supplies, or of biomass sources as relevant.

The project is a government initiative which was launched in 2008 by ARDA, formerly known as Sugar Beet RSA, in partnership with the IDC which are both government-owned entities. Project concept was proven at pilot scale through research conducted by ARDA and construction of a commercial plant is anticipated to commence by the end of 2012 and it is expected to be fully operational in 2014. The government of South Africa has provided $258.5 million subsidy towards the project. The commercial scale of the project is classified under the “Creator” model of business (as per categories outlined in ACP questionnaire under section 3.2) whereby feedstock sourced from contractor farmers will be processed into bio-ethanol which will in-turn be sold to refineries. ARDA is involved in the strategic and operational planning of the whole

bio-ethanol supply chain up to the point the ethanol gets to the refineries; thereafter the refineries decide its fate.

Drivers

Describe any external drivers that were important for initiating the case study and for its forward progression eg government mandates, subsidies, tax exemptions, legislation, local pressure groups. Analyse the data to highlight the enabling and constraining factors. Describe how these may have influenced the way in which the project has developed.
Describe any relevant technology drivers for example, was established technology adopted, was local or internationally-led technology adopted?
Indicate knowledge and attitudes to the concept of an environmental footprint

A decision to produce bio-ethanol from sugar beet and sorghum was taken by government following research findings which indicated that initial idea of producing sugar alone from sugar beet was not going to be economically feasible due to the quality of sugar beet produced in the Great Fish River Valley despite the high quantities. Use of sorghum was motivated by its overproduction which exceeds local consumption demand. ARDA was assigned to start the bio-ethanol production project with a mandate from government to implement the National Bio-fuel Industrial Strategy of South Africa and to contribute towards rural development and land reform through farm mentorship and assistance in commercial agriculture development. As a result ARDA assisted farmers and land beneficiaries who will produce the feedstock by offering financial support, business facilitation and development, business plans, technical advisory services and mentorship programmes.

The technology used has been developed through research carried out by ARDA and more research will still be conducted towards improving the process. An Environmental Impact Assessment and a positive Reporting Obligations Database was received. With regards to environmental footprint the following are anticipated; (carbon footprint) 30% savings estimated on greenhouse gas emissions, (energy footprint) 26.7% energy saving per litre of product produced will be achieved by using alternative technology such as steam dryer instead of coal-fired dryer and by making the plant a Combined Heat Power plant, (water footprint) raw water will be sourced from the Great Fish River and all effluent generated will be re-cycled and re-used in the processing plant, and (agricultural footprint) the project will make use of underdeveloped and underutilised agricultural land to grow the feedstock.

Support

Describe any support (or lack of support) from Investment Promotion Agencies, export promotion agencies, trade associations, government agencies etc that has had an impact on the sustainability of the case study. Include here any impact that this may have had on the way the business plan evolved.

Financial and strategic planning support towards implementation of the project has mostly been received from governmental departments that are involved directly with the project (ARDA,

IDC and National Department of Rural Development and Land Reform). The following have also worked co-operatively with the above mentioned departments by using their influence and authority within the community to ensure successful implementation of the project; MEC's, local politicians, local municipality majors, traditional councils, Eastern Cape Rural Financial Agency, district officers and members of the communities identified for feedstock production.

Jobs

Describe the case study expectations in terms of jobs planned/created, and how far these expectations have been met from initial position. Include details of the percentage of jobs that required training, and percentage of jobs and nature of these jobs given to women. Describe whether the mix of paid and unpaid activities changed after the project began

It is estimated that 3315 sustainable jobs will be secured in phase 1 of the project, which involves construction of the factory and initial production of ethanol. It is also estimated that an additional 800 to 1000 jobs will be secured temporarily during construction. In phase 2 there will be 2000 long term jobs dealing directly with the agricultural side of production. Currently there are 50 people working under ARDA on a long term basis on the pilot plant and every person involved in each activity of the project has been paid for their service. None of the job positions so far have been specifically reserved for women as each person is employed on the basis of their expertise not necessarily gender.

Business targets and wealth creation

Describe the case study expectations in terms of business targets and wealth creation, and how far these expectations have been met from initial position

While ethanol will be the main product there will be by-products such as Dried Distilled Grain Soluble Solids which will be utilized as animal feed as well as Vinasse from sugar beet processing. There will be business and employment opportunities for different contractors and individuals who will be hired for different tasks once production has started (e.g. transporting companies who will transport the feedstock from field to storage and from storage to the ethanol plant have already been short-listed and local community members will be labourers on the fields planting the feedstock). The agricultural sector of the project (feedstock production) is expected to boost food security through crop rotation as well as farming skill development while also promoting maximal utilization of resources such as unused land and manpower. There is also a possibility for export of the product and by-products and improvement of infrastructure such as railway lines and roads for transportation of feedstock.

Training

Describe how knowledge of the processes involved was gained and then communicated to employees, and whether expert opinions were sought.

So far training has only focused on agricultural skills for production of feedstock. Four crop production managers, of which one is a woman, have been trained intensively (theoretically and practically) to supervise daily farming activities, specifically for production of sorghum and

sugar beet without any need for manuals. These people are college and university graduates with diplomas and degrees respectively but without work experience. There has not been any training for ethanol production yet and this will only happen once the factory is ready for operation. People will be hired for their skills and expertise for different ethanol production tasks.

Local community stakeholder groups

Describe the stakeholder groups that the case study engaged with, the order of engagement and whether the stakeholder groups changed with time, and if so, explain why.
Describe the methods used to engage with stakeholders and the representatives chosen, for example whether women were actively involved, whether communities were represented by their tribal chief, or by democratically elected leaders etc.
Describe how frequently case study operatives engaged with community stakeholders.
Explain whether there were any conflicts along the way, describe what they were and how they were resolved if at all.
Describe the perceptions of surrounding communities about what the project would bring and what perceptions the stakeholders had over their rights and whether this coincided with current legislation.
Describe whether there were any notable unintended consequences, for example, whether women's access to land water and fuel and household access was affected, and whether long-term income increases were enough to compensate all households for reduced access to land and increased prices

Project operatives had to engage with the following groups from time to time, in no particular order, whenever there was a need to discuss to discuss project implementation strategies: local farmers, municipality majors, political organizations (mostly African National Congress party and Democratic Alliance party which are most influential political parties in South Africa and the former being the ruling party). These groups represent the community members at their different levels of authority and the groups have not changed so far. Communication was and still is mostly in a form of personal visits, e-mails and telephone. Some concerns, which were mostly due to impatience from community members who want to start working, were resolved by involved stakeholders providing the people with relevant information and explanations. Community members generally regarded the establishment of the project as a platform that will create job and food security opportunities.

Impact on agricultural practice

Describe whether the availability and type of food on local markets changed after the project began and whether there was any impact on localised supply of or demand for food and fuel and if there were any credibly attributable impacts on prices
Describe whether there were any changes in land use as a result of e.g. new biomass farms being established.

At this point there have not been any measurable impacts on the livelihoods of the surrounding communities since the project has only conducted at pilot scale however once the commercial scale is fully operational it is anticipated that the communities will benefit. Intercropping and crop rotation will be practiced as part of the standard sorghum and sugar beet production process. Therefore, agricultural practice will not only focus on production of the feedstock (sugar beet and sorghum) but will also contribute towards knowledge and agronomy of other

crop plants for supply and consumption by the local community. Part of the Core Estate land purchased for production of the feedstock was previously used for livestock grazing and considered to be underutilized land; running of the project will result in full crop production on such land resulting in increased food production and improved farming practices.

Future growth plans and recommendations

Describe what the future growth plans of case study are, if any, and what the perceived opportunities and threats might be for future growth.

It is expected that a number of different money-generating projects will emerge from the project in the future and as the technology is explored further. However no plans have been made towards implementation or expansion as yet.

Case No. 5	***Ethanol from sorghum (Mabele Fuels)***

Name of reporter: Prudence Mambo
Contact details: pmambo@gmail.com

Time period of interrogation: Approximately 1 h 13 minutes 38 seconds

Methods used in interrogation:

- Voice recorder
- Template Questions in Appendix 2
- Telephonic Conference

Stakeholders interviewed- Mr Asogan Moodaly
General Manager of Mabele Fuels
Email Address: asogan@mabelefuels.com
Physical Address: Mabele Fuels (PTY) Ltd
Lobby 2
2nd Floor Marina Centre
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There were no permissions or restrictions on the use of information

The Biofuel/energy supply chain

Biomass Feedstock

- Grain sorghum generated on farms in close proximity to the Mabele Fuels refinery in Bothaville will be utilized to supply the plant. Grain pre-treatment is not required, thus minimal carbon dioxide emissions are anticipated to get the stock refinery ready. Grain silos will be utilized to store the grain at the plant prior to ethanol production.

Transportation Methods to Ship Biomass to Processing Units

- Road and rail will be utilized to transport the feedstock from the farms to the refinery at a maximum distance of 150 km away.

Key Technologies Used

- Mabele Fuels will employ **first generation fermentation**, which involves the introduction of yeast and water to a substrate culminating in the production of ethanol. The final product will be stored in fixed roof tanks. Fixed roof tanks protect the ethanol produced from water invasion.

Retail Outlets

- Mabele Fuels will sell ethanol to SASOL, Total, Shell, MGM, Chevron, BP and Petro SA who will subsequently supply the blended ethanol and petrol biofuel to their various consumers. Sasol is already blending their fuel with 2 % ethanol produced by the Industrial Development Corporation (IDC) and selling this product to the average consumer.
- Currently Mabele Fuels do not foresee expansion into the export market due to competition with Brazil and America. Pricing is the major mitigating factor in preventing export, as currently they cannot compete with the large companies in America and Brazil.

The case study

Originally the company was branded as Ethanol Africa (2004). However, following delays in the implementation of government mandates most of the original shareholders lost interest. The company was consequently rebranded as Mabele Fuels and has been running since 2006, while awaiting government mandates since 2007. The 2007 government mandate impeded the biofuels industry within South Africa as it did not explicitly state that fuel companies were obligated to utilize bioethanol for their blending; thus without a market the industry could not develop. Government was to aid the implementation of the Mabele Fuels project by providing mandatory directives, incentives and pricing for the biofuels industry in South Africa.

The company Mabele Fuels is yet to commence operations however it has managed to secure a majority of the funding requirements. These funds will however only become available once government promulgates legislature regarding mandatory petrol: bioethanol blending. The relevant legislature should have been passed in July 2012; however it is yet to proceed (August 2012). Mabele Fuels will eventually serve as a bioethanol plant, generating ethanol for blending with fossil fuel petrol. Construction of the refinery is however, anticipated to commence at the end of 2012 following the implementation of the relevant legislature. The scale of bioethanol produced by the plant will be 150 million litres per annum. For every tonne of grain fermented by the plant, one tonne of carbon dioxide will be generated corresponding to one tonne of ethanol produced. Carbon dioxide will then be harvested and used for beverage carbonation by another company called Afrox, while ethanol generated will be blended with petrol.

Drivers

The South African government mandate requiring 2 % blending of bioethanol with all fossil fuels will induce a market that will be satisfied by two companies Mabele Fuels and the IDC. The government is opting to gradually increase the biofuel mandate, so as to circumvent an unsustainable demand for or oversupply of grain. Consumers in the United States of America could not cope with the sudden elevated supply of grain in anticipation of a booming biofuels industry. This resulted in the grain being dumped on the world market. South Africa has opted for a gradual increase in the ethanol content of the biofuel blend. This gradual inclination will

accommodate the assessment of the impact of the biofuel industry on the economy, while addressing concerns of grain for ethanol impacting food as well as fuel production. Currently Mabele Fuels do not foresee an international market for the export of their bioethanol.

Following a due diligence analysis by the Environmental Protection Agency (EPA), the results showed a 30% reduction in biofuel production costs when compared to fossil petrol. There was also a significant reduction in carbon dioxide emissions. The biofuel industry is energy positive, 1.3 units of energy are generated for each unit of fuel consumed.

The main biofuels driver was that the government was willing to support the industry resulting in good financial returns with numerous benefits such as:

- Job creation
- Rural development
- Clean fuel
- Reduction in pollution
- Implementation of a plant that was financially sound.
- It was also the right thing to do

The benefits of bioethanol production far out-weigh the costs, while utilizing low risk technology.

Support

The original shareholders saw an opportunity based on proposed government mandates, based on the draft biofuels strategy. However, the final draft disappointed the industry. Government needs to expressly tell commercial oil companies to buy the bioethanol to create a market for the product. Thus, nothing has developed in South Africa in the past 6 years. Mabele Fuels will however fulfil this niche.

The Mabele Fuels project is currently financed through private investment. Funding has been a challenge to obtain and further hindrance has been due to the government not passing suitable mandates. Mabele managers have maintained interest from funders by educating their investors; the challenge has been maintaining the investors' interest in the project.

Mabele Fuels currently would not seek government funding though the company has qualified for a tax write off in the form of the Support Programme for Industrial Innovation (SPII) funding from Department of Trade and Industry (DTI). The eventual annual turnover of the company will be more than one billion rand. Therefore there has been no external support and support will only come into play once the plant is up and running.

Jobs

Currently there are only 6 full time employees of Mabele Fuels. Existing shareholders have invested their own money in order to run the business. Agro-processing increases job creation as it is a multiplier industry. The jobs created will be sustained over time, the more incentives in

place the greater the job creation. There is no point in creating more jobs without a market to sustain them.

Jobs to be created:

- 34 000 jobs in total anticipated to be generated by biofuel industry according to government.
- The DTI estimates 21 000 jobs will be generated by Mabele Fuels
- However, Mabele Fuels has a more conservative estimate of 16 000 jobs to be created within South Africa

Business targets and wealth creation.

Business achievements thus far include:

1. Acquiring the Land Record of Decision
2. Conducting the Environmental Impact Assessment (EIA)
3. Attaining the SPII allowance
4. Licence acquisition
5. Completion of a feasibility study
6. 70 % loan approved by the bank pending government mandate
7. Assisting government to pass the mandates
8. The company only anticipates large returns following implementation of the project as construction and operation of the plant is yet to commence.

Training

Mabele Fuels will advertise for skilled workers currently available in South Africa. Workers from existing plants may be absorbed into the bio-refinery. Unemployed youth following training will be absorbed into the plant and eventually supplying services to the plant. Youths up-skilled by the plant also start up their own businesses to aid in the normal function of the plant; therefore there will be a knock on effect. Sasolburg and Secunda are successful examples where businesses flourished around a plant.

Local community stakeholder groups

Agricultural land owners, democratically elected leaders, municipalities, local traders, service providers, policy makers or regulators were contacted as part of the EIA. Currently the managers interact with policy makers and regulators every 2 weeks. While they communicate with landowners every 6 months as they will eventually provide the plant with raw materials. This will aid the farmers in diversifying their risks onto currently underutilized land. However until the government passes the relevant mandate Mabele cannot raise expectations of the landowners in case they lose interest while waiting for government mandates. Communication with the

municipality occurs every 2 months as the municipality provides licenses, roads, zoning certificates, water and power for the plant. The problem with the municipality has been the turnaround time. However there has been great interest and support for the Mabele Fuels project. The modes of communication have been phone calls, emails and visits, culminating in informal meetings. The company enjoys an overall good rapport with everyone involved. Though government officials were initially lukewarm regarding the Mabele Fuels concept gradually their relationship with the company has strengthened over time, though the passing legislature is still slow.

Impact on agricultural practice

As a drought tolerant crop sorghum can be planted on marginal land thus conserving water. The refinery will generate its own electricity using coal. Bothaville has coal bed methane; therefore and in future, the refinery may opt to utilize these reserves for energy.
The agricultural land footprint will be minimal especially as the land utilized for sorghum cultivation is not suitable for maize crops. Thus the land is usually left fallow, so there will be the use of land that is currently non-productive.
Mabele Fuels anticipate no impact to the food market. There will be minimal crop switching to satisfy the biofuel industry. Smaller farms currently struggling to compete with commercial scale farms should thrive due to fewer inputs required to successfully cultivate sorghum. Land previously left fallow will be brought back into production. This economic activity will result in employment. The project will positively impact household incomes.

Future growth plans and recommendations

People will move to Bothaville to sustain the emerging economy. They will earn more money in the area. Women will be able to farm and generate substrate for the plant. Mabele will also comply with the women's equity plan which is a government mandate. An unnamed Women's group may eventually become a shareholder in the plant.
Dried Distillers Grain Solubles (DGGS), a by-product of ethanol fermentation, which contain elevated protein and fibre, will be sold potentially to the South African, USA, European and Chinese markets. South Africa currently imports approximately 150 tonnes of high protein feed for animals. The DGGS is not as high value as soya meal however Mabele Fuels may be able to infiltrate the market simply due to the cost of transport of the DGGS decreasing.
Growth plans are currently to get up and running, however as government raises the mandate from 2-5 % Mabele will expand and build another facility, possibly elsewhere in the country. Markets for ethanol are currently well supplied but not for the blending of fuel, thus they may wind up flooding the market with ethanol.
Government support is SLOW. Everything is in place except government support. It is

destroying enthusiasm.

Extra Literature Used

Department of Minerals and Energy, (2007) Biofuels Industrial Strategy of the Republic of South Africa http://www.info.gov.za/view/DownloadFileAction?id=77830 accessed on 28/06/2012
Mabele Fuels, (2012) Sorghum to Ethanol http://www.mabelefuels.com/ accessed on 28/06/2012
The manual for first generation biofuel production is available online via Google. The technology is well established and can be accessed through KATZEN, PRAJ or VOGELBUSCH.

7. Exit interview and value of training – Upon completion of the interrogations and compilation of the individual case study reports, students were debriefed in an exit interview. The interview concentrated on the value of the training and implementation of the skills acquired, touched on aspects relating to general interrogation and project evaluation, and reviewed the written report (including editorial). In addition, the *rapporteurs* were asked to comment on the major 'driver' (economic, social, political) of the project that they had investigated, elaborate on the role of government/local authorities/regulators, and comment on the contribution of biofuels projects to sustainable agricultural practices and the 'food versus fuel' debate. It was hoped that the exit interview would provide the report writers with additional information to bolster their final efforts.

In short, all student *rapporteurs* responded favorably when asked about the value of the training provided and indicated that without prior training it would not have been possible to plan and execute the activities as smoothly as they had. Most agreed that certain aspects of the interview/interrogation could and in hindsight, have been improved quite considerably. However, there was general consensus that each of the case studies with seemingly similar issues made it difficult to address the topic of "biofuels supply chain" with the degree of rigor required. For example, in only one instance had the project been implemented and the objectives met (Community Biogas – Three Crowns). In all other cases, government and/or local authority recalcitrance meant that the project was (and in most instances still) in abeyance. For the most part, the obstacle appeared to rest with government's inability to secure the necessary mandates and the inability of local municipalities to commit (time, money, and expertise) to project implementation and realization.

Of the five cases studied three were seen as driven primarily by economics (Bio-ethanol Plant, Phytoenergy, Mabele Fuels) and heavily government-involved. The Community Biogas project at Three Crown and the Algae-to-energy project (Fort Hare University, Alice) were perceived as socially/societally driven. Interestingly, the latter were originated and funded by non-governmental organizations and/or academic institutions. The perceived economically-driven cases appeared to be hindered by the inability of government (usually the principal share-holder) to move forward, the continuing change in political landscape and to far too

many government 'controlled' meetings where emphasis appeared to be on "understanding the problem" rather than "implementation of the agreed solution".

It was also clear from commentary during the exit interviews that many of the projects were 'not' conceived with sustainability in focus. For example, the supply of feedstock for the Bio-ethanol Plant (Cradock) is not secure and so too the supply of grain sorghum to Mabele Biofuels. Similarly, there was uncertainty about who the end-user(s) would be. Mabele Fuels is awaiting a mandate from government to regulate the consumption of bio-ethanol by petrochemical companies in South Africa (to ensure a market) whereas the Bio-ethanol Plant in Cradock appears set solely on supplying to Europe – but even this is not cemented. Likewise, the Phytoenergy driven initiative to produce canola (rape seed) for biodiesel generation appears to be largely "oilseeds for money" based. Canola production has yet to commence and there is uncertainty about the downstream processing i.e. is it to be processed locally or shipped abroad? In short, the supply chain is not rigid and the apparent fragility could undermine successful implementation and outcome of these projects. In contrast, the socially or societally driven projects were grown from and by the end-user and implemented as a 'need' to solve existing obstacles. The obstacle at Three Crowns was a defunct sanitation system. The overpowering odours and fly infestations made it very unpleasant for children and parents to participate in day-to-day school activities. On-site digestion of waste has improved conditions dramatically such that pupils and parents now play an active role in every school day. Similarly, the Fort Hare University Agric Park programme is constrained by electricity supply and price. With the commissioning of new anaerobic digesters for animal waste an opportunity presented itself for biogas harvest and use. By integrating the EBRU developed algae pond systems for waste water treatment, both treated water and a steady supply of algae-to-bio-methane will be available to the user. Methane thus produced will be used to drive the food processing component of the Agric Park and success in Alice will see its roll out to the remaining Agric Parks destined for Port Shepstone, Butterworth, and Dutywa. Fort Hare hopes to decouple most (probably all) of the Agric Park energy requirements from the national grid and operate solely on a bio-methane/solar energy budget after completion and installation of the algae-to-energy system. The project has been rescheduled and will commence 1 October 2012.

It is obvious that any and all plant-based biofuels projects are by their very nature elements of the "food versus fuel" debate. The projects described in this report are no different and will compete for available land with food crops. Although several biofuels projects in South Africa have become dormant due to a government decision to impose a moratorium on the use of arable land for biofuels, government involvement in the Mabele and Bio-ethanol projects might explain the delay in securing the necessary mandates. That is, a conflict of interest exists and government is unsure of how to proceed. Even so, it was evident in the debriefing sessions that the projects investigated were being touted as efforts to stimulate regional agriculture including Phytoenergy. Purportedly, the stimulus will be provided by the

infusion of technology and infrastructure to support biofuels crop production. It is hoped that a knock-on effect will kick start a local food producing market. However, in the absence of progress to realize not only feedstock production but transport, processing and marketing (i.e. a complete biofuels supply chain), it is doubtful whether these biofuels projects will have any beneficial effect on regional agriculture. By comparison, the societally driven biofuels project initiated to address specific community needs both have a complete biofuels supply chain in place. In addition biogas (methane), these systems produce treated water which is used for irrigation of crops that provide food to the community. These systems also generate a biomass that can be used as a biofertilizer and feedstock for anaerobic digestion. Consequently, these are (Community biogas at Three Crowns) and will (Algae-to-energy, Fort Hare University) approach zero waste in that all products along the supply chain either are or will be utilized.

8. Perpetuity of the training course at Rhodes University – Consensus from the students who attended the training course is that was invaluable. The course and the exercise allowed the student to examine real project situations from conception to implementation. While perhaps to be expected based on inexperience, these same students were not (opinion only) equipped to scrutinize the case studies with due care/caution. Even so, experience can only be gained by carrying out the task and from subsequent evaluation and feedback of what was uncovered and achieved. Thus, introduction of a similar training course with the associated interrogation and evaluation exercises could enhance analytical competency. Furthermore, acquisition of the skills imparted in training will benefit understanding of the process and pitfalls of implementing bioprocesses.

At Rhodes University several opportunities exist for integration of the training course. First, as a component of the one week certificate course in Bio-entrepreneurship offered to Honours and postgraduate students annually. Second, the course could be integrated into the MSc course-work degree as a component of the Environmental Management module. Third, there is the possibility to offer the course at irregular intervals to students in biotechnology, environmental science, and environmental education and as a component in the MBA in environmental management. It is suggested that a full feasibility study be carried out to explore these opportunities.

9. Concluding remarks – In summary, the training course equipped students to prepare, plan, arrange, and conduct all interviews. However, inexperience resulted in relatively poor evaluation and reporting. Although, and not for lack of trying, only one interviewee was available per project. The exit interview indicated that all found report writing a challenge and assessment in terms of the topic “biofuels supply chain” appeared to escape most. However, “government” recalcitrance on policy decisions was identified as key in preventing progress and implementation of many of these projects. It is recommended that a version of this training course be considered for elaboration at the higher degree level in biotechnology.