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ASSESSMENT OF THE BIOFUELS INCENTIVE MODEL

ADVISOR NAME: BRENT CLOETE

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EXECUTIVE SUMMARY

The proposed biofuels regulatory framework aims to incentivise the production of biofuel on a commercial scale for use in transport fuel through the use of an incentive scheme that will guarantee an efficient producer a guaranteed 15% Return on Assets (ROA). It is hoped that the commercial production of biofuels will lead to significant economic development and employment in the agriculture sector. The quantum of the incentive required to generate this target level of ROA will be determined on a monthly basis by a Biofuels Incentive Model (BIM).

The proposed mechanism is equivalent to a feed-in tariff in that it provides investors with a hedge against changes in operation and maintenance costs and a fixed guaranteed return. While this is a recognised approach to developing new industries in the low-carbon space, it does not minimise the cost of the incentive scheme over time through market completion and increased learning in the way that the Renewable Energy Independent Power Producer Procurement Programme, for instance, does.

The rationale for the level of guaranteed return is not clear from the BIM or supporting documentation. This level of return is questionable given the level of certainty provided by removing external risks relating to movements in input and output prices. The stipulation that producers are only required to pack back “excessive profits” to the incentive scheme once a ROA of greater than 20% is achieved seems unnecessary.

Given that the incentive calculation is based on the theoretical assets of an efficient reference plant, the recoupment of past support could be required as soon as the ROA exceeds 15% without damaging firms’ incentives to increase efficiency. Also, at this level of support, there should be no need for firms to receive additional incentives to invest in the industry. In contrast to what is suggested in the *Biofuels Pricing and Manufacturing Economics Study*, thus, firms that qualify for the biofuels incentive should not be allowed to access additional investment incentives such as an accelerated depreciation allowance. The Department of Energy has indicated that biofuels producers included in the scheme will not qualify for additional incentives, but the issue is not addressed in the *Position Paper*.

The BIM proposes paying current market rates (closely linked to international commodity prices) for feedstock. It is unclear how this will incentivise agricultural output to increase to the extent envisaged in the biofuels regulatory framework when these prices are already available to farmers on the open market.

In terms of the BIM itself, it provides valuable insights into the economics of biofuel production in South Africa and is clearly the result of significant time and efforts. It is, however, not currently in a form conducive to policy development. It does not provide an indication of the most likely path of incentives going forward, eschewing forecast in favour of random data (albeit data that does trend upwards) to calculate possible incentive levels, and does not easily allow for scenario or sensitivity analysis. Importantly, the model does not provide sufficient information to calculate the expected cost of the incentive scheme over time.

Much of the information in the model may also have become dated since 2011 (when it was initially developed) as input and cost assumptions are not updated consistently, with some values updated monthly, some annually, and others simply inflated by either CPI or PPI. Given that the incentive is expected to be paid monthly, it is advisable that as many values as possible are updated on a monthly basis. Capital costs, in particular, may need to be revisited. Recent literature has shown that the capital cost of biofuels plants may have come down since 2011, and the Rand-US Dollar exchange rate is also significantly weaker currently than the rate of 7.2 on which the initial capital cost estimates were based. At the very least a once-off update of as many of the inputs, variables and assumptions as possible should be done before the BIM is used to calculate biofuel incentive rates.

Issues with the mechanics of the model have also been identified, relating to the way in which costs, inputs, asset values and depreciation are adjusted for inflation and how working capital is defined. It is also assumed that there is no capital expenditure (CAPEX) associated with maintenance activities over the 20-year life of biofuel plants.

Updating and refining the BIM is also justified on the basis that the biofuels producer incentive is expected to be much more expensive than anticipated in the *Position Paper on the South African Biofuels Regulatory Framework* (which mentions an expected increase in the fuel levy of about 4.5 cents per litre on all petrol and diesel consumed in South Africa – implying an expected total cost of around R900m per annum). Based on forecasted input values, the BIM indicates that the actual cost of the fuel levy is likely to be about R1.59bn per annum. The average monthly fuel levy over the 91month period from June 2010 to December 2017 required for producers to achieve a 15% ROA is 5.1 cents per litre for sorghum-based bioethanol, 8.9 cents per litre for sugarcane-based bioethanol, and 8.5 cents per litre for soya oil-based biodiesel.

A sensitivity analysis highlighted that the expected total cost of the biofuel incentive is particularly sensitive to changes in the Basic Fuel Price (BFP) for petrol and diesel and feedstock prices. It is also relative sensitive to changes in the size of the initial capital investment and the amount of feedstock that is required to produce a unit of biofuel.[1]

All else being equal, the BFP of petrol and diesel would need to be approximately 18% higher than forecasted for the cost of the incentive scheme to cost less than R1bn per year.

[1] Unfortunately the amount of time required to update the BIM to enable the development of a baseline incentive cost estimate limited the amount of sensitivity analysis that could be undertaken. A list of additional variables to subject to future sensitivity analysis is included in Section 7.3.

1. INTRODUCTION

The Biofuels Industrial Strategy approved in 2007 called for the development of an incentive mechanism to support the achievement of a 2 % penetration of biofuels into the local road transport fuel pool. In 2013 the government announced the introduction of a fiscal production incentive for biofuels that will be funded by a biofuels levy on all petrol and diesel sold for domestic consumption. The incentive is based on a 15 % return on assets (ROA) for an indicative efficient biofuels plant. The level of the incentive will be determined through the use of a reference financial model comprising three individual models for:

- a sorghum based bio-ethanol plant; • a sugarcane based bio-ethanol plant; and
- a soya oil based biodiesel plant.

The National Treasury has requested an Assessment of the Biofuels Incentive Model (ABIM) to understand the calculations behind the model, conduct sensitivity analyses highlighting areas of risks and their likely magnitude, and identify possible risk mitigation options. This assessment will enable the National Treasury to respond effectively to possible parliamentary and other queries relating to the incentive, and to assess its fiscal risk.

2. ECONOMIC AND REGULATORY THEORY

2.1 Overall approach

According to the Position Paper, the biofuels subsidy framework is aimed at (DoE, 2014):

… [providing] the basis for a **transparent framework to be used in selecting biofuels manufacturing projects** to receive a biofuels subsidy from Government and establish the principles for calculating the subsidy to be afforded to the selected manufacturers of biofuels in order for the biofuels manufacturer **to earn a 15% Return on Asset (ROA).** If the ROA is calculated to be above 20%, there shall be a "claw-back" and biofuels manufacturers will be required to pay the excessive profits into the subsidy scheme.[emphasis added]

The proposed mechanism is equivalent to a feed-in tariff form an economic and incentive perspective in that it provides investors with a hedge against changes in operation and maintenance costs ensuring a constant margin which, if their efficiency is equal to the efficient plant used in the BIM, provides a return equal to the target return of 15% ROA. Instead of a fixed price (as would be the case with a feed-in tariff), a firm receives a variable price matched with a variable subsidy (with an inverse relationship to the biofuel price). The net effect is thus similar to receiving a fixed price.

The Position Paper (DoE, 2014) calls for a two-stage selection process:

The first stage will be qualification for the subsidy and the second stage will be adjudication of qualifying projects.

In the event that the manufacturing capacity of the qualifying projects exceed the target 2% fuel penetration level, … adjudication criteria [will be used to] consider the socio-economic objectives of the Biofuels Industrial Strategy to select the projects that will receive the subsidy.

The size of the subsidy is not included in the selection criteria (in that the ROA is fixed), and neither is cost-effectiveness of biofuels production (bioethanol from sugarcane will require a much larger average incentive than bioethanol from sorghum – to the extent that Tait (2011) identifies sorghum as the preferred feedstock and cautions against the use of sugarcane).

Given South Africa´s experience in the electricity sector it seems worth exploring a mechanism similar to the Renewable Energy Independent Power Producer Procurement (REIPPP) programme to minimise the cost of the incentive scheme. At the very least sorghum-based plants should be preferred to sugarcane plants where possible.

The Position Paper (DoE, 2014) mentions that the subsidy will be provided for "… a period of 20 years, though it is expected that the subsidy amount will reduce over this period." It is not clear how this is possible given a fixed ROA expectation. It may be that there is an assumption that market dynamics will lead to the model-calculated incentive naturally reducing over time. If this is the case, then these assumptions need to be clearly specified in order to be interrogated.

No justification for the 15% ROA is provided beyond stating that it is the same rate of return targeted in the now defunct Marketing of Petroleum Activities Return (MPAR) framework utilised in the liquid fuels industry. Given that the return is guaranteed (for an efficient plant), it is unclear whether such a high rate of return is required to incentivise biofuels investment. This issue is considered further in Section 4.1.

2.2 BIM as a policy tool

The current version of the BIM was not designed to facilitate policy analysis. It does not, for example, include any forecasts for input values and instead relies on random data (albeit data that does trend upwards) to generate an incentive path. Random data complicates scenario development since it hides the cumulative impact of short or medium term trends. More fundamentally, however, the model currently re-calculates random values automatically whenever any cell value in the model is changed. It is thus not possible to compare the impact of changes in model assumptions. Possibly for this reason the model is also not set up to easily allow scenario or sensitivity analysis, and assumptions are mostly locked and need to be changed manually.

The model does not currently generate estimates the total costs of the incentive scheme to consumers of transport fuel. The cost of the incentive per litre of biofuel is calculated, but the size of the resulting fuel levy is not calculated, and neither is the total cost of the levy applied on the national fuel pool. While the cost of the scheme can be manually calculated by applying estimated fuel levy values to total liquid fuel consumption in South Africa, this is not currently possible since only petrol (and not diesel) volume estimates are included in the model.

The model also does not run for the full 20 years of the planned incentive.

Critically, the desired rate of return is currently not an input value that can be easily changed in the model. It is thus not possible to compare the fiscal implications of different levels of support to the nascent biofuels industry.

2.3 Cost Benefit Analysis

One of the main benefits mentioned in the Policy Document, namely “significant employment and economic development, particularly for agriculture“ is unlikely to materialise. The scheme proposes paying market rates (closely linked to international commodity prices) for feedstock. It is unclear how this will incentivise agricultural output to increase, when these prices are already available to farmers on the open market.

Even if demand for certain feedstocks were to lead to temporary shortages, and thus to higher or import-parity pricing-based local prices, a significant local supply response (as would be required to generate the economic development benefits referred to above) is likely to drive prices back down towards current levels. In response to increased prices, firms may also chose to import feedstocks rather than source locally (as is Tait (2011) mentions is likely in the short term in response to initial feedstock shortages). This would also reduce the impact of the incentive mechanism on agricultural output.

In any event, if biofuels demand is expected to change the pricing dynamics of feedstocks over time, then these expected changes need to be reflected in the BIM - which is not currently the case.

2.4 Allocative efficiency

The model assumes production continues even in periods even when revenues are below the cost of raw material. In the model this shows as negative gross profit (i.e. Biodiesel Economic Model sheet cell AQ37).

If revenues are below variable cost, the efficient solution is to not produce since:

3 The cost of the subsidy would be lower by not having to cover net negative marginal costs (while still allowing the plants to make the required ROA by only covering fixed costs plus the required return); and
4 Allocative efficiency is improved within the economy since inputs are diverted from biofuels production to alternative uses that generate more value.

A strict condition that only allows production if the revenue is above total variable costs (raw materials plus other variable cost) should thus be considered. This will not jeopardise either the viability of the biofuel plants (still making their 15% ROA) or the long-term feedstock supply (which is diverted to alternative uses).

In roughly half the months between June 2010 and December 2013 this condition was not satisfied for the Biodiesel Economic Model with its original assumptions.

Given that a policy decision has been taken to enforce 2% biofuels penetration in the national fuel pool, it is likely that there will be a preference for production during all periods. If this is the outcome, it needs to be recognised that the resulting lack of allocative efficiency imposes an additional cost on the broader South African economy.

2.5 Basis for receiving incentive

The Position Paper posits that (DoE, 2014):

Biofuel manufacturers will be paid the subsidy calculated from the reference financial models (in cents per Litres) multiplied by the manufacturer's actual volumes **produced and delivered** to blenders. [emphasis added]

Production and delivery are not necessarily equal when a product can be stored and therefore the criteria for qualifying for an incentive payment needs to be clarified. While using "production" as a criterion avoids the incentives for gaming by storing product until the subsidy goes up, it does open the door for receiving the subsidy and then exporting the biofuel. Given that biofuel is a highly tradable commodity, having "delivered" biofuel to blenders is probably the appropriate criterion for receiving the incentive.

3 ENGINEERING AND CAPITAL ASSUMPTIONS

This component of the review provides comments on the following aspects of the biofuels incentive model:

- Capital costs; Plant size;
- Plant inputs per production output (i.e. are the raw material, chemical and utility input requirements in the right order of magnitude);
- Costs of plant inputs (excluding sugarcane, soya and sorghum which are being covered by other reviewers); and
- Availability of feedstocks

3.1 Capital costs

The model uses inner battery limit[2] costs for a sorghum ethanol plant of R927 million for a plant of 158,000 m^3/a, with the sugarcane ethanol plant costing 25% more due to feedstock preparation requirements. The diesel plant cost is R 629 million for a plant of 113,636 m^3 per annum. The costs used in the model are based on discussions with several technology

[2] The reason inner battery limits are used here are that they appear to be those costs that are comparable to the international studies discussed later. However the international studies are not sufficiently detailed in terms of inclusions and exclusions to state this assertion with 100% certainty.

providers. The cost per unit capacity, in both Rands and in US$ using an exchange rate of R7.20 per US dollar (as was used in the model), is shown in Table 1,

Table 1 Cost per Unit of Capacity used in Biofuels Incentive Model (BIM)

Plant	R/litre	US$/litre
Sorghum bioethanol	5.87	0.81
Sugarcane ethanol	7.34	1.02
Biodiesel	9.99	1.39

Source: Tait (2011)

A number of studies are available in the public domain that review the capital costs of biofuel plants, with arguably the most recent and comprehensive being GSI and IISD (2013). This study both reviewed other studies, and obtained data for individual biofuel installations across Europe, bringing all values to 2011 figures. A summary of the costs of some of the plants presented in this study is given in Table 2. Further, more aggregated data from that study is reproduced in the annex to this report.

Table 2 Cost of selected biofuels plants in Europe

Location	Size (m3/a)	Year built	Cost in Euro (million)	Euro/litre	ZAR/litre	US$/litre
Biodiesel						
France	200,000	2007	215	1.08	10.38	1.46
France	150,000	2007	234	1.56	15.03	2.12
France	250,000	2007	200	0.8	7.73	1.09
France	150,000	2008	35	0.23	2.25	0.32
Germany	130,000	2008	43	0.33	3.19	0.45
Germany	127,000	2013	70	0.55	5.32	0.75
Spain	226,400	2010	42	0.19	1.79	0.25
UK	189,000	2012	39	0.21	1.99	0.28
Bioethanol						
France	180,000	2011	74	0.41	3.97	0.56
Germany	226,400	2006	22	0.1	0.95	0.13
Germany	113,200	2006	24	0.21	2.05	0.29
Germany	113,200	2006	32	0.29	2.76	0.39
Germany	226,400	2007	85	0.38	3.63	0.51
Italy	226,400	2009	50	0.22	2.13	0.3
Italy	226,400	2010	26	0.11	1.09	0.15
Spain	113,200	2008	20	0.18	1.71	0.24
Spain	226,400	2009	25	0.11	1.07	0.15
Spain	226,400	2010	42	0.19	1.79	0.25

Source: GSI and IISD (2013)

Notes:

1. All costs presented above were brought to 2011 values in the study.

2. Conversion from Euros to Rands and US$ were made using average 2011 exchange rates provided by SARS , of ZAR/Euro = 9.66 and US$/Euro = 1.36.
3. Only plants constructed after 2005, and with a capacity of 100,000 to 250,000 m3/a are shown in the table above. The study from which this table was drawn shows plant sizes constructed in Europe ranging from less than 10 m3/a to over 600,000 m3/a.

It is not necessarily appropriate to make a direct comparison between different plants for a number of reasons including (i) there are different inclusions and exclusions in the plant cost, (ii) different locations have different costs, and (iii) plant costs change over time (with the model having been constructed in 2011). Also, the data presented in the table above also does not distinguish between different feedstocks. The information provided in the table above does however raise the possibility that biofuel capital costs may have come down since 2011. The *Biofuels Pricing and Manufacturing Economics Study* (Tait, 2011) on which the model assumptions are based suggests that there are economies of scale for building larger plants. While not conclusive, this may not be supported by the data presented above..

Despite the limitations to comparing cost figures for different production plants, the fact that assumptions about capital costs have a large impact on the calculated incentive paid to producers (see Table 6), and the fact that the original capital cost estimates was based on a Rand-US Dollar exchange rate of 7.2, advocates in favour of greater analysis of plant costs. Updating costs to the latest available figures would thus be advisable before using the model to determine biofuel production incentives.

3.2 Plant size

The modeller bases the size of plants in the model on international studies that have found that the capital costs of larger plants are more economical than smaller ones. While this assertion is consistent with other industrial processes where economies of scale offer plant capex cost savings, this correlation is not directly demonstrated in the data presented in Table 2, and hence could be challenged.

An additional factor which can affect the overall profitability of a biofuel plant is the transport cost of feedstock, with large plants requiring feedstock to be brought in from further and further afield, thus incurring higher operating costs. This factor is not taken into account when looking at investment cost only. It is noted that, although not directly used in assessing optimal plant size, the documentation accompanying the model suggests a single feedstock transport cost is considered.

Given the size of the biofuel plants proposed, this assumption is questionable and it would be prudent to review it to see whether relaxing it will impact on the choice of optimal plant sizes (and the overall economic models).

It is noted that a wide range of plant sizes, both larger and smaller than those included in the model, have already been built in Europe, and hence the sizes are not considered unreasonable. A number of smaller plants, however, may be considered less risky by investors and may allow for the target return on assets (RoA) rate to be lowered while still incentivising entry into the biofuels industry (see Section 4.1 for a discussion of the rate of return assumption).

3.3 Plant input requirements and costs

Plant input requirements include feedstocks, chemicals, water and electricity (with water and electricity requirements depending on the process).

3.3.1 Feedstock input ratios

Feedstock costs make up by far the greatest component of cost in the model, and therefore it is important to check whether the amount of feedstock per product output used in the model is appropriate. Even a few percentage points in increased efficiency of conversion can have a substantial impact on cost of biofuel production. Feedstock costs are considered in Section 5. Table 3 compares the feedstock requirements used in the model with a selection of literature reports.

4 **Table 3 Feedstock requirements per tonne of product**

Feedstock	Product	Tonnes feedstock/m3 product	Reference
Sorghum	***Bioethanol***	***2.41***	***Biofuels incentive model***
Sorghum	Bioethanol	2.44	USDA (2006)
Sorghum	Bioethanol	2.63	Biomass producer (undated)
Sugarcane	***Bioethanol***	***12.5***	***Biofuels incentive model***
Sugarcane	Bioethanol	12.3	DME (2006)
Sugarcane	Bioethanol	13.54	USDA (2006)
Sugarcane	Bioethanol	11.76	BNDES (2008)
Soya	***Biodiesel***	***6.14***	***Biofuels incentive model***
Soya	Biodiesel	3.57 to 8.20	Brent et al (2010)
Soya	Biodiesel	5.83	DME (2006)
Soya	Biodiesel	8.33	Bullock, (2010); Fichart, (2010) [Quoted in Sparks et al (2010)]

The table shows a closer correlation in the small selection of reference sources for yield per tonne of sorghum and sugarcane, although a slightly wider range of yields is seen for biodiesel from soya. The latter may be worth investigating further.

3.1.2 Chemical requirements

Unfortunately speciality chemical costs are not available in the public literature and so could not be checked in the short time period over which this review was conducted.

The chemical requirements for bioethanol are relatively small (~6% of total costs for sorghum ethanol and a fraction of a percent for sugarcane ethanol) and if volume requirements in the model are inaccurate by a few percentage points this is not expected to have a significant impact on the overall model outputs. Due to time constraints, these figures were therefore not checked.

Chemical volumes used as inputs for biodiesel make up a greater percentage of total expenses (18%) and hence are more important to check. It was confirmed that the volume requirements are within the ranges that would be expected from other studies (see, for example, Brent et al, 2010), with some variance being expected depending on the configuration of the plant. It is important to highlight that the cost of methanol, which makes up nearly 8% of the total expenses of biodiesel production, is linked to the crude oil price. The same holds true for sodium methylate that is made from methanol, and makes up a further 5% of production costs. These costs are thus likely to have changed since the model was originally built, and should be updated to the latest available values before the model is used to determine biofuel producers' incentives.

3.1.3 Utilities

Different plants use various combinations of electricity, gas and steam (from coal boilers), making comparison difficult. It is noted, however, that the electricity cost used in the model (based on information from Sasol Chemcity in Tait (2011)) appears to be very high (at R 445/MWh). Although Eskom has a wide range of tariffs depending on the user and supply contract, none of their tariffs in 2014 exceed R 240/MWh (excl VAT). The cost is however in line with estimates of electricity prices for firms in the liquid fuels industry that obtain their electricity from municipalities provided in Cloete et al (2011).

The cost of steam and nitrogen could not be checked.

3.1.4 Availability of feedstocks

The three plants described in the model required 380,000 tonnes of sorghum, 1,6 million tonnes of sugarcane and 698,000 tonnes of soya, respectively. The production of sorghum in South Africa varies from 100,000 tonnes to 180,000 tonnes per annum (DAFF, 2010), suggesting that imports would be required (as identified in the supporting documentation supplied with the model). South Africa produces about 18.8 million tons of sugarcane annually (SASA, undated), so the requirement for this plant would represent about 9% of national production. Finally, in 2010, it was reported that soya bean production in South Africa ranges from 450,000 to 500,000 tons per annum, also potentially pointing to a need for imports. The need for imports was also identified in the model documentation.

4 FINANCIAL ASSUMPTIONS

4.1 Guaranteed Return on Assets

The biofuels subsidy is calculated to allow an indicative plant to achieve a return on assets (excluding cash deposits) of 15% before interest and taxes. If the indicative plant is earning between 15% and 20% then there is no subsidy or claw back, and firms are only required to pay “excessive profits” back into the subsidy scheme once its return is greater than 20%.

There are two forms of risk carried by investors requiring compensation through expected returns in order to induce investment. These are internal risks relating to the efficiency of the firm (does the plant operate as efficiently as the indicative plant), and external risks relating to price movements in input and output prices.

Internal risks are more easily managed because they can be controlled by the firm. Where the firm is not achieving the same levels of efficiency as other firms in the market, it can investigate the reasons for this and restructure accordingly. As such these risks are normally transitory. External risks can be managed in the short run through financial derivatives, but may jeopardise the long run viability of a firm operating in a commodity market.

A rate of return (or a WACC) of 15% is commonly used in the South African economy as the required rate of return for investment. For most industries this is deemed sufficient to compensate for the risks involved in making the investment. In the current case, however, it may not be appropriate because the intervention purposefully and substantially changes the risk profile of investment. In guaranteeing a rate of return on assets subject to the firm achieving normal levels of efficiency, the subsidy scheme assumes all the external risks of price movements in input prices and output prices. The risk of making an investment is thus far lower, and hence the required return by prospective investors would be lower. The extent of this difference would depend on the relative importance of external risks to internal risks. In the extreme, where there is relative certainty that the firm will be able to achieve normal levels of efficiency, the required rate of return would start to fall to the higher of the cost of borrowing and the risk free rate of investment (long term government bonds).

The alternative extreme is that there is a substantial amount of uncertainty about the ability of firms to achieve a normal level of efficiency. This may be because the technology is unproven or because investors have poor information. In such a circumstance the subsidy scheme does little to alleviate investor concerns because the guaranteed rate of return is predicated upon the assumption that the firm achieves a certain level of efficiency. The result here is that the guaranteed rate of return would have to be inflated to compensate for the uncertainty around the technology or lack of information by investors. Importantly, if this is the case, there are far less costly methods of accounting for technology uncertainty and imperfect information.

The scheme also allows for some upside benefit (and additional 5% RoA) to flow to investors where input costs and output prices result in returns in excess of 15% RoA. This means that investors’ expected returns will be higher than 15% if they believe that prices may move favourably in the future. Thus, if the required rate of return is indeed a 15% RoA, the scheme should guarantee something below 15% such that, once including the expected returns from favourable price movements, the end result is an expected RoA of 15%.

A final comment is that investors do not typically think in terms of a required return on assets, but rather a required rate of return on equity. This means that access to financing, the rates thereof, and the ability to leverage an operation are important considerations in the investment decision. The more volatile the earnings of a firm are, the higher the likelihood of financial distress and the lower its efficient level of leveraging. Note that, because debt is by definition always cheaper than equity, the efficient level of leveraging is where the benefits of more debt (benefits being lower cost of capital) begin to be outweighed by increasing costs (probability) of financial distress.

The proposed scheme directly intervenes in this relationship by reducing the volatility of earnings. Specifically, if the firm hovers around a normal level of efficiency, its returns will be remarkably stable. Given this, firms that are accepted onto the scheme will be able to leverage their operations substantially which in turn increases the return on equity remarkably. Indeed, even if the optimal leveraging is not possible immediately, investors will slowly be able to increase the leveraging over time as their performance record grows. Investors will build this expectation into their decision upfront and this too will reduce the RoA required to induce investment.

The documentation accompanying the model does not seem to contemplate any of these considerations. It is unclear what process was followed to decide on the 15% return on assets. Given that the subsidy scheme is contemplated to match the 20 year lifespan of a plant, the size of the subsidy should be set with great care and be based upon a sound understanding of the underlying risks and investor sentiment in the market generally and also specific to this industry.

4.2 Recouping excessive incentive support

As mentioned in the preceding section, only once a biofuels plant is earning greater than 20% ROA will the firm will be required to pay the "excessive profits" back into the subsidy scheme. This is modelled on the MPAR system previously used in the liquid fuels industry to provide return of between 10% and 20% on the marketing assets of wholesale marketers. In the MPAR scheme, however, returns were calculated on *actual* managed assets rather than on the *theoretical* assets of an indicative efficient firm as is the case in the BIM (Mondliwa and Roberts, 2014). In the case of actual assets, it makes sense to allow additional ROA before clawing back previous subsidies since this incentivises regulated firms to strive to increase their efficiency and maximise their profits. In the case of theoretical assets, however, firms already have an incentive to be as efficient as possible. If a firm manages to be more efficient than the reference firm used in the BIM, it will achieve a higher ROA than 15%. Only external conditions that affect all firms will allow the reference firm to generate a ROA of more than 15%.

Not clawing back returns that lead to a ROA of 15% thus increases the overall cost of the biofuels incentive, but it does not incentivise individual firms to be more efficient. It is therefore advisable that the incentive claw-back kicks in as soon as the ROA of the reference firm goes over 15%.

4.3 Incentive double-dipping

Tait (2011) mentions that biofuels plants qualify for an accelerated depreciation allowance over three years of 50%:30%:20%, and that while for accounting purposes depreciation should be calculated at the maxim rate allowable, for economic purposes depreciation should be calculated over the useful lifetime of the assets (20 years). This amounts to incentive double-dipping. The biofuels incentive was explicitly set at 15% ROA because policymakers believed this is a level of return that will incentivise entry into the industry. If this is the case, then no further incentives are justified. It is therefore suggested that either biofuel plants are excluded from qualifying for an accelerated depreciation allowance, or alternatively the ROA is calculated on an after-tax basis that explicitly accounts for the impact of the allowance.

4.4 Tax shield in Blending Value calculation

The rational for the tax shield formula in the Blending Value calculation is questionable. It is not clear why the tax shield would reduce O&M expenditure per unit. Also, since the rest of the model is pre-tax, it is not clear why tax issues are being considered in this part of the model at all.

5 INPUT ASSUMPTIONS

Input and cost assumptions in the model are not treated consistently. Some values are updated monthly, some annually, and others simply inflated by either CPI or PPI. Given that the model was originally created in 2011, it is unclear to what extent the initial relationships between variables have remained constant.

The price of a significant input cost like methanol, for example (see discussion in Section 3.3.2) is correlated with oil prices. In the model, however, the June 2010 methanol cost has been projected to grow at PPI over time. Since oil price movements is only one of the factors driving headline PPI, the relationship between the expected and actual methanol price is expected to become weaker over time.

Given that the incentive is expected to be paid monthly, it is advisable that as many values as possible are updated on a monthly, rather than annual, basis (with the obvious exception of prices that are set annually).

It is therefore advisable that the number of “user inputs” to be manually updated is increased to ensure that the information used to calculate the biofuels incentive is as up-to-date as possible (while remaining cognisant of the transaction cost involved in updating the model). At the very least it is suggested that a once-off update of as many of the inputs, variables and assumptions as possible in the model is done before it is used to calculate biofuel incentive rates. This is particularly relevant when it is considered that many of the costs included in the model are influenced by the Rand-US Dollar exchange rate. The original exchange rate used was 7.2 Rand to the US Dollar, compared to around 11 Rand to the US Dollar currently.

6 MODEL DESIGN ISSUES

6.1 Working rules

The Working Rules document (Version 4) does not seem up to date. It refers, for example, to the ICE sugar price, whereas the latest version of the BIM used the SASA sugarcane price as a benchmark for sugarcane feedstock prices.

The Working Rules also lack definition, referring for example only to the "year-on-year consumer price index inflation (CPI)" and not specifying the precise series to use ("Total consumer prices (All urban areas)").

6.2 Indexation

The BIM includes a number of instances where indexation has been applied inconsistently.

6.2.1 CPI and PPI indexation of certain costs

This issue applies specifically to Labour, Maintenance, factory overheads, general overheads, and Administration. In the model the general formula for indexing costs is as follows:

$Cost_i$ = (Reference annual cost / 12) * (1+ annualized inflation $rate_i$)

Where i=1,2…12, annualized inflation rate can be PPI or CPI.

This formula expresses costs at the end of year, and would be adequate if all other components are also expressed at end of year. But this is not the case. A formula consistent with monthly payments would be:

$Cost_i$ = (Reference annual cost / 12) * (1+ annualized inflation ratei)^(i/12)

6.2.2 Annual indexation

The application of indexation to subsequent years is problematic as some components of costs (notably Labour and maintenance) are based on a reference year but compound indexation is not applied in the model (i.e. the impact of inflation in previous periods is ignored).

This issue applies to Asset values, Labour, Labour overheads, Maintenance, Insurance, Factory overheads, General overheads, administration and all variable costs (see for example line 17-28 of
"data" sheet. The same problem applies to asset indexation (see "Economic model – Bioethanol", line 83-85)

The formula is corrected from 2012 onwards for all costs, except for assets (where the formula is corrected in 2013).

The under-indexation is however carried forward (since initial values are too small). The issues with mechanical indexation notwithstanding, it is often not clear in the model in what terms reference values are expressed (i.e. whether capital costs are in 2011 or 2010 values).

6.2.3 Indexation and depreciation

The current month's depreciation is calculated on the previous month's net fixed assets, to which the previous month's depreciation is added to get total depreciation to date. This is incorrect as it essentially "misses" a month of inflation indexation for every depreciation calculation.

The current month's depreciation should be calculated on the current month's inflated total capital value (ignoring depreciation), to which the amounts of depreciation calculated in previous months should be added (after each of value has been inflated to the present date) to calculate the total depreciation to date.

The current methodology under depreciates the capital stock, and as a result fixed assets will not be fully depreciated after the 20 year useful life of biofuel plants.

6.2.4 Blending value calculation

The following issues were identified with the blending value calculation:

Operational and maintenance (O&M) cost per m^3 does not include 2015 indexation:

$(O\&M/m^3)_{2015}$ = Capex (valued at 2014)*Percentage of O&M / ethanol $required_{2015}$

The O&M value for 2015 is thus expressed in 2014 (and not 2015) Rands. The correct formula would be (as correctly implemented from 2016 onwards):

$(O\&M/m^3)_{2015}$ = (Capex (valued at 2014)* % O&M / ethanol $required_{2015}$)*(1+PPI_{2015})

It is also not clear why a fixed figure for ethanol required (for 2015) is used while all other forecasts (shown below) use the forecasted value of ethanol required for each year.

The capital cost element (per m^3 ethanol) is not being indexed at all. Each year a capital investment stream to set NPV equal to zero is calculated as follows:

Capital $investment_j$ = (initial Capital $investment_{2014}$ / economic lifetime)*(1+ discount rate)

Where j is number of years;

Then,

NPV (discount rate; initial capital investment2014; Capital investment_j) = 0

This, however, implies that the annual flow (Capital investment_j) is expressed in 2014 terms. Annual capital costs are calculated as:

Annual capital costs_j per m^3= Capital investment_j /ethanol required

But this value is expressed in 2014 terms and hence needs to be indexed. A correct approach would thus be:

Annual capital costs_j per m^3= (Capital investment_j /ethanol required)*(1+PPI_j)

6.3 Definition of working capital

Working capital is not correctly defined in the model. In Tait (2011) working capital is correctly defined as:

WK = Stock + Debtors – Creditors

But in the model, for the purpose of calculation ROA, “Assets” are defined as:

Total Assets = Total fixed assets + Stock + Debtors

The correct way to consider working capital (consistent with Tait (2011)), would be as follows:

Initial total assets: Total assets_0 = Total fixed assets_0 + Stock_0 + Debtors_0 – creditors_0 and

Asset evolution Total assets_i = Net total fixed assets_i + Δ(Stock_i + Debtors_i – creditors_i)

6.4 Maintenance CAPEX

The model assumes there will be no capital expenditure (CAPEX) associated with maintenance activities, and thus that all CAPEX is done when the initial investment is made. This assumption is questionable.

7 SENSITIVITY ANALYSIS

The current version of the model is not set up to allow forecasts or standard sensitivity analysis. Consequently the model was adjusted with external forecast data to allow the development of a baseline incentive forecast. The specific issues identified in the previous section have not been addressed, and the results in this section should thus be viewed as indicative. Given the issues identified with indexation, the baseline forecast will probably slightly underestimate the expected cost of the incentive.

Given the suspicion that much of the original information in the model may be dated, the baseline forecast is developed from June 2010. So strictly speaking the baseline forecast mimics a scenario where the biofuels incentive had been in operation since June 2010. It is suggested that the baseline forecasts and sensitivity analysis be updated once a large-scale update of the assumptions and inputs in the model has been undertaken.

7.1 Baseline incentive cost estimate: methodology

A baseline forecast was created for the period June 2010 to December 2017. The table below shows the sources for all the forecast data used. Historical data was also updated to check the validity of the information currently in the model.

Table 4 Forecast data sources

Variable	Forecast sources	Historical data sources
PPI	National Treasury 2014 MTBPS	SA Reserve Bank
CPI		
BFP unleaded petrol 95	National Treasury 2014 MTBPS : forecasted changes in Petrol price – Gauteng applied to latest BFP data from DoE website)	DoE website
BFP ultra low sulphur diesel		
SAFEX yellow maize price	BFAP	BFAP
SAFEX sorghum		
SAFEX soya		
SASA sugarcane price		
Annual sales of petrol	SAPIA 2013 Annual Report	SAPIA 2013 Annual Report
Annual sales of diesel		

The updated historical data largely matched the inputs already in the model, with the exception of the SAFEX prices (with the largest variation between the two sets of data being 10.2%) and annual petrol consumption (where the model values are consistently higher than those reported in the SAPIA 2013 Annual report.

The user-defined automated BIM options used for the baseline forecast is shown below:

Table 5 User-defined BIM modelling specifications

Target ethanol blending percentage	2%
Petrol-alcohol mix specification	Ron-Mon=10
Waiver	No waiver
Blending configuration	Depot blending only
Additives	Ethanol manufacturers additise

A new sheet (User inputs – sensitivity) was added to the BIM to facilitate the sensitivity analysis. The results from rows 25 to 40 from this sheet feed into the original User inputs sheet. Cell H20 in User inputs – sensitivity is a dropdown menu that provides the option to pick "Original" (the data currently in the model) or "Forecast" (new data entered to generate baseline incentive cost forecast).

The model results are shown in the original "Summary" sheet. A new sheet ("Summary Original") was created to show the hardcoded original model results. This sheet serves as a test to ensure the model is correctly specified. When the "Original" option is chosen in User inputs – sensitivity'H20, the values in the sheets Summary and Summary original should be similar for the period June 2010 to July 2014. The values for later months won't be the same because all the random "dummy data" would have been recalculated.

The total incentive costs for each month (fuel levy multiplied by relevant petrol or diesel volumes) are shown in rows 48-50 of Summary sheet. The fuel levy values are shown in rows 24 (bioethanol from grain), 30 (bioethanol from sugar crops) and 37 (biodiesel from vegetable oils). These values are calculated by dividing the incentive per litre values in the preceding row by 50 (to account for biofuels being 2% of total fuel pool to which the levy will be applicable).

Cell G54 shows the average yearly incentive cost based on the period June 2010 to December 2017, while cell G62 shows the average yearly cost based on the period June 2010 to July 2014
(the period that current model has "actual" data for). When using the original model specifications only G62 is relevant since it is not affected by recalculated random dummy data.

Cells C48 to C50 indicate the percentage of the 2% biofuel requirement provided by each biofuel feedstock option. In the case of biodiesel this is assumed to always be 100% (since only biodiesel can be mixed with diesel)[3], but the percentage of biofuels volume to be mixed with petrol can differ between grain and sugar crops.

7.2 Baseline incentive cost estimate: results

Using the variables outlined in the two tables above, and assuming all bioethanol is generated from sorghum, the forecasted total cost of the biofuels incentive is R12.03bn for the 91 months from June 2010 to December 2017. This equates to an average annual cost of R1.59bn. This annual value is used as the baseline incentive cost estimate for the purpose of sensitivity analysis in the next section.

The average monthly fuel levy over this 91month period required for producers to achieve a 15% ROA is 5.1 cents per litre for sorghum-based bioethanol, 8.9 cents per litre for sugarcane-based bioethanol and 8.5 cents per litre for soya oil-based biodiesel.

Had the biofuels incentive been in operation since June 2010, the average yearly cost up to July 2014 (based on actual values) would have been slightly lower at R1.55bn per year. Using the original information in the BIM, the average yearly cost from June 2010 to July 2014 would have been R1.63bn per annum.

[3] This is not a hard rule, since in theory it would seem that DoE (2014) allows for more than 2% of bioethanol to be mixed with petrol and less than 2% of biodiesel with diesel (or vice versa) as long as the overall percentage of biofuel in the fuel pool (diesel and petrol) is equal to 2%.

7.3 Sensitivity analysis

Sensitivity analysis was undertaken using the forecasted baseline cost information for the period June 2010 to December 2017. The results are show in the table below.

Table 6 Sensitivity analysis

Variable	Change in variable	Percentage change in average incentive cost per year	
		Total	Change from baseline
Percentage of bioethanol form grain crops	10% reduction (i.e. 10% of bioethanol produced from sugar crops)	R1.63bn	2.7%
Percentage of bioethanol form grain crops	50% reduction (i.e. 50% of bioethanol produced from sugar crops)	R1.80bn	13.7%
PPI and CPI	10% increase	R1.63bn	3.0%
BFP (petrol) and BFP (diesel)	10% increase	R1.25bn	-20.9%
SAFEX yellow maize price, SAFEX sorghum price SAFEX soya price*	10% increase	R1.87bn	18.1%
Capital investment – Sorghum and soya plants*	10% increase	R1.74bn	9.6%
Feedstock input requirement – grain sorghum and soya beans*	10% increase	R1.72bn	8.7%
Co-products per unit of biofuel (DDGS for sorghum plant, soya meal and glycerol for soya plant)*	10% increase	R1.57bn	-1.2%

Note: * Bioethanol from sugar cane not in forecasted baseline cost estimate.

It is clear that the model is most sensitive to changes in the BFP and feedstock input prices. It is also, however, relatively sensitive to changes in the size of the initial capital investment and the amount of feedstock that is required to produce a unit of biofuel.

All else being equal, the BFP of petrol and diesel would need to be approximately 18% higher over the period Jun 2010 to Dec 2017 for the cost of the incentive scheme to be less than a R1bn per year on average.

Unfortunately the amount of time required to update the model to allow the development of the baseline incentive cost estimate reduced the amount of time available for sensitivity analysis. In addition to the sensitivities shown in Table 6, it would also be interesting to consider the impact of varying the values of the following factors on the estimated cost of the biofuels incentive:

- Target ROA
- Estimated total fuel pool (diesel and petrol)
- Divergence between petrol and diesel demand
- Reference plant size
- Chemical and utility input costs

- Variables that move the expected incentive cost in the same direction to develop best and worst case scenarios
- Impact of bioethanol blending options

8 ADMINISTRATION OF THE INCENTIVE SCHEME

A number of issues relating to the implementation of the biofuels producers' incentive have not yet been addressed. Primary amongst these issues is how the incentive and related fuel level will be implemented. Communications with the Department of Energy highlighted the expectation that varying the biofuels fuel levy on a monthly basis may require monthly changes to the Fuel Levy Regulations administered by SARS. It is not clear how feasible this is in practice.

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10 APPENDIX A

The table that follows was reproduced from the EU study reported previously, available online at http://www.iisd.org/gsi/sites/default/files/biofuels_subsidies_eu_annex.pdf.

TYPE OF REFINERY	SOURCE		COST (€/LITRE)
Biodiesel	Haas, McAloon, Yee & Foglia, 2006, *A Process Model to Estimate Biodiesel Production Costs*	Capital cost total (10 x 10 ^6 gallon) Soybean biodiesel	0.23
	T. Randall Fortenbery, 2005, *Biodiesel Feasibility Study: An Evaluation of Biodiesel Feasibility in Wisconsin*	Capital costs per litre – 8,000 tonnes per year biodiesel	0.11
		Capital costs per litre – 30,000 tonnes per year biodiesel	0.09
		Capital costs per litre – 100,000 tonnes per year biodiesel	0.08
	Department for Transport's (DfT) [United Kingdom], 2012, Fuel Quality Directive model data	3.5 terawatt hours Biodiesel plant - per unit capacity cost	0.42
	Ecofys, 2012	Biodiesel 50 ktonne installation	0.33 - 0.50
Ethanol	Ecofys, 2012	Ethanol 30 ktonne installation	0.43 - 0.58
	McKinsey Quarterly, 2007, *Positioning Brazil for Biofuels Success*	Per litre cost Brazilian Ethanol production plant (mill) cost - 200,000,000l	0.46
	DfT [United Kingdom], 2012, Fuel Quality Directive model data	2.2 terawatt hours Ethanol plant - per unit capacity cost	0.43
Biofuel	Bindraban, Bulte,Conijn,Eickhout, Hoogwijk & Londo, 2009, *Scientific Assessment and Policy Analysis WAB 500102 024, Can biofuels be sustainable by 2020? An assessment for an obligatory blending target of 10% in the Netherlands*	Capital costs for first generation biofuel per unit capacity	0.41
		Capital costs for all biofuels per unit capacity	1.05