MABELE FUELS (PTY) LTD

Job creation impact of a 150,000 m^3 per annum bioethanol plant in South Africa

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B2	-	2% Biodiesel with 98% diesel blend
bu/acre	-	Bushels per acre
DDGS	-	Distiller's Dried Grains with Solubles
E5	-	5% Ethanol with 95% petrol blend
E10	-	10% Ethanol with 90% petrol blend
E15	-	15% Ethanol with 85% petrol blend
EPAct	-	Energy Policy Act
IPAP	-	Industry Policy Action Plan
m^3pa	-	Cubic metres per annum
MTBE	-	Methyl Tertiary Butyl Ether
SAB	-	South African Breweries
tons/ha	-	tons per hectare
US	-	United States of America

Executive Summary

Job creation in South Africa is a national prerogative. This is made clear from the President's State of the Nation address as well as the Department of Economic Development's New Growth Path. The New Growth Path identifies several key drivers of job creation i.e. infrastructure, the agricultural value chain, the mining value chain, the green economy, manufacturing sectors and tourism and high level services.

Mabele Fuels (Pty) Ltd maintains that the bioethanol industry satisfies Government strategy in terms of job creation, particularly with regards to jobs in development of infrastructure, agricultural value chain development and the green economy.

The purpose of this study was to objectively determine the number of jobs created due to a 150,000 m^3pa grain sorghum to ethanol plant to be built in South Africa and to provide indicative costs per job. The goal of this study is to add impetus to Government's implementation of the Biofuels Industrial Strategy that was published in December 2007.

It was determined that ±16,700 sustainable direct, indirect and induced jobs would be created from the operation of a 150,000 m^3pa bioethanol plant ranging from the agricultural, logistics, spinoff industries and plant operations value chain. This was calculated from 1st principles and was validated using a pure economic calculation as well i.e. jobs created per R1Million of sales in agroprocessing.

Assuming a 100% General Fuel Levy rebate, the cost per job would be ±R15,000 which compares well with the current youth wage subsidy currently mooted by Treasury with a cost per job of R28,000 per job. The cost per job is actually significantly lower with an effective cost per job of about ±R6000 per job as the company will pay taxes back to Government.

On this basis, a Producer Incentive as discussed in the Biofuels Industrial Strategy, over and above the Fuel Tax rebate incentive, should also be considered by National Treasury with the cap on this incentive equating to R28,000 per job.

These calculations also do not take into account the benefit to the country's balance of payments due to forex saved on displacing 150,000 m^3pa of imported petrol volumes. This volume of imported petrol is worth approximately R785 million.

1 Introduction

In his 2011 State of the Nation address, President Jacob Zuma stated that the South African Government has declared 2011 the 'Year of job creation through meaningful economic transformation and inclusive growth' (Zuma, 2011).

This is not a new sentiment, and Government's strategy for creating decent work, reducing inequality and defeating poverty are clearly spelt out in the New Growth Path which was published in 2010.

Job creation in the following key sectors has been prioritised in the New Growth Path:

1. Infrastructure
2. The agricultural value chain
3. The mining value chain
4. The green economy
5. Manufacturing sectors as per the Industry Policy Action Plan ("IPAP") 2
6. Tourism and high level services

(Patel, 2010)

Mabele Fuels (Pty) Ltd ("Mabele") intends to construct at least one biofuel plant to be located in Bothaville, South Africa; that will utilize grain sorghum as feedstock to produce bioethanol. The bioethanol produced in this plant will as per the cabinet approved Biofuels Industrial Strategy of South Africa, be blended with petrol in South Africa utilising local agricultural feedstock (Energy, 2007).

It is the contention of Mabele that the bioethanol industry as promulgated serves Government strategy with regards to energy infrastructure development, agricultural value chain, the green economy and most especially job creation.

The purpose of this report is to objectively quantify the number of jobs that could be created if a 150,000 m^3pa bioethanol plant was to be established in South Africa. It is Mabele's view that the job creation imperative requires the immediate attention and focus of Government; in speedily implementing the incentives and structures as per the Biofuels Industrial Strategy which was approved in December 2007.

2 Background

2.1 Technology

Ethanol is produced from the fermentation of sugar with yeast. The sugar can be extracted directly from a sugar containing plant such as sugarcane or sugar beet, or can be obtained from converting starch in starch containing plants to sugar prior to fermentation. The basic process of converting sugarcane to ethanol is as follows:

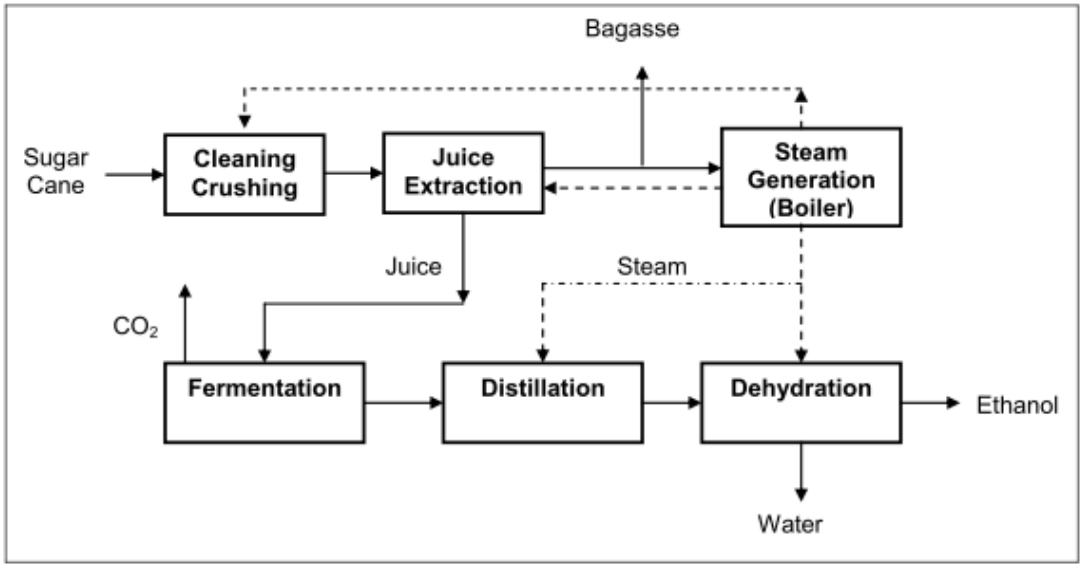

Figure 1: Sugar cane to ethanol flow diagram Source (Anon, 2006)

The basic process of converting starch containing crop such as maize is as follows:

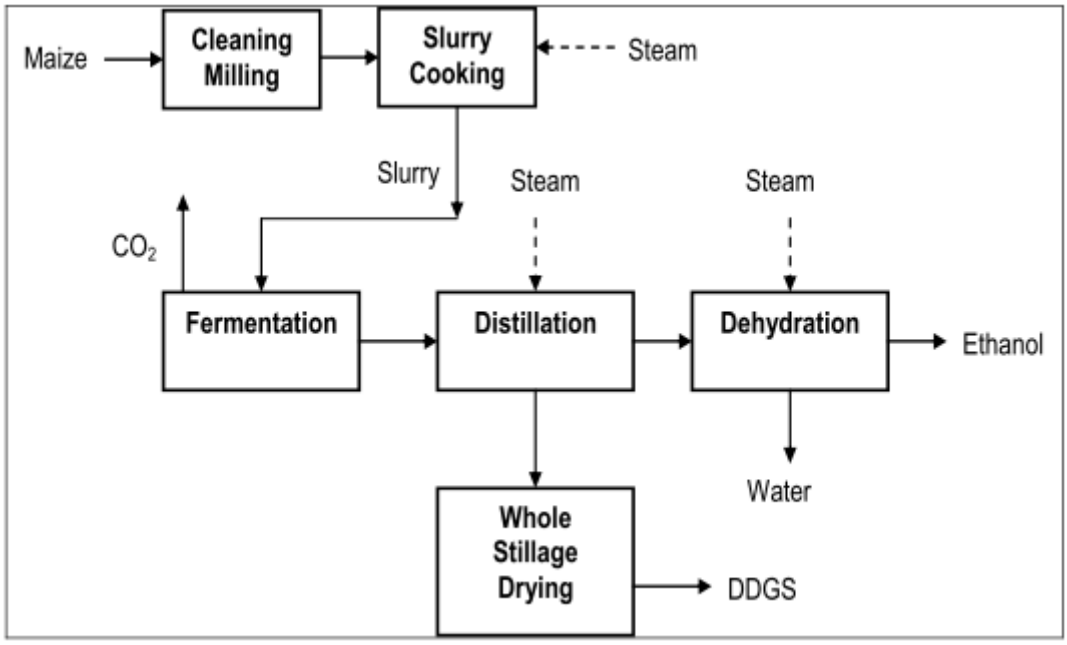

Figure 2: Grain to ethanol flow diagram: Source (Anon, 2006)

2.2 Global Ethanol Production

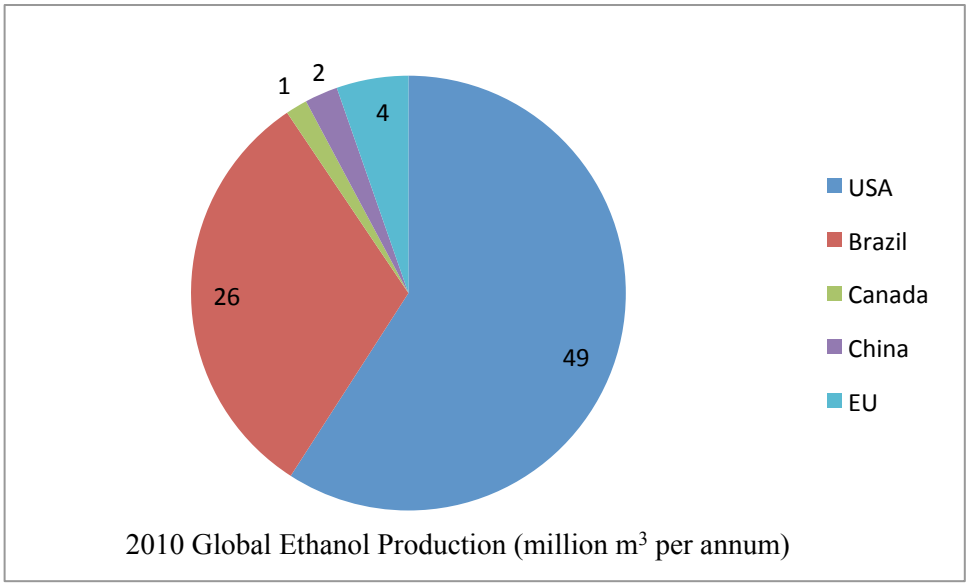

Figure 3: Global ethanol production. Source: (Cooper, 2011)

As can be seen in Figure 3 above, global ethanol production is dominated by the USA with an excess of 49 million cubic metres of ethanol in production from 204 biorefineries (Cooper, 2011). Brazil used to dominate global ethanol production up to 2005. Production in Brazil is now about half that of US production but is still significant at 26 million cubic metres of ethanol per annum. As a matter of perspective, South Africa's total petrol consumption is approximately 12 million cubic metres – a 10% ethanol blend ("E10") would only represent 1.2 million cubic metres of ethanol. On this basis, only the United States and Brazil will be discussed in this section with regards to the international background on ethanol as a blend component for petrol.

2.2.1 The United States of America

Ethanol is not a new fuel. In the 1850s, ethanol was a major lighting fuel in the United States. During the North American Civil War, a liquor tax was placed on ethanol to raise money for the war. The tax increased the price of ethanol such that it could no longer compete with other fuels such as kerosene in lighting devices. Ethanol production declined sharply because of this tax and production levels did not begin to recover until the tax was repealed in 1906.

In 1908, Henry Ford designed his Model T to run on a mixture of gasoline and alcohol, calling it the fuel of the future. In 1919, when Prohibition began, ethanol was

banned because it was considered liquor. It could only be sold when it was mixed with petroleum. With the end of Prohibition in 1933, ethanol was used as a fuel again. Ethanol use increased temporarily during World War II when oil and other resources were scarce. In the 1970s, interest in ethanol as a transportation fuel was revived when embargoes by major oil producing countries cut gasoline supplies. Since that time ethanol use has been encouraged by offering various tax exemptions for producing and blending ethanol into gasoline, as well as an import tariff on ethanol.

In 1988, ethanol was added to gasoline for the purpose of reducing carbon monoxide emissions in North America. Ethanol is an oxygenate which results in more complete combustion of the carbon in petrol. Demand for ethanol increased when Methyl Tertiary Butyl Ether ("MTBE"), an alternative oxygenate, was banned in 2000. The 2005 Energy Policy Act ("EPAct" focused on the renewability of ethanol (Renewable Fuels Standard) and mandated an increase in its use to 28.4 billion litres to 2012. Actual production has far surpassed this target.

The U.S primarily uses grains as a feedstock for bioethanol production.

(FOLichts. and AgreaCeas, 2007)

2.2.2 Brazil

Brazil was the world leader in fuel ethanol production and utilization up to about 2005 when the US overtook Brazil's production figures. The Brazilians use sugarcane as the primary feedstock to produce up to 50% of the nation's automotive fuel.

After the 1973 oil crisis, the Brazilian Government in 1975, initiated the Pró-Álcool program to phase out fossil based liquid fuels in favor of ethanol.

The Brazilian government set three main drivers that encouraged ethanol production:

1 Control of ethanol distribution by state owned oil company Petrobras
2 Guaranteed alcohol price
3 Low interest loans for agro-industrial ethanol companies

The car manufacturers in Brazil produce cars that run on petrol, alcohol and in the last decade 'Flex Fuel' vehicles have been developed which can run on either petrol or

alcohol. Almost 90% of new vehicle sales in Brazil for the 2006/2007 years were pure ethanol or flex fuel vehicles.

Government intervention includes ethanol blending obligations on the oil companies, fuel tax exemptions, and lower motor vehicle duties for ethanol powered vehicles.

(FOLichts. and AgreaCeas, 2007)

2.3 Ethanol blending in South Africa

South Africa has a long history of blending ethanol with petrol. Union Motor Spirit (a 1:1 ethanol to petrol blend) was blended with petrol to produce an effective 12.5% percent ethanol blend (Buchanan, 1979), from the 1950's to mid 1960's (Preen, 2006) and (Goosen, 2011).

Furthermore, Sasol blended 12% synthetic ethanol with petrol in the mid 1980's to 1996 and then from 1998 to early 2000's (Robertson, 1998) and (Goosen, 2011). Note that consumer and oil industry complaints in the 1980's to 1996 period were primarily due to the higher alcohols present as a result of the coal to liquids process. These issues were later resolved with a more pure (85%) ethanol blends (Thomas and Kwong, 2001).

Today, biomass derived ethanol is produced in South Africa primarily for the potable and industrial markets. Synthetic ethanol is currently blended into the fuel pool at SASOL up to 2% at Secunda. Mossgas based in Mossel Bay also produces synthetic ethanol which is blended in limited amounts with petrol.

South Africa commenced with the phase out of lead in petrol in 2006. This has increased the value of ethanol as an octane blendstock as lead is used primarily to boost the octane of petrol. Further Clean Fuels regulations should further increase the value of ethanol as a blendstock due to the phase out of high octane aromatics and benzene in petrol.

That being said, oil refiners are still reluctant to uptake ethanol as evidenced by the lack of bioethanol industrial development in South Africa.

3 Literature review - jobs created from grain derived ethanol

3.1 United States of America

Emphasis is placed on the result of the US model due to the success in implementation as well as the main feedstock in the US being grain based.

3.1.1 United Nations Environmental Programme report

According to a United Nations Environmental Programme report, the number of jobs (direct and indirect) attributed to ethanol production is 154 000 jobs in 2006 (Renner, Sweeney and Kubit, 2008). The jobs are in agriculture, logistics, processing and support services, and include indirect and induced jobs.

US ethanol production in 2006 was 4 855 million gallons (18 378 000 m^3) (Cooper, 2011).

This implies direct and indirect job creation of 0.01 jobs per m^3 using the United States model. This in turn implies that a 150,000 m^3pa plant will create 1500 jobs if the conditions and technology of the US model is the basis.

3.1.2 Renewable Fuels Association report

A further recent report prepared for the United States Renewable Fuels Association by an independent economics consultant, Cardno Entrix, showed the total number of direct, induced and indirect jobs created by the industry at 400,677 (Urbanchuk, 2011).

US ethanol production in 2011 was 13 000 million gallons (49 210 000 m^3) (Cooper, 2011).

This implies total job creation at 0.01 job per m^3 and again in turn implies that a 150,000 m^3pa plant will create 1500 jobs.

It should be noted that large economies of scale with about 40% of farms ranging from 400ha to 4000ha (Key and Roberts, 2007), high degree of mechanisation as well as exceptionally high yields of maize in the US of 182 bu/acre (11.42 tons/ha)

(Johanns, 2010) resulting in lower land requirements; will result in lower employment in agriculture compared to South Africa. The effects of these characteristics are discussed later in the document.

3.2 South Africa

3.2.1 Sustainable Energy and Climate Change Partnership report

A report from Cape Town based Agama Energy (Austin, Williams, Morris, Spalding-Fecher and Worthington, 2003) indicated that an E15 ethanol blend (1 545 000 m^3pa) would create 62,000 jobs with 53,000 jobs being in agriculture and 9000 jobs being in small scale bioethanol plants. This assumes South African petrol demand of about 10 million litres. The study's assumptions were as follows:

- Sweet sorghum would be used as the primary feedstock. Note that 'sweet' sorghum is different to regular, commercialised 'grain' sorghum. Sweet sorghum is not commercialised in South Africa and is closer to sugar cane than a grain
- Available molasses (hence no new agriculture) would account for at least 237,000 m^3pa of ethanol. Thereafter, new plantings would be required for additional ethanol demand
- The sweet sorghum yield would be 46 ton/ha/crop
- Crops would yield twice a year
- Area per farmer would be 5ha
- Ethanol yield would be 54 litres/ton sweet sorghum

These assumptions were not substantiated in the report.

The author may not necessarily agree with the results of the study, nor with the input assumptions but the methodology provides a useful framework to progress the investigation using a different feedstock and set of assumptions. The calculation methodology is presented in Appendix 1: Agama energy calculation methodology.

3.2.2 National Biofuels Study Report

A feasibility study that was prepared for the South African Biofuels Task Team indicated that an E10 blend level has the potential to create about 50,000 jobs mostly in rural areas (Anon, 2006).

Some of the assumptions were as follows:

- Volumes of ethanol equivalent to E5 were attributed to maize
- Further volumes of ethanol equivalent to E5 were attributed to sugar cane
- Volumes of biodiesel equivalent to B2 were attributed to soya bean

450 direct jobs were expected to be created in the processing plants for an effective E10 and B2. About 4500 jobs were expected to be created due to the processing plant and associated multiplier (direct and indirect jobs).

1050 jobs were expected to be created in the logistics industry due to the job multiplier difference between the petroleum and logistics industries.

The agricultural sector was expected to create about 34 300 direct and indirect jobs assuming new land was planted.

These numbers **exclude** induced jobs i.e. jobs created by additional spending.

The Feasibility study employment numbers can be summarised as follows:

Number of Jobs Created	Refinery Sector	Agriculture Sector	Transport Sector	All Sectors
Direct in Biofuel	450	4,300	1,050	5,800
Indirect	4,050	30,000		34,050
Total (Direct + Indirect)	4,500	34,300		39,850

Figure 4: Summary of direct and indirect jobs as per SA Biofuels Feasibility study. Source (Anon, 2006) cited in (Clayton, McDougall, Perry, Doyle, Doyle and O'Connor, 2010)

The study utilised an input-output model utilising data from the 2003 Trade and Industrial Policy Strategies institution ("TIPS") based on their version of the social accounting matrix ("SAM"). The results which **include** induced jobs are as follows:

Scenario	Total Jobs Created Sources			
	Refining	Biofuels	Agriculture	Net Impact
E10	-4 771	11 025	40 216	46 470
B2	-1 095	732	8 183	7 820
E10 + B2	-4 952	11 859	48 399	55 306

Figure 5: Direct, indirect and induced jobs created. Source (Anon, 2006)

As can be seen in Figure 5 above the total jobs attributed to E10 bioethanol is 46,470. The study indicates that the oil refining industry would lose 4,771 jobs if bioethanol was to be established in South Africa, which in the opinion of the Author is a highly overstated number and should be ignored. Therefore the job contribution to E10, assuming the calculations and assumptions were reasonable in the study, would be ±50,000 jobs.

Unfortunately the job split between the sugar cane to ethanol production volumes, and the grain to ethanol production volumes are not indicated in the report. Furthermore, the actual assumptions and calculation spreadsheet/model is not included in the report which makes it difficult to critically assess the plausibility of the job creation numbers. That being said, the above information is useful in deriving the overall job multipliers used for indirect and induced jobs for this particular study:

	Direct Impact	*Indirect impact*	*Direct and indirect*	*Induced impact*	*E10 Economy wide impact*	*Overall Multiplier*
Processing plant	450	4,050	4,500	6,525	11,025	9.4
Agriculture	4,300	30,000	34,300	5,916	40,216	24.5

Figure 6: Derived job multipliers from the South African Biofuels Feasibility study

The table is particularly useful as an indication of employment multipliers used for the agricultural and processing plant sectors.

3.2.3 South African Breweries (“SAB”) report

Econex and Quantec Research were commissioned by SAB to carry out a study on the contribution of SAB to the South African economy. While the study is specific to the potable alcohol industry, the report is useful in providing industrial sector job multipliers for indirect jobs especially as the industries are similar i.e. a grain feedstock is used to produced ethanol (alcohol). The job creation impact of the malt

beer industry on the South African economy and derived multipliers is tabulated below:

Impact of the malt beer industry on the SA economy - 2009						
Employment by industry	***Direct Impact***	***Indirect impact***	***Direct and indirect impact***	***Induced impact***	***Economy wide impact***	***Overall Multiplier***
Agriculture, forestry and fishing	11,149	5,244	16,393	9,883	26,276	2.36
Mining and quarrying	55	1,339	1,394	1,870	3,264	59.35
Food and beverage	7,986	217	8,203	2,889	11,092	1.39
Textiles, clothes and leather goods	130	287	417	2,771	3,188	24.52
Wood and paper, publishing and printing	780	938	1,718	2,111	3,829	4.91
Petroleum products, chemicals, rubber and plastic	141	650	791	1,631	2,422	17.18
Other non-metal mineral products	383	613	996	591	1,587	4.14
Metals, metal products, machinery and equipment	1,997	1,693	3,690	1,410	5,100	2.55
Electrical machinery and apparatus	13	196	209	257	466	35.85
Radio, TV, instruments, watches and clocks	4	37	41	196	237	59.25
Transport equipment	274	1,790	2,064	1,115	3,179	11.60
Furniture, tobacco and other manufacturing	44	290	334	1,337	1,671	37.98
Electricity, gas and water	129	218	347	867	1,214	9.41
Construction (contractors)	646	5,797	6,443	2,604	9,047	14.00
Wholesale, retail, catering and accommodation	4,085	3,281	7,366	80,058	87,424	21.40
Transport, storage and communication	250	1,100	1,350	7,706	9,056	36.22
Finance, insurance, real estate and business services	6,054	8,783	14,837	27,982	42,819	7.07
Community, social and other personal services	2,242	4,347	6,589	26,949	33,538	14.96
Total Employment	36,362	36,820	73,182	172,227	245,409	

Figure 7: Impact of the malt beer industry on the SA economy – 2009. Source (Econex and Quantec, 2010)

4 Bioethanol employment value chain

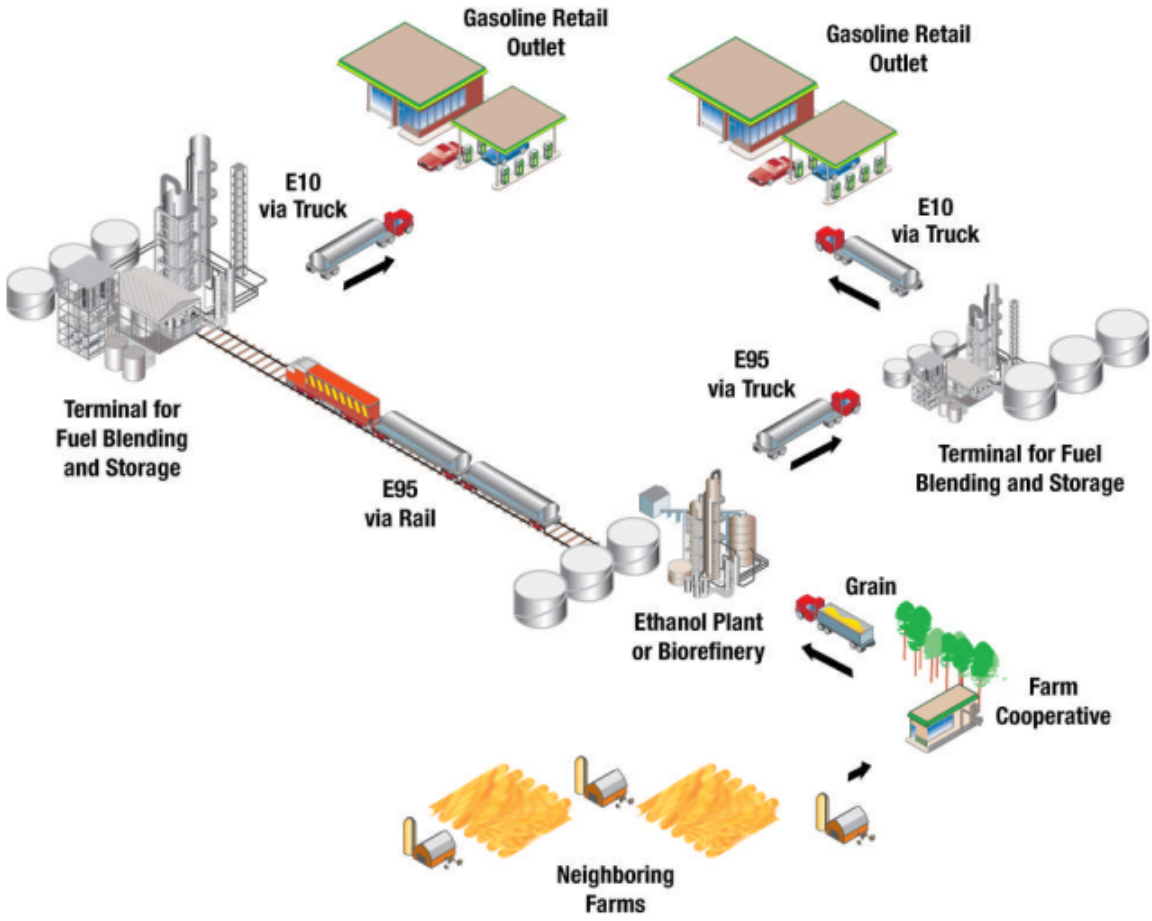

Figure 8: Typical ethanol production and blending value chain. Source US National Renewable Energy Lab cited in (Denicoff, 2007)

While Figure 8 above is a 'snapshot' of the US ethanol production value chain, it is equally relevant to South Africa. Grain feedstock is produced on farm, transported to nearby farm cooperative silos, from where it is shipped to the bioethanol plant. Ethanol is then transported to a depot or refinery for blending before being transported for retail. Missing from this illustration is the Distiller's Dried Grains and Solubles ("DDGS") animal feed component which is transported to animal feed mills or feedlots, as well as spin off industries such as light engineering, ash brick manufacturing, CO_2 recovery, etc.

The job creation potential is discussed further in the following sub sections. The following assumptions are made:

- New land will be placed under grain sorghum cultivation as dictated by the Biofuels Industrial strategy
- Small scale/developing farmers will form cooperatives to leverage economies of scale and some degree of mechanisation as per commercial farmers.
- The conservative assumption is that these cooperatives will obtain the same yields as the commercial farmers. Note that the lower yields imply more land under cultivation, and this implies more jobs.

A similar but more detailed calculation to (Austin et al., 2003) was used to determine the direct jobs created and can be found in Appendix 2: Mabele Plant direct jobs calculation.

4.1 Direct jobs created in agriculture

4.1.1 Grain sorghum background

Sorghum is an indigenous crop to Africa and is a hardy, drought resistance crop providing better food security than maize in many rural communities. Sorghum is cultivated mainly in drier areas, especially on marginal soils that are shallow and have heavier clays (du Plessis, 2008).

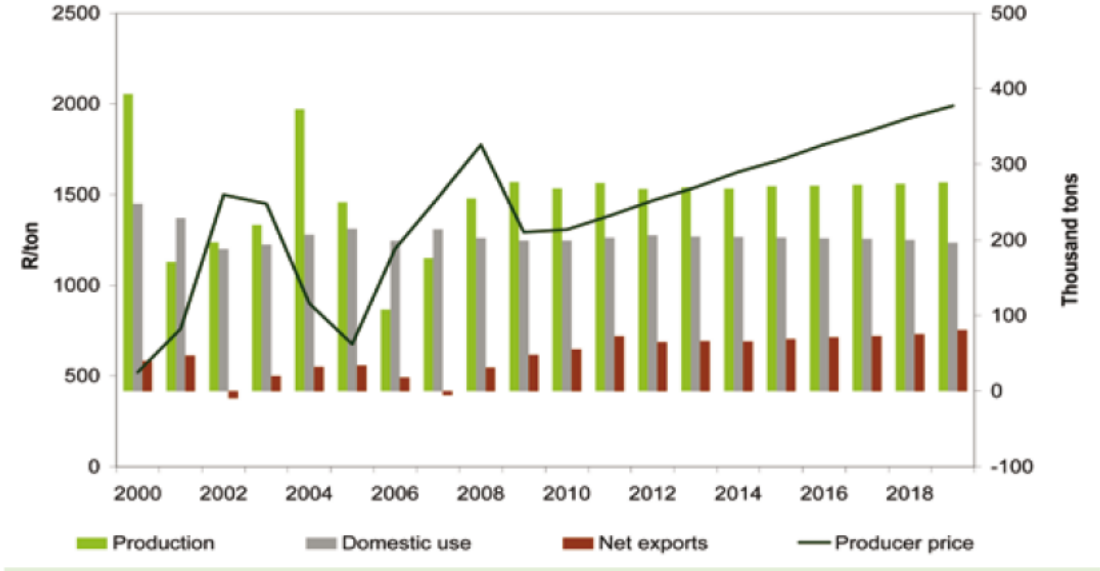

Figure 9: Sorghum production use, exports and price. Source (Meyer, Vermeulen, Labuschagne, Mapila, Kalaba, Parastan et al., 2010)

As can be seen in Figure 9 above, sorghum production has been as high as 400,000 tons per annum in the past. The production is expected to remain within the 270,000 tons per annum to 276,000 tons per annum range going forward in the absence of bioethanol production. It must be noted that the decline in production from 2000 is due to change in consumer preferences for sorghum beer towards more commercial beers as household income improves (Meyer et al., 2010).

4.1.2 Job creation due to increased sorghum demand

The Biofuels Industrial Strategy is quite clear in stating that biofuel feedstock needs to be produced on new or underutilised land (Energy, 2007).

The total annual sorghum requirement for a 150,000 m^3pa plant is 363,000 tons.

The area planted to sorghum in 2009 was 85,743ha which yielded a crop of 276500 tons (Meyer et al., 2010). This implies an average yield of 3.2 tons per hectare.

Therefore the total land to be planted to sorghum is ±113, 500 hectares.

Employment intensity of Agriculture

Sector	Hectares under production per permanent worker
Horticulture	12.97
Field Crops	33.64
Mixed farming	98.15
Animal production	188.77

Source: Vink and Kirsten, 2008

Figure 10: Employment intensity of agriculture. Source (Karaan, 2010)

According to Vink and Kirsten (2008), cited in (Karaan, 2010) the employment intensity of agriculture for field crops is 33.64 hectares per permanent worker. Therefore, the number of direct permanent jobs created is ±3,400. Note that this does not take into account seasonal or casual labour. The above is summarised in the calculation as follows:

Agriculture			
Requirement	363,000	tons of grain	
Yield	3.2	t/ha on average based on 2009 average	
Area required	113,438	hectares of land needed	
Rule of thumb: Jobs	33.64	hectares per PERMANENT agricultural job	
Jobs created	*3,372*	*jobs in agriculture*	

Figure 11: Direct jobs created in agriculture

4.2 Direct jobs created in bioethanol processing plant

Estimates of jobs created per operational plant range from 40-45 jobs (Anon, 2006), to 45-60 jobs (Swenson and Eathington, 2006). However it should be noted that in a South African context, the provision of a canteen, cleaning staff, security and agricultural extension services will likely add another 30-40 jobs. Agricultural extension services will be incorporated as part of the bioethanol plant organogram to source feedstock and provide assistance to farmers. This is necessary to ensure security of agricultural feedstock supply.

Therefore it one would expect that the total staff complement of a bioethanol plant in South Africa would be about 80 to 100 people.

For the purpose of this study, it is assumed that a conservative ±60 direct jobs would be created in the bioethanol plant.

4.3 Direct jobs created in logistics

The major items and associated volumes that will be transported to and from the plant are tabulated below:

		Total (tpa)	Daily (tons)	Weekly (tons)	Mode	Truck payload (tons)	Daily delivery
Outbound							
	Ethanol	120,000	400	2,800	Road	32	13
	DDGS	121,000	403	2,823	Road	32	13
	Ash	28,878	96	674	Road	32	3
Inbound							
	Grain Sorghum	363,000	1,210	8,470	Road	32	38
	Coal	100,191	334	2,338	Road	32	10
	SUM	733,998	2,447	17,127			76

Figure 12: Volumes of commodities transported to and from the plant

Total daily volumes to be transported are approximately 2,447 tons while typical truck capacity for such commodities is approximately 32 tons. Therefore the number of trucks (and hence drivers or direct jobs) required on a daily basis is ±76.

4.4 Direct jobs created in spinoff industries

A major industrial plant such as the one under discussion will provide significant infrastructure in rural areas. Infrastructure will include roads and bridges and the plant itself could easily provide steam, cooling water and process water to surrounding industries. The Sasol One site in Sasolburg is an example of this phenomenon.

Furthermore, the byproducts of the plant also provide an opportunity for businesses. The job creation potential of these opportunities are tabulated below:

Spin off Industries			
Accommodation		100	jobs (estimated)
Brick making from Ash		40	jobs (estimated)
Animal Feed/Feedlot		100	jobs (estimated)
CO2 Recovery		20	jobs (estimated)
Support services e.g. workshops, etc		40	jobs (estimated)
Logistics of spin off industries		20	jobs (estimated)
Total		320	jobs (estimated)

Figure 13: Job creation potential of spinoff industries

±320 direct jobs are attributed to spinoff industries.

4.5 Total Economic Employment Impact

The total direct jobs created by a 150,000 m3pa plant are ±3,800. However these results do not take into account indirect and induced jobs.

Using the multipliers derived from the SAB study and the multipliers derived from the Biofuels Feasibility study for South Africa produces employment figures of ±16,700 and ±83,200 respectively - please refer to Appendix 3: Mabele Plant Total Economic Employment Impact for the detailed calculation.

To be conservative the author has chosen the lower ±16,700 total employment number to be more realistic and conservative in terms of actual economic impact.

This can be summarised in the table below:

First Principles calculation					
Capacity		150,000	m^3pa		
JOB CREATION					
				SAB study Multiplier	Economy wide impact
Agriculture		3,372	*jobs in agriculture*	2.36	**7,947**
Plant		60	jobs	17.18	**1,031**
Therefore truck jobs created		76	jobs	36.22	**2,770**
Spin off Industries					
Accommodation and leisure		100	jobs (estimated)	21.40	**2,140**
Brick making from Ash		40	jobs (estimated)	37.98	**1,519**
Animal Feed/Feedlot		100	jobs (estimated)	1.39	**139**
CO2 Recovery		20	jobs (estimated)	17.18	**344**
Support services e.g. workshops, etc		40	jobs (estimated)	2.55	**102**
Logistics of spin off industries		20	jobs (estimated)	36.22	**724**
Total		320	jobs (estimated)		
TOTAL DIRECT JOBS INCLUDING SPINOFF		3,829	jobs		**16,716**

Figure 14: Table of total employment in South Africa due to a 150,000 m^3pa ethanol plant

4.6 Overall jobs created from an economists perspective

To validate the above results on an order of magnitude basis, the overall job creation impact was assessed using pure economic principles.

The job creation impact of various industries in South Africa were compared in (Pollin, Epstein, Heintz and Ndikumana, 2006) with respect to creating policies centred around employment. Trade and Industry Policy Strategy data were utilised to generate the following multipliers per industry:

A) LABOR INTENSITY BY INDUSTRY:

Employment levels in industry per R1 million in output	
Agriculture	18.6
Apparel and textiles	9.0
Social and community services	5.6
Mining	4.0
Wood, paper and furniture	4.0
Capital goods	3.9
Motor vehicles	2.8
Accommodation and travel	2.2
Agro-processing	2.3
Chemicals	1.5

B) EMPLOYMENT MULTIPLIERS BY INDUSTRY:

Total employment created in South Africa per R1 million in industry sales	
Agriculture	27.9
Apparel and textiles	18.2
Agro-processing	18.0
Wood, paper, and furniture	15.3
Social and community services	14.9
Mining	13.0
Accommodation and travel	11.7
Capital goods	11.3
Chemicals	9.5
Motor vehicles	8.6

Figure 15: Labour intensity and multipliers per industry

The following assumptions were used:

- Ethanol price the same or close to the Basic Fuel Price of petrol at 523c/l for the 150 million litres of output
- DDGS price at R1500/ton for 121,000 tpa

Using these assumptions and the multiplier as detailed in Figure 15 above, the total jobs created are ±17,400 which compares well with the first principles calculation above. The calculation is detailed in Appendix 4: Job creation based on total sales. Once more

it seems more prudent to use the lower and more conservative job creation number of ±16,700.

5 Discussion and Conclusions

5.1 Job creation

A background to the bioethanol production process, global production figures and some history was provided with specific attention the United States, Brazil and South Africa.

A literature review was conducted in terms of job creation associated with ethanol production in the United States. Emphasis was placed on the US grain based model as the Mabele plant is also grain based. The conclusion is that a similar sized plant in the US would create total employment of 1500 jobs including direct, indirect and induced jobs.

None of the South African biofuel studies considered grain sorghum as a feedstock and the associated jobs created, and only one (Austin et al., 2003) contained the detailed calculation in estimating the jobs created. The South African Biofuels Feasibility study and the SAB study were useful in determining job creation multipliers.

Using a similar but more detailed calculation to (Austin et al., 2003) it was determined that ±3,800 direct jobs would be created primarily in agriculture. Using the Overall Economy wide multipliers derived from the SAB and SA Biofuels Feasibility studies, job creation numbers of ±16,700 and ±83,200 respectively were produced. A verification exercise was carried out using a pure economists approach to calculating job numbers. Job creation of ±17,400 was calculated based on total sales and the appropriate multiplier.

It was decided that the ±16, 700 job creation numbers would be the most prudent and conservative to use. That being said, this number is significantly higher than the United States number of 1500 jobs being created for a similar sized plant. This can be explained by the following significant factors:

- The US farming sector obtains significantly higher yields of about 11,4 tons per hectare of grain compared to sorghum of 3,2 tons per hectare. This results in 3.5 times less land being placed under agriculture and hence 3.5 times less employment for the same tonnage of grain.
- This is further exaggerated by the high degree of mechanisation in the United States, as well as economies of scale where 40% of the farms range from 400 hectares to 4000 hectares in size.
- Furthermore multiplier effects in a developing country would be higher than that of a developed country. By definition a developed country would already have significant established infrastructure, businesses and markets even in the absence of new capital investment.

It should be noted that the Mabele plant's production capacity would only amount to a 1.25% ethanol blend. A 10% ethanol blend utilising grain sorghum as feedstock could conceivably create ± 130,000 jobs if the jobs are scaled up proportionately to production capacity.

5.2 Fiscal impact and cost per job

Assuming that bioethanol is brought into the fuel tax net (which may be a prerequisite for depot blending and is already the case for biodiesel), a 100% exemption on the General Fuel Levy should be granted for bioethanol; such that this exemption accrues to the bioethanol producer.

Assuming a General Fuel Levy of R1.70 (which is the case at present), a 150,000 m^3pa per annum plant would effectively be subsidised by an amount of R255 million and would support ±16,700 jobs.

The cost per job would be ±R15,300 which compares well with the current youth wage subsidy currently mooted by Treasury with a cost per job of ±R28,000 per job (Ensor, 2011). The cost per job is actually significantly lower, as a plant of this size would pay more than R150 million in taxes back to Government which implies an effective cost per job of about ±R6300 per job.

On this basis, a Producer Incentive as discussed in the Biofuels Industrial Strategy, over and above the Fuel Tax rebate incentive, should also be considered with the minimum cap on this incentive equating to R28000 per job.

These calculations also do not take into account the benefit to the country's balance of payments due to forex saved on displacing 150,000 m^3pa of imported petrol volumes. This volume of imported petrol is worth approximately R785 million assuming a Basic Fuel Price (which is the same as the import parity price) of R5.23/litre at present.

6 Recommendations

It is recommended that the incentives promulgated in the Biofuels Industrial Strategy be implemented as soon as possible to launch to biofuels industry as one of the key engines of job creation in South Africa.

As a start, it is recommended that bioethanol be brought into the fuel tax net as is the case for biodiesel - this may be a pre-requisite for depot blending in any case to ensure fuel tax recovery.

Once this is implemented, a 100% exemption on the General Fuel Levy should be granted as recommended in the Biofuels Industrial Strategy of South Africa.

Furthermore, a Producer Incentive as per the Strategy should also be considered with a minimum cap of R28000/job.

The above should be implemented as matter of urgency by Government, in conjunction with other key activities such as mandating offtakes, and establishing the price of ethanol (note that at the time of writing, these particular activities are underway).

The biofuels industry represents a unique opportunity for job creation, rural and agricultural development, empowering restituted land owners, developing the green economy, improving South Africa's balance of payments and contributing to energy security in South Africa.

Appendix 1: Agama energy calculation methodology

Petrol production in study			10,300,000,000	litres per annum
	Feedstock		Sweet Sorghum	
	Yield		46	tons/ha/crop
	Crops/yr		2	
	Area/farm		5	ha/farmer
	Ethanol Yield		54	litres/ton
			% of total ethanol consumption in 2012	% of total ethanol consumption in 2020
	Target	1	2.3	5
	Target	2	5	10
	Target	3	7.5	15
			Total ethanol consumption in 2012 (litres)	Total ethanol consumption in 2020 (litres)
	Target	1	236,900,000	515,000,000
	Target	2	515,000,000	1,030,000,000
	Target	3	772,500,000	1,545,000,000
			Sorghum rqmnt (tpa) in 2012	Sorghum rqmnt (tpa) in 2020
	Target	1	-	5,150,000
	Target	2	5,150,000	14,687,037
	Target	3	9,918,519	24,224,074
			Annual area rqd (ha) in 2012	Annual area rqd (ha) in 2020
	Target	1	-	55,978
	Target	2	55,978	159,642
	Target	3	107,810	263,305
			Farmers in 2012	Farmers in 2020
	Target	1	-	11,196
	Target	2	11,196	31,928
	Target	3	21,562	52,661

Appendix 2: Mabele Plant direct jobs calculation

First Principles calculation		
Capacity	150,000	m^3pa
Conversion efficiencies Grain		
Ethanol	2.42	tons grain per m^3 ethanol
JOB CREATION		
GRAIN ONLY		
Agriculture		
Requirement	363,000	tons of grain
Yield	3.2	t/ha on average based on 2009 average
Area required	113,438	hectares of land needed
Rule of thumb: Jobs	33.64	hectares per PERMANENT agricultural job
Jobs created	*3,372*	*jobs in agriculture*
Plant	60	jobs
Daily tons moved	2,447	tons
Truck capacity	32	tons
Trucks required	76	trucks
Therefore truck jobs created	76	jobs
Spin off Industries		
Accommodation	100	jobs (estimated)
Brick making from Ash	40	jobs (estimated)
Animal Feed/Feedlot	100	jobs (estimated)
CO2 Recovery	20	jobs (estimated)
Support services e.g. workshops, etc	40	jobs (estimated)
Logistics of spin off industries	20	jobs (estimated)
Total	320	jobs (estimated)
TOTAL DIRECT JOBS INCLUDING SPINOFF	3,829	jobs

Appendix 3: Mabele Plant Total Economic Employment Impact

First Principles calculation						
Capacity	150,000	m^3pa				
Conversion efficiencies Grain						
Ethanol	2.42	tons per m^3 EtOH				
JOB CREATION						
GRAIN ONLY			SAB study Multipilier	**Economy wide impact**	SA Feasibility study multiplier	**Economy wide impact**
Agriculture						
Requirement	363,000	tons of grain				
Yield	3.2	t/ha on average				
Area required	113,438	hectares of land				
Rule of thumb: Jobs	33.64	hectares/ job				
Jobs created	*3,372*	*jobs in agriculture*	2.36	**7,947**	24.50	**82,616**
Plant	60	jobs	17.18	**1,031**	9.40	**564**
Daily tons moved	2,447	tons				
Truck capacity	32	tons				
Trucks required	76	trucks				
Therefore truck jobs created	76	jobs	36.22	**2,770**		
Spin off Industries						
Accommodation	100	jobs (estimated)	21.40	**2,140**		
Brick making from Ash	40	jobs (estimated)	37.98	**1,519**		
Animal Feed/Feedlot	100	jobs (estimated)	1.39	**139**		
CO2 Recovery	20	jobs (estimated)	17.18	**344**		
Support services e.g. workshops, etc	40	jobs (estimated)	2.55	**102**		
Logistics of spin off industries	20	jobs (estimated)	36.22	**724**		
Total	320	jobs (estimated)				
TOTAL DIRECT JOBS INCLUDING SPINOFF	3,829	jobs		**16,716**		**83,180**

Appendix 4: Job creation based on total sales

Ethanol Plant Sales excluding incentives			
Ethanol volumes	150000	m^3pa	
Ethanol price	5230	Rands/m^3	
Ethanol	784,500,000	Rands/annum	
DDGS volumes	121,000	tpa	
DDGS price	1,500	Rands/ton	
DDGS	181,500,000	Rands/annum	
Total Sales	966,000,000	Rands/annum	
or	966	million	
Employment multiplier	18	jobs per R1 million in industry sales	
Total Jobs	17,388		

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