DEFINING PERFORMANCE TARGETS THROUGH INTERPRETATION OF STANDARD COMPARATIVE PERFORMANCE INFORMATION

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EXECUTIVE SUMMARY

Setting performance targets for a business is a strategically important function. These targets focus the efforts of teams and team members, and as such define the direction of development of the business's competencies and thus its competitiveness. In the highly competitive world of commodities, it is imperative that resources be focused optimally. This implies that the focus be placed on those few aspects that if achieved, it would yield maximum benefit.

The objective of this report is to, for the Natref refinery:

- Define and prioritise those business aspects that should be focused on over the next three years so as to maximise profit and long-term competitiveness,
- Define target performance levels for the respective aspects, and
- Define interim targets that could be applied in yearly performance incentive schemes.

The aspects of importance for Natref have been defined through an analysis of the South African liquid fuel industry, its profit profile and the implications for Natref specifically. Benchmarking was primarily based on the 2002 refinery performance survey, as executed by Solomon Associates.

Optimal profit performance is subject to the combination of optimal integration, and optimal relative performance of the contributing functional roles. Over-emphasis of one role relative to another inevitably results in lower than achievable long-term profitability.

Benchmarking the relative performance of refineries is complicated by the extensive differences between refineries and their respective business situations. As a result, technical aspects can be consistently compared through a process of normalisation and peer groups. However, no fundamentally sound method could be found to compare the overall performance of refineries in different business situations. Return-on-investment and refining margin were evaluated, but found unsuitable for this purpose. As a compromise, the Profit Index as developed by Natref, is proposed for evaluating integrated refinery performance. In addition, a new parameter, the Profit Potential Index, aimed at measuring growth of relevant value-adding capability, is proposed. Evaluation of and performance targets for total cash cost, fixed cost, and variable cost, round of evaluation of integrated performance.

Total production cost, including fixed and variable cost, has to improve by approximately 10% to be competitive with the Asia-Pacific peer group and other South African refineries. It is proposed to achieve a 10% composite cost reduction over the next three years. The targeted improvement in energy consumption, if achieved, could represent the full 10% reduction in operating cost.

It was found that Natref's performance in terms of energy efficiency was of the poorest of all the refineries included in the 2002 benchmarking survey. Given the increasing cost of energy, it is considered critical to improve energy efficiency. The proposed three-year performance target of 92 EII, if achieved, will result in matching the average energy performance of the Asia-Pacific peer group, but will still fall short of the energy efficiency of the best performers in the group.

Refinery availability is of strategic importance in the current industry situation where Natref production is cut back due to over-capacity and tactics. It is thus recommended that performance in terms of availability be targeted to be first quartile, whereas third quartile performance was achieved in the 2002 benchmarking survey. The overall availability performance is required to increase to 96.7%.

The following practices are recommended for implementation in addition to the performance targets set:

Operating cost is strongly influenced by the R/$ exchange rate. Systems are required to pro-actively identify the impact of this exchange rate.

In contrast with previous practice of always operating Natref at full capacity, Natref's production rate is subject to market share, product demand and price competitiveness since termination of the Main Supply Agreement. Sasol's overall unbalanced product slate results in Sasol being long in petrol production capacity and short in diesel production capacity. Sasol is thus obliged to sell part of its petrol production at discount prices, which motivates other producer-distributors to maximise their production of diesel and to minimise petrol production. Marginal sales are in competition with the marginal cost of production with other South African refineries for inland sales, and with that of Asia-Pacific peer group refineries for export markets. More emphasis is thus required on knowledge of marginal production cost, and on minimising marginal production cost than was before.

It is concluded that producer-distributors utilise the imbalance in product supply capacity stemming from Synfuels' product slate to negotiate price discounts. It would thus be in the interest of the producer-distributors to increase their production capacity according to demand growth so as to maintain the petrol over-supply situation and thus reduced purchase prices.

The optimisation model for the refinery forms the backbone towards determining not only the marginal cost of production, but also for optimisation of business decisions, crude purchasing, profit apportionment between the Shareholders, and for determining the Profit Index and the Profit Potential Index. As such it is recommended that the accuracy of this model be targeted at 15USc/bbl.

Finally, crude oil cost represents approximately 90% of the overall production cost. Yet the refinery has only indirect input on crude slate optimisation, i.e. via the accuracy and number of crudes represented in the refinery model. It is recommended that this input be expanded.

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ABBREVIATIONS

bbl	-	barrel
BEP	-	break-even point
BFP	-	Basic Fuel Price
c/l	-	cents per litre
DHC	-	Distillate Hydro-cracking unit
EDC	-	Equivalent Distillation Capacity
EII	-	Energy Intensity Index (Solomon Associates)
IRR	-	Internal rate of return
kUEDC	-	thousands UEDC
LP	-	Linear Programming
MIRR	-	Modified internal rate of return
MSA	-	Main Supply Agreement
NPV	-	Net present value
PPI	-	Production Price Index
RCD	-	Reduced Crude Desulphurisation unit
ROCE	-	Return on capital employed
ROI	-	Return on investment
RSA	-	Republic of South Africa
SHE	-	Safety, Health and Environment
SABS	-	South African Bureau of Standards
SAPIA	-	South African Petroleum Industry Association
T&I	-	Turnaround and Inspection shutdown
TSA	-	Total South Africa
UEDC	-	Utilised Equivalent Distillation Capacity
WACC	-	Weighted average cost of capital

DEFINING PERFORMANCE TARGETS THROUGH INTERPRETATION OF STANDARD COMPARATIVE PERFORMANCE INFORMATION

1. INTRODUCTION

Setting performance targets for a business is a strategically important function. These targets focus the efforts of teams and team members, and as such define the direction of development of the business' competencies and thus its competitiveness.

In the highly competitive world of commodities input cost is critical. In addition labour cost represent a large percentage of the input cost. Personnel input is thus considered a scare resource, and as such must be applied effectively. Effective use of personnel requires that they be focused optimally. This implies that the focus be placed on those aspects that if achieved, it would yield maximum benefit.

Excellent performance in relatively less important aspects will not render the business more competitive, nor will it maximise profitability. Excellent performance in mission critical aspects is required to realise competitive advantages and maximise profitability.

The standard benchmarking information that is available to the refinery offers a standard comparison of performance of a large number of refineries. Each of these refineries however operates under different conditions, market requirements, opportunities, and driving forces. It could thus be expected that critical performance aspects for the respective refineries would not be the same, although a big overlap could be expected. It could also be expected that as conditions change, the critical performance aspects of a refinery could change.

In order to focus personnel most effectively, it is required that those performance aspects be identified that, if performed excellently, would maximise competitiveness and profitability.

Identification of the most important performance aspects of the refinery for the time period under consideration could thus be considered the foundation for maximising competitiveness and profitability. This will be the main focus of this investigation.

Once the most important performance aspects are identified, realistic but stretching performance targets must be compiled. This is achieved through benchmarking these performance aspects with international best achievements and practices, followed by an analysis of what could be considered achievable and required by this refinery.

The objective of this report is to, for the Natref refinery:

- Define and prioritise those business aspects that should be focused on over the next three years so as to maximise profit and long term competitiveness,
- Define target performance levels for the respective aspects, and
- Define interim targets that could be applied in yearly performance incentive schemes.

The following process was applied to reach these objectives:

- Define critical performance aspects
- Benchmark performance with regards to these aspects
- Define the gap between current performance and pacesetter performance
- Prioritise areas of improvement
- Define impact for the respective improvement levels
- Set performance targets.

1.1. Background

Natref is an inland oil refinery, operated under shareholding of two shareholders, 63.64% to Sasol, and 36.36% to Total South Africa (TSA) respectively. The two shareholders operate separate competitive distribution and retail businesses, and do not always have the same profit drivers. In addition, the major shareholder is in the process of re-organising and of taking new business partners on board. This re-organisation will also influence performance goal setting, and as such is kept in mind in making recommendations.

The Natref refinery represents merely one of several production facilities at the disposal of the shareholders. Part of the optimisation matrix of these entities are the production volumes and types at each of its facilities, and that available from suppliers.
As mentioned before, the objective of this investigation is the development of performance targets for specifically this refinery, rather than for the parent businesses.

The focus of this investigation will thus be the understanding of those external parameters that ultimately influence the profitability of this refinery, and on identifying those aspects relevant to this refinery's performance that would maximise its contribution to the bottom line profitability of the parent businesses.

1.2. Restricted distribution and contents

Due to the sensitivity of the topic under discussion, it was agreed that the report will be subject to limited and approved distribution outside the refinery and shareholders, more specifically it will be distributed only to key personnel of the Potchefstroom Business School.

In addition it was decided that since some of the issues discussed could be of strategic value, that apart from benchmarking information critical to the report, the content of the report will be based on publicly available information only. No discussions with any shareholder representatives were held so as to minimise the risk of divulging shareholder sensitive information.

2. CRITICAL PERFORMANCE ASPECTS OF A REFINERY AS A BUSINESS

The performance of a refinery could be grouped into two main categories of performance indicators namely:

- Business performance indicators, and
- Technical performance indicators.

2.1. Business performance versus technical performance

Business performance indicators are those aspects that indicate the economic or financial performance of the refinery. These indicators are typically all-encompassing measurements, indicating the net effect of all effort, including the impact of industry conditions.

Technical performance indicators are those aspects that indicate the technical performance of the respective functional groupings in the business, which support good financial performance of the refinery as a business. These functional groupings include:

- Operations (Production, Maintenance, Technical services, Human Resources practices, and Commercial services),
- Marketing,
- Planning and Distribution,
- Financial practices, and
- Project execution.

The all-encompassing performance of the business is influenced by:

- The relevant industry specifics and its condition,
- The effective integration of the different functional groupings in the business, and
- The degree of excellence achieved in relevant functional areas of the business.

The relevant industry specifics and its condition are not in the control of a specific business, but it strongly influences its profitability.

However, effective integration of the different function groupings in the business, and the degree of excellence achieved in relevant functional areas of the business are in control of the business itself. To maximise profitability, these aspects should be optimised given the industry specifics.

Technical performance of the refinery could be excellent, but due to low gross margins, i.e. poor product prices relative to crude oil costs, profit levels in the industry as a whole could be low. Refineries with poor technical performance would in such a scenario experience even poorer financial performance.

In a scenario where margins are high, general industry profits and own profit could be good despite relatively poor technical performance. Once again, those with best technical performance would achieve above average profit levels in such a scenario.

The most likely long term margin scenario is determined by the balance between supply and demand. Available refinery production capacity in most world regions, and specifically our region, the Asia-Pacific region, are greater than the product demand, i.e. a general situation of over-capacity (Solomon, 2003a:II-4). World- and regional gross profit margins are thus driven down due to competition between producers to achieve optimum capacity utilisation of their production facilities so as to maximise own profit. Since refining products in general could be considered commodity products with standard quality specifications, the refining market could be considered as elastic (Smit, Dams, Mostert, Oosthuizen, Van der Vyfer & Van Gass, 2002:224). The balance between supply and demand thus determines long-term prices. Since there is situation of surplus production capacity, and demand growth is tempered by ever improving engine-technology, it could be expected that long-term margins will be deflated.

Given a general industry view of long term reduced gross margins, refineries that have poor technical performance will likely experience poor financial performance, at the risk of losing the interest of investors.

It can also happen that a facility achieves excellent technical performance, but that its financial performance is poor. Consider the following hypothetical scenarios:

- Purchasing technically perfect crude oils at high, although market-related prices, inherently limits the profit potential. Similarly could selecting the lowest cost crude oils result in poor conversion to saleable products, resulting in average financial performance. Finding the optimal balance between crude cost and technical implications, rather than optimising them individually, would yield the highest profit.
- A facility could be achieving pacesetter performance in one aspect at the expense of performance in another aspect, resulting in a combined under performance. Consider a scenario where prevention of production interruptions is over-emphasized at the expense of pushing production capacity. If the impact of equipment downtime would be smaller than the potential income through a more aggressive production strategy, then the net financial performance would be depressed. Inversely, if an aggressive production strategy results in losing more income due to equipment wear and tear and subsequent unavailability than would be lost through a more conservative strategy, the net profitability would also be deflated.

It could thus be concluded that:

- Optimal profit performance is subject to the combination of:
    - optimal integration, and
    - optimal relative performance

  of the contributing functional roles. Over-emphasis of one role relative to another inevitably results in lower than achievable long-term profitability.
- Benchmarking of functional technical performance provides an indication of performance of mission critical technical functions, and
- Benchmarking of overall financial performance in turn provides an indication of:
    - The combined effectiveness of functional activities, i.e.
        - effectiveness of integration of functional activities,
        - relative emphasis placed on functional activities.
    - The performance of mission critical functional activities.

As such both business performance and technical performance should be benchmarked, and performance targets for both set.

2.2. Business performance indicators

The following indicators are typically applied in the crude oil refining industry to gauge the overall business:

- Profitability indicators such as return on investment (ROI), return on capital employed (ROCE), net present value (NPV), internal rate of return (IRR), and modified internal rate of return (MIRR),
- Net cash margin
- Break-even point
- Market value
- Growth rate

2.3. Technical performance indicators

The following indicators or aspects are typically used to evaluate the performance of respective functional areas in the crude oil refining industry:

- Refinery availability or on-line time
- Capacity utilisation
- Product and raw material losses
- Product yield
- Raw material cost – crude & non-crude
- Cash operating cost:
    - Fixed cost
        - Personnel
        - Maintenance
        - Insurance
        - Taxes
        - Royalties
    - Variable cost
        - Chemicals and catalyst
        - Energy
        - Hydrogen
        - Utilities

- Capital invested
- Working capital
- Innovation / Continuous improvement
- Product slate
- Gross margin, net margin, financing costs, depreciation
- Environmental performance

Given all these business and technical performance indicators, their relevancy and relative importance for Natref should be defined.

3. ASPECTS OF IMPORTANCE FOR NATREF

In order to define which business performance aspects and which technical performance aspects are important to Natref, it is required to analyse the industry of which Natref forms part and to define those aspects determining profitability.

3.1. Industry analysis

3.1.1. Regulation

Government regulates the liquid fuels business in South Africa. Government firstly controls product prices. It also controls the way in which the different role players compete, either directly or indirectly. This includes control of retail licences, product quality requirements, logistics, and importing of products.

Up to 2003 the Main Supply Agreement (MSA) obliged the respective oil companies to purchase a certain quota product from Sasol, with Sasol dictating the slate of supply, i.e. the fraction petrol, jet fuel, and diesel. As part of this agreement Sasol was not allowed to operate retail outlets. Sasol was however afforded retail facilities on the forecourts of all retail companies.

This agreement was terminated on 1 January 2004 under initiative from Sasol. Distributors are no longer obliged to purchase product from Sasol provided no product is imported into the country. The remaining regulation by Government is price regulation, number and location of retail outlets, product specifications, and import regulation.

3.1.2. Product pricing

The retail prices and consumer prices for petrol and kerosene are set through legislation. For diesel only the minimum consumer price is set through legislation, retailers are allowed to sell at higher prices.

The Basic Fuel Price (BFP) formula is set and controlled by Government. The BFP is conceptually an import parity pricing formula and is intended to establish a realistic estimate of what it would cost to import substantial volumes of refined fuel. The BFP is based on (SAPIA, 2004:1):

- International spot prices,
- Freight costs to South Africa,
- Demurrage,
- Insurance,
- Transport losses,
- Wharfage,
- Coastal storage, and
- Stock financing.

The BFP is changed on a monthly basis, specifically on the Wednesday closest to the 15th of the month.

In addition, the BFP sets the maximum wholesale price for petrol, kerosene, and diesel. Refiners and fuels distributors are however not forced to sell or purchase at the BFP from each other. The BFP practically is the maximum price that could be charged for the respective products. The actual purchase price is subject to negotiation; the upper limit being the BFP and the lower limit whichever agreement could be reached between supplier and buyer. Key however is that no player is allowed to import product into the country unless it can reasonably prove to government that such product is not available from other producers in the country, or that reliable supply to consumers cannot be maintained.

The BFP formulation further makes provision for differences in transport cost to different locations in South Africa, thus both wholesale and retail price vary according to location.

Essentially the BFP ensures a certain fixed wholesale margin for wholesale distributors, a fixed retail margin for retailers and controlled consumer prices to prevent exploitation of the consumer. However, variances in crude and product prices and thus the refining gross margin between subsequent price change dates, are absorbed by the refiners producing the respective products.

Export of product is allowed as long as it does not negatively influence availability of product in the country, with no regulation of the pricing there-of.

3.1.3. Production capacity

South Africa is currently in a position of having excess production capacity equivalent to the extent of ± 20% (SAPIA, 2003:62). This implies that a producer with less market share than production capacity will either operate with idle production capacity, sell production to other distributors, or could export given logistics allow.

Inversely, a distributor with less production capacity than market share could purchase products from refiners with idle production capacity. The highest purchase price would be at BFP. Depending on the situation, lower prices could be negotiated. In most cases it would make sense to fully utilise own production capacity rather than to purchase product since the marginal production cost is lower than the marginal income.

TSA is in the position of having more market share than production capacity (SAPIA, 2003:63). TSA will thus operate its share of Natref to capacity, and purchase additional product demand at the most attractive price possible.

In a scenario where tenders are invited by net purchasers of product, the bottom limit of the tender price as offered by producers with idle capacity is inherently set by the marginal cost of production including crude costs. All other aspects equal, the supplier with lowest marginal cost of production has the best potential of winning the tender.

Another important consideration is the production capacity for certain product types. The product demand for a certain product could be greater than could be produced in available facilities. This imbalance between demand and production capacity could be absolute, or could be 'artificially' created to maximise own profit. Consider the scenario of Sasol Synfuels' diesel production capacity being limited. Competitors could decide to maximise their own petrol production because the margin on petrol is better than on other products, at the expense of diesel production, thereby artificially but justifiably worsening the excess of petrol production and the shortage in diesel production. Sasol would have reduced off-take of petrol and would have to reduce throughput to balance stocks, whilst diesel is imported into the country.

Alternatively Sasol could reduce their wholesale selling price for petrol, making it attractive to the other producers to maximise their profits through maximising diesel production and purchasing the balance of petrol demand from Sasol. The extent to which Sasol would have to reduce its supply price of petrol would be defined by the prices at which the competitors could import diesel, or even lower. In such a scenario the marginal value of Synfuels' petrol would be equal to or less than the import parity of diesel bought on the spot-market.

By maximising its capacity to produce diesel, Sasol and its subsidiaries would reduce the extent to which competitors could artificially create product excesses to influence pricing.

Similarly would TSA be maximising its diesel production capacity at Natref be able to purchase more product at attractive prices.

3.1.4. Demand growth

It could be argued that as demand grows, also the relative growth rates of petrol and diesel, the excess refining capacity in South Africa would be reduced up to the point that South Africa becomes a net importer of product.

If diesel growth exceeds the growth of petrol, e.g. impact of taxi-recapitalisation project, then Sasol's position is weakened in the sense that it is already at the limit of the percentage diesel it can supply. In such a scenario, Sasol would have to sell petrol at a discount to encourage other producers to minimise its petrol production. This situation would last until such a time that petrol demand matches the maximum production capacity of all South African facilities combined. From that point onwards Sasol would no longer have to sell part of its petrol production at discount to BFP. As this point is approached smaller part of its production would be sold at discount.

In a scenario where petrol growth exceeds diesel growth, the total South African demand slate becomes more in line with what Sasol can produce. However, the other producers could still artificially create an imbalance through maximising petrol production and minimising diesel production, thus forcing an excess of petrol production whilst importing diesel. This strategy could only work as long as producers still have capacity to increase their percentage petrol production. In this scenario Sasol would reach the point of achieving BFP for its full production sooner.

Once the other producers are at maximum production, the need for Sasol to offer discounts on petrol will terminate and industry will have to purchase Sasol's full available petrol production at petrol BFP. At that point would Sasol be able to also sell its Natref production at full refining margin.

Industry could potentially prevent such a situation by expanding its production capacity according to market growth, and through ensuring that the additional capacity have the flexibility of either producing petrol or diesel, so that favourable prices could be negotiated with Sasol. Alternatively, industry could use this possibility to negotiate better margins on purchases from Sasol.

The implication for Sasol's Natref-production is that, especially for the next three years, marginal production of petrol would likely be sold below BFP but marginal diesel production would yield BFP.

3.1.5. Market share

Given the current legislated retail and wholesale pricing of products, market share cannot be gained on the basis of price competitiveness. In addition, the product qualities are standardised through legislation, thereby limiting marketing options. Market share growth strategies can thus only be based on the other marketing basics of place or location, and promotion. Diversification into niche markets and non-energy products such chemicals could be considered.

Due to the history of the liquid fuels market, there currently is an imbalance in market share relative to production capacity (SAPIA, 2003:64). The now discontinued Main Supply Agreement as described earlier dictated that Sasol not be allowed to take part in the retail market, in exchange for the other oil companies having been obliged to lift Sasol product according to a specified quota.

With this agreement now dissolved, Sasol has larger production capacity than market share, and its product slate is not in balance with demand of the other role players.

On the other hand the other refiners have larger market share than their respective production capacities (SAPIA, 2003:63). They also have the objective of purchasing that part of product demand beyond their own production capacity at the lowest possible prices so as to maximise profit. This is achieved through specific short term and long-term strategies.

3.1.6. Logistics

A mismatch between the geographic layout of consumer location and production sites in South Africa generates some constraints on the system. Most of the competitor production capacity is located in Durban, whilst the majority of consumption is in the Gauteng area. The Durban production sites are linked with Gauteng consumers via a single, multi-product pipeline owned and operated by Petronet. The capacity of this pipeline is limited but it should be possible to increase its capacity through capital investment.

Currently Petronet is allowed to deliver product on a fungible basis, i.e. since the products are delivered according to South African Bureau of Standards (SABS) specifications, product put into the pipeline from Producer A could be delivered to clients on behalf of Producer B. This increases the capacity of the pipeline to a large extent since some deliveries are virtual, e.g. TSA, which is based in Sasolburg, could deliver product in Kroonstad even though no product physically flowed in a southern direction in the pipeline.

Sasol's physical location influences its export options and competitiveness. Overland access to inland Southern Africa countries is favourable, however both the distance to the closest port, but also physical availability of logistics influence export by sea.

3.1.7. Distributors vs. Producer-distributors

Three categories of product wholesalers / distributors are active in the market:

- Producer-distributors,
- Distributors, and
- Producers.

Producer-distributors are those businesses whom both distribute product wholesale and refine product. These role players include Engen, BP, Shell, Sasol, Total, and Caltex. These businesses profit from both refining and wholesale margins, and in some cases even from the retail margin.

A second group limits its participation to distribution and retail, e.g. Exel, Oil Afric etc. Its income is based on the wholesale and retail margins.

PetroSA forms an individual third grouping that acts purely as a producer.

Natref, through its shareholders, forms part of the Producer-distributor category.

3.2. Profit profile

The refining business serves a commodity-based market, where the product qualities are regulated; in South Africa specifically it is regulated by Government through the SABS. Although there is potentially room for niche products, e.g. offering higher quality products such as higher-octane petrol for high performance vehicles, the niche potential is small and limited by logistics.

The following analysis is aimed at defining those aspects that drives the profitability of a refinery.

3.2.1. Gross margin

Gross margin is defined as the average difference between income from sales and raw material cost. This term is generally applied to rate oil refining profitability. It excludes variable costs other than crude cost, and also excludes fixed costs, financing costs, marketing costs, final product transport costs, and general head-office costs. Gross margin thus only considers the primary input costs.

3.2.2. Refining margin

Refining margin is defined as the Gross margin less cash costs. The refining margin is the incentive to produce products in own facilities rather than purchasing them from other local producers, or importing it.

3.2.3. Cash costs: Fixed and variable cost

Refining equipment being capital intensive represents a big part of the costs incurred, but is not included in the definition of cash costs.

Cash costs consists out of fixed and variable costs, the basis of its definition being those costs that do or do not vary with short term production volume variations.

Labour requirements are practically independent of capacity utilisation, especially in a remote location like South Africa. Similarly maintenance requirements are independent of short-term production rates. Other costs such as insurance are also independent of capacity utilisation. These costs are classical fixed costs, and represent ± 30 to 50% of the average cash cost of production, excluding financing and depreciation costs.

Variable costs are those costs that vary as production rate or product type is varied. These include raw materials, energy, chemicals, catalyst, hydrogen, and utilities.

Although these items are variable with production rate, a portion there-of is essentially fixed. For example, when commissioning a production unit there are heat losses to atmosphere which once the unit is commissioned stays essentially constant. A certain portion of the variable cost could be considered fixed. Should these fixed components be appreciable, then it should be defined and included in the calculation of marginal production cost.

3.2.4. Marginal production cost

Marginal production cost is that cost which is incurred to produce a marginal quantity of product (Smit *et al.*, 2002:203).

Marginal production cost is not equal to the average variable production cost. Marginal production cost considers only the cost incurred to produce an additional, or marginal amount of product.

For Natref it is known that the energy efficiency increase as throughput is increased. This implies that the marginal consumption of energy is lower than the average consumption of energy. Similarly as production is increased the most profitable processing units are utilised first, resulting in relatively reduced yields as less profitable units are commissioned. Another example is that of hydrogen which is supplied out of own production up to a point. From this point onwards hydrogen must be imported, thus representing a step-increase in the marginal cost.

Marginal cost could thus be higher or lower than the average variable cost.

In having to decide between increasing production or purchasing additional product, as well as when pricing additional sales, the marginal cost of production rather than average cost of production or margin should be considered.

3.2.5. Relative and absolute price of different products

The different products are priced differently as is dictated by international demand (refer BFP formulation). The difference in price between the different products is defined as the price differential. Assuming the price of 93 octane leaded petrol as the reference, the petrol-diesel price differential varies between +12% and -8% on a month-to-month basis (Department of Mineral and Energy Affairs, 2004:2), depending on short-term international conditions.

The price of any one product could vary with as much as 20% over a three-month period. Although one of the objectives of the BFP-philosophy is to ensure a market related refining margin to refiners whilst the consumer is protected, actual refining margins vary on a daily basis. The BFP is however updated once per month only. This results in temporary reductions or increases in refining margin, which is used to maximise profitability. For example, consider a scenario where the crude price increase by 5$/barrel (bbl) one day after the BFP has been finalised. Since the BFP would then be based on a relatively low crude oil price, whilst crude then purchased is at a higher actual price, it would result in a reduced, even negative, refining margin. In such a case it makes sense to purchase from other producers, e.g. Sasol which is coal based, or to import product. In such a scenario the purchaser's profit would be optimised given the situation, and Sasol could increase sales to such a producer-distributor. Also, the producer with lowest marginal production cost has the best chance of still selling at a profit in such a situation. Such capability could be of strategic value.

The inverse situation could also result, i.e. where BFP is high relative to dated crude oil prices. In such a situation own production would be maximised and purchases minimised.

Those producer-distributors with excess capacity and/or petrol/diesel-swing capability are in the best position to swing its production according to short term positive/negative price imbalances.

A producer-distributor can thus target to produce such a product slate that would maximise its profit, whilst purchasing the balance required to satisfy the available market demand. The impact is that the net seller cannot dictate its production slate but must change its production pattern to the preference of the buyer, which results in reduced margins for the seller.

3.2.6. Net profit before financing and depreciation costs

Net profit before financing and depreciation costs is the result of the total value of sales minus the sum of all input costs, including fixed and variable costs but excludes financing and depreciation costs.

This measurement represents the income within the control of the team managing and operating the facility, and marketing its products. It excludes the impact of past decisions, e.g. investment and technology decisions, and thus shows only the results achieved by the team given governing industry conditions.

3.2.7. Net profit after financing and depreciation costs

Net profit after financing and depreciation costs includes financing and depreciation costs. This parameter is used by investors in determining the inherent value of a business, and also represents the true value to current investors. Financing and depreciation costs are influenced primarily by big investment decisions. As far as past capital investment decisions are concerned, its financing and depreciation cost impact cannot be changed. When considering future investment such cost can be changed and should be considered.

3.3. Profit drivers for Natref specifically

Given the general industry and profit profile background, those aspects which defines the profitability of Natref as a business can be identified.

Marketing and head-office costs are not allocated to the refinery for the purpose of this analysis since this facility represents only part of the owners' activities in this industry. Essentially the same marketing and head-office costs would be incurred with or without the refinery as part of their respective portfolios.

The bottom line profitability is a function of:

- Income from sales,
- Input costs including raw material, and
- Capital employed.

The objective is not to maximise or minimise these parameters individually, but to optimise the combined contribution.

3.3.1. Income from sales

Maximising net profit implies:

- Optimisation rather than maximisation of the amount of sales,
- Optimisation rather than maximisation of the prices obtained for products, and
- Optimisation rather than minimisation of costs.

A basic objective is to maximise production or turnover up to the point where the facility is at full capacity, or up to the point where marginal production cost equals marginal income (Smit *et al.*, 2002:224), whichever comes first. Production can only be increased to the extent that there is demand for the production. Demand is however limited by industry conditions and in Natref's case specifically, combined market share of the shareholders.

The Natref shareholders are in fundamentally different situations. TSA is in a situation where its production capacity is smaller than its market share, i.e. it is a net purchaser of product. In this regard TSA generates both refining and wholesale margin on own production, but only wholesale margin on the portion of product purchased. Its strategy is thus to maximise own production, thus making capacity maximisation a key performance aspect for the refinery.

Sasol is in the reverse situation, i.e. it has more production capacity than market share and as such is a net seller of product. Its production strategy is to allocate production to those sites that would maximise net income, i.e. to those sites that has the highest marginal net income.

The whole industry is currently in a situation of excess production capacity. In order to maximise profit, producer-distributors first utilise own capacity to its fullest before purchasing product from other producers, the objective being to benefit from both the refining margin and the wholesale margin as far as possible. Basically all the producer-distributors are in a position of having more market share than own production capacity due to the influence of the original supply agreement (SAPIA, 2003:63).

The only conditions where producer-distributors would sustainably operate with idle capacity are when:

- Other producers are willing to offer product at lower price than it could be produced in own facilities,
- Marginal production cost start increasing and exceeds marginal income or alternative purchase price due to inefficiencies or constraints at higher capacity utilisation,
- Product could be imported at lower price than could be produced in own facilities or purchased from other South African producers.

The implication for the Sasol share of Natref is that it is firstly competing with the marginal profitability of Synfuels. Synfuels is inherently more profitable than Natref due to its coal-based technology and diversified product basket. As such Synfuels' production will be maximised at the expense of Natref production.

In order to sell Synfuels' full petrol production, it has to reduce its price to producer-distributors to such an extent that it is attractive to these producer-distributors to cut back own production, or to swing their production slate to balance Synfuels' production slate, i.e. maximising diesel production at the expense of petrol production. The extent to which the price must be reduced to justify idle capacity at the client's own facilities is equivalent to the clients' respective refining margins, since purchasers have to forego this margin if they buy rather than produce. The incentive to the purchaser would be additional margin, transport cost, and optimisation of own operation. This leaves Synfuels with only that part of the margin that they have due to their coal-to-liquid technology and chemicals production.

Instead of reducing production, such producer-distributors could also export product to the extent that they have excess production capacity. Export margins are lower than the refining margin due to amongst others, the additional logistics and transport cost involved, but could be used by Synfuels to justify a higher selling price to such producer-distributors.

The implication for Natref is big: reducing the price of product produced at Natref sufficient to justify other producers to reduce capacity, requires forfeiting basically the full refining margin, or at the minimum sell at export parity. The only customers from whom better prices could be obtained are those distributors whom not have own production facilities.

It is thus of key importance that the marginal cost of production at Natref be lower than that of the other South African refineries, alternatively that the marginal cost of production be minimised so as to enable exporting.

Sasol's ability to export is limited in terms of logistics, and it would not make sense to sell product produced at Natref at nil refinery margin unless for strategic reasons. Sasol is thus likely to reduce its production at Natref to the minimum physical capability of the equipment, up to the point where its Synfuels facilities are at capacity, and up to the point where at least one of the other producers' facilities are loaded to capacity.

In conclusion it could be said that as long as the market demand in South Africa is smaller than the production capacity, Sasol's marginal petrol production at Natref will be sold at a discount relative to BFP, and will compete with product offerings from other producers. Sasol could also address the logistics that limits export, and so find additional market. Minimising marginal production cost would enable Sasol to be more competitive in winning tenders, and to increase the feasibility of exporting, thereby increasing turnover and capacity utilisation. Minimising marginal production cost would always benefit TSA since it would increase its margin. Minimising average and marginal production cost is thus another critical performance aspect for Natref.

Since Sasol is not actively challenging the minimum capacity achievable at Natref, it is probably breaking even with regards to its Natref production. Reducing the Natref throughput further so as to eliminate any forced selling by Sasol is thus no longer considered a critical performance aspect.

Other refiners can further force the situation through worsening the imbalance by swinging its production slate in the same direction as Sasol. In this way a bigger excess of petrol and shortage of diesel is created, thus enabling buyers to negotiate even better prices for petrol. The extreme situation is that where the out-of-balance product is imported whilst there exists idle capacity inland.

Sasol probably views this from the opposite perspective, it would not freely sacrifice the normal refining margin on any of its production. To minimise this, it firstly must expand its market share. Secondly it has to balance its production slate with the demand so as to minimise the imbalance situation as a lever towards imports, or having to compete with imports.

The question that should be answered is whether Sasol's production at Natref could be used to correct the inherent imbalance in its product slate offering. Firstly Sasol is competing with the available production capacity of the competitive producer-distributors. Thus whilst there is idle capacity available, Synfuels will operate Natref at minimum capacity. At minimum capacity a change in diesel produced at Natref of 5% impacts the Sasol product offering by merely 1%. It is thus unlikely that a change in production slate at Natref has much of an impact on Sasol's utilisation of Natref. However, if the production at Natref could be changed to yield more diesel than petrol, less discount relative to BFP will be suffered for a given crude rate at Natref.

TSA is a net purchaser of product. Since Sasol's production slate directionally worsens the over-production capacity of petrol, it is probably forced to reduce price offerings on petrol more than on diesel. It would thus be beneficial for TSA to maximise diesel production at Natref, so that it could purchase more petrol at discount from Sasol.

From this perspective it would be beneficial to both Shareholders to increase the production slate to maximum diesel production. The extent to which this percentage could be increased is limited, and as such the value addition of this aspect should be quantified before including it as a strategic performance goal.

Although TSA is operating their share of Natref at full capacity, Sasol is operating their share for strategic reasons, and to balance supply and demand. Demand varies because of unplanned interruptions at other production sites, or due to strategic actions from other players. These occurrences represent opportunities to maximise turnover. There is thus a high premium on this refinery's ability to increase its product offering on short notice.

Since the one shareholder is at full capacity, and the other continuously defending against arguments for imports, losses in production are either unrecoverable or have strategic impact. Refinery availability and reliability is thus critical to both shareholders.

3.3.2. Profit margin: optimising operating cost

Net profit before financing and depreciation costs is the result of the total value of sales minus the sum of all input costs, including fixed and variable costs.

3.3.2.1. Value of sales

Value of sales is the result of:

- the volume of sales, and
- the price achieved per unit sales.

The volume of sales is maximised through maximising own retail share, and then maximising sales to other distributors. Other distributors' objective is to purchase product at the lowest possible purchase price. Marginal sales volume is thus probably at reduced profit margin.

The selling price per product is thus not constant at any point in time. The price achieved depends on the:

- Idle production capacity of net-buyers,
- Idle production capacity of other net-sellers,
- The balance between production-slate and demand-slate: if there is a smaller % demand for petrol than the % production of petrol, then petrol will yield poor prices.

The objective is thus to produce such a basket of products that would best suit the demand pattern so as to maximise selling price achieved. Currently the excess in production capacity in the country is the largest for petrol, and least for diesel. The ability to produce more diesel should directionally yield most value. Given the different situations of the two shareholders, the shareholders value products produced at Natref differently, in many cases the values differ much from BFP.

It is critical for the marketer whom has to submit tenders to know exactly what the marginal cost of production is so as to tender at such prices that would maximise its net profitability. Inversely, it is critical that a buyer knows at all times at what cost it could produce product itself so that optimal decisions regarding purchase prices could be made.

It is thus of critical importance that the true marginal value of products, and the true marginal cost of production be known.

The price at which a product is sold does not necessarily reflect its strategic value to the owner. Natref is maximising the production of diesel despite it having a lower market value than petrol, so that Sasol's 'excess' of petrol due to Synfuels' production slate is reduced. Similarly TSA maximises its diesel production at Natref so that it could purchase more low cost petrol from Sasol. It could be argued that the marginal value of diesel production at Natref thus equals the BFP price of petrol, or diesel BFP, whichever is highest. Similarly, the marginal value of petrol is lower than petrol BFP, at best it could be based on export parity.

Due to the unique situation of the refinery and its shareholders having to maximise the production of lower market value products, it would make sense that the true or strategic value of the product slate be used in evaluating the performance of the refinery, rather than using standard prices.

3.3.2.2. Marginal cost of production

An increase in production at Natref could be defined as marginal production, and as such will be produced at a marginal production cost.

Neither marginal nor variable cost of production at Natref is competitive with that of Synfuels, and as such will production at Synfuels be maximised before production at Natref is increased. Marginal production ex Natref will thus have to be sold either at the expense of marginal production at other South African refineries, or be exported. In both cases it would be in competition with the marginal production cost of either South African refineries or Asia-Pacific refineries.

It can thus be concluded that marginal production cost should:

- Be competitive when compared with that of Asia-Pacific producers, and
- Be well defined so that marketers can optimise decisions.

In a scenario where the proposed Engen merger realises and an additional production facility becomes part of the decision matrix for Sasol, the same reasoning would govern, except for the fact that the facility with the lowest marginal cost of production would be operated to capacity first. The Natref-drivers so identified are thus robust towards such an event.

3.3.2.3. Average variable cost

Where-as marginal cost is important when considering increased production, the average variable cost negatively influences the average profit margin, and as such the average variable cost should be minimised.

3.3.2.4. Fixed costs

Fixed costs are incurred independent of the throughput or utilisation of the refinery.

Since fixed costs are independent of capacity utilisation, it essentially results in a minimum throughput hurdle to the business. Reduced fixed costs render the refinery more robust against difficult business conditions such as reduced throughput or low margins.

Minimising fixed costs, always in a responsible and sustainable manner, is a performance parameter that is critical to the bottom-line profitability of the refinery, and is especially relevant in the current situation where Sasol is minimising its utilisation of Natref.

3.3.3. Capital employed

Capital employed include the following categories of capital:

- Fixed investment in land, equipment, and technology:
  - Directly economically justifiable,
  - Not directly economically justifiable,

- Renewal capital required to extend the service life of equipment,
- Operating capital, i.e. capital required to operate the factory, including stock, raw material, spares, catalysts and chemicals.

Fixed investments in the refining industry are typically irreversible, and either incremental or very big. Fixed investments typically are required to meet organisational investment hurdle rates with regards to value created. It is typically required that such an investment yield an internal rate of return equivalent to the weighted average cost of capital (WACC) + 5%:

$$IRR_{required} \geq WACC + 5\%$$

Effectively nothing could be done to change capital already invested, focus should be put on ensuring that all new capital investments meet the hurdle rate of $IRR_{required} \geq WACC + 5\%$.

Capital investment required for renewal maintenance and not-directly-justifiable investments such as for safety, health and environmental (SHE) aspects are much more difficult to manage since it is typically required for infrastructure which is critical to the sustainable operation of the facility in general, but does not contribute to additional profit. It is thus a key performance aspect to ensure that renewal maintenance and SHE capital be optimised, both in terms of the cost there-of but also in terms of the need for it.

Operating capital is capital that has an inherent value but is not available for sale since it is required for operations. Operating capital includes items such as crude oil stocks, final product stocks, intermediate products, inventory of operating units, emergency catalyst stocks, and spares. All this material is required for successful operation of the refinery, but does not have a direct yield on its value. Optimising, rather than minimising, operating capital should thus be considered as a key performance parameter for the refinery.

It is important to note that fixed capital in the refining industry is virtually irreversible once committed. It therefore does not make sense to include the effect of past investments in future performance metrics. The impact of past capital investment decisions should however form part of future strategies and policies, and investment policies should ensure that incremental future investments would yield the required incremental return on investment.

Investments made in the past could however not be ignored. The objective should be to maximise the value addition of past investment decisions given current industry conditions and current requirements.

It is needless to say that the refinery is operated with the primary objective of returning a competitive yield on the investment made by its shareholders. Both current, short term and longer-term profitability must be maximised. Maximisation of profitability in general, but also sustainable profitability is a critical performance aspect for the refinery.

3.3.4. Summary of critical performance aspects

Following is a summary of the critical performance aspects identified out of the industry analysis as profitability drivers for the refinery:

- Capacity maximisation,
- Marginal production cost to be:
    - Minimised,
    - Competitive when compared with that of Asia-Pacific producers and South African producers,
    - Well defined so that sellers and buyers can optimise decisions

- Minimisation of petrol-to-diesel production ratio,
- Ability to increase production volumes on short notice,
- Refinery availability and reliability,
- Accurate information regarding the true value of products,
- The true cost of production given current crude prices,
- The true value of products should be used in evaluating and driving the performance of the refinery,
- Minimisation of fixed costs,
- Ensuring that new capital investments are likely to meet the hurdle rate of $IRR_{required} \geq WACC + 5\%$,
- Optimisation of renewable maintenance and SHE capital, in terms of the cost there-of but also in terms of the need for it,
- Optimisation of operating capital,
- Maximisation of profitability, and
- Sustainable profitability.

4. BENCHMARKING THE CRITICAL PERFORMANCE ASPECTS

4.1. Inherent differences between refineries

When benchmarking performance, the inherent differences between that being compared must be understood, and where relevant taken into consideration.

There are more than 900 refineries in the world. Comparison of the relative performance of these refineries are complicated by the fact that all these refineries are unique, i.e. all differ, and the differences range from minor to major terms. The refineries could differ on the following bases:

- Crude processing capacity,
- Complexity,
- Product slate,
- Market,
- Sole enterprise vs. part of bigger group of companies,
- Crude type processed,
- Age, and
- Location.

4.1.1. Crude processing capacity

A very big refinery has the benefit of economy of scale (Smit *et al.*, 2002:215). Since bigger production units could be utilised:

- Less personnel, both administrative and operational, is required per unit of production,
- Lower investment per unit production is required. Typically the following rule of thumb applies to capital investment as a function of equivalent distillation capacity (EDC):

$$\text{capital}_{\text{big}} / \text{capital}_{\text{small}} = (\text{EDC}_{\text{big}} / \text{EDC}_{\text{small}})^{0.67}$$

- Production units are more efficient:
    - Lower effective capital required enables investment in more advanced technology,
    - Less equipment items per unit production,
    - Smaller percentage losses due smaller surface area and/or equipment items required per unit production,
- Lower maintenance cost per unit production is incurred,
- Lower purchase prices due to larger purchase volumes could be achieved.

4.1.2. Complexity

Refineries' configurations range from very simple topping refineries, where basic products are extracted at low cost and the remaining raw material sold, to very complex refineries where not only the basic products are extracted, but also the remaining residue upgraded to final product through advanced upgrading technology, and further value added through downwards integration in the value chain, such as production of chemicals.

More complex refineries have the benefit of producing higher value products, however at the expense of higher input cost and higher capital investment. Simpler refineries have the benefit of very low input cost and low capital investment, but produce lower value products.

4.1.3. Product slate

Two neighbouring refineries could be considered to operate in the same market, and as such could be considered to be directly comparable. However, since certain parts of this shared market could be so small that only one production site is justified, only one site would be equipped with such facilities, rendering the two sites different from a both a business and technical point of view. Consider the lube oil market; this product volume is so small relative to the other products that only one facility of economically viable size could be carried in a particular location.

Strategic decisions, such as a decision to focus on a certain part of the available market, export or specialisation strategies could also render two neighbours considerably different from a technical point of view, even though their financial performance could be similar.

4.1.4. Market

When considering the differences that could justifiably exist between two geographic neighbours, it is not difficult to imagine that sites that are physically removed could have even bigger technical differences. Reasons for different technical configurations could be any one or combination of the following:

- Same reasons as neighbouring refineries discussed above,
- Different markets due to:
  - Different population densities,
  - Agricultural vs. industrial vs. urban markets,
  - Environmental requirements resulting in demand for different grades of fuels, e.g. USA, Europe, Japan, Africa,
  - Localised demand for chemicals and other value-added products,
  - Local and regional excesses or shortages in production capacity,
  - Political instability, and
  - Local industry structure.

4.1.5. Sole enterprise vs. part of bigger group of companies

Refineries that operate singly should have different strategies than refineries that operate as part of bigger enterprises. A conglomerate could decide to directionally specialize production at certain sites, so as to optimise value added. This would lead to differing refinery configurations, with some sites operating at lower margins whilst other sites would operate at elevated margins, the net result an improved overall margin and profitability.

4.1.6. Crude type processed

Crude quality, and thus its inherent value, differs from crude well to crude well. The differences are particularly pronounced in terms of geographic location of the well. Middle-Eastern crudes, West-Texas crudes, West-African crudes and North-Sea crudes vary extensively in quality, inherent value, availability in terms of quantity and geographical location, and production cost, and as such do the configuration of refineries processing different types of crudes differ.

4.1.7. Age

An older refinery could be expected to be equipped with less technologically advanced processing equipment, to have less efficient equipment, more interruptions or breakdowns and directionally more personnel. On the other hand should such a refinery have less depreciation and financing costs, which should again boost its ROI and other financial performance indicators. This in turn could enable such a site to apply capital to modernise. Ideally such modernisation should be an ongoing process, renewing technology on a continuous but economically driven basis.

4.1.8. Location

Beyond differences in market due to differences in location, refineries' configurations and business strategies differ largely based on location. Consider a refinery located in a major refining hub. Available is a wide range of support and maintenance services, outlets for intermediate streams, distress cargoes, and integration opportunities. All this will influence the refinery's choice about technology, investment in spare equipment, conservatism in operational strategy, and personnel numbers.

In contrast to the hub-location stands an isolated refinery, distant from other refineries and isolated due to the absence of expensive transport logistics. Such a refinery will not experience the luxury of exporting its intermediate products to neighbouring facilities when critical processing units experience outages. Neither is contracted expertise available for addressing sudden problems and malfunctions. This type of scenario oblige the remote refinery to invest in equipment and technology that will render it more reliable and independent of the mentioned aspects, it will increase personnel numbers to overcome some of the disadvantages of being isolated. In such a scenario the business- and operational strategy will also take cognisance of the location impacts and these strategies would tend to be more conservative.

Lastly, in a remote or isolated scenario as described, the producer is likely to carry a strong responsibility for ensuring product availability in comparison with any one production site in a hub scenario. This in turn leads to greater investment requirements as well as more conservative operating strategies.

4.2. Concept of normalisation to a common basis

Given the array of inherent differences between refineries as described, it is obvious that certain aspects of refineries' operation cannot be coldly or directly compared. These aspects have to be translated to a common basis through scientific means. This is defined as standardisation or normalisation.

The concept of standardisation / normalisation is that of putting different aspects that need to be compared on a similar basis. For example, to compare the cost of production of two sites, rather than comparing the overall costs incurred at the respective sites, the variable cost per unit produced is compared (Smit *et al.*, 2002:209). The cost has thus been normalised to a common basis.

It is of critical importance that the common basis be relevant from a business competitiveness perspective. In the example presented the production cost was standardised to a per unit basis, which supports an evaluation of the competitiveness of the production cost of respective facilities.

Ideally all aspects of the business being benchmarked should be normalised so as to compare apples with apples. Some aspects are easier to normalise than other.

Technical aspects such as availability, energy consumption, product yield, and operating cost could be easily compared on a unit-by-unit basis. To normalise and compare the energy consumption of one DHC (Distillate Hydro Cracker) unit with that of another DHC unit is relatively simple despite differences in size, design and feed quality. Techniques have been developed to compare the technical performance of whole refineries of which the size, configuration and complexity differ.

Even when a refinery has an unique operational environment combined with intentional deviation from certain pacesetter aspects, such as operating in a remote location, could technical aspects be benchmarked through application of a premium or handicap for a defined situation and strategy.

Natref enrolled the services of an external specialist company, SOLOMON ASSOCIATES, for benchmarking with other refineries. Solomon Associates includes more than 75% of the world's refining capacity in its benchmarking, and has been actively benchmarking refinery performance for over 20 years (Solomon, 2004:2).

Business performance aspects are much more complex to normalise. Consider net operating margin. A refinery situated in for example Singapore will be exposed to a certain combination of product demand and product prices, which in turn are the result of regional supply and demand. At the same time a refinery in South Africa will be exposed to a different set of product prices, although indirectly linked with those experienced in Singapore, and a unique supply and demand situation as is dictated by the local economy and local production facilities.

Refineries base their short term business strategy optimisation efforts on the reigning regional product prices and regional supply and demand situation: Assume the Singapore and South African facilities in the example respectively has exactly the same configuration, capacity, technical performance and integration efficiency. It could be expected that these sites would have different crude oil decisions, product slates and unit utilisations because they serve markets which offer different product prices and have different product demands. Consequently they would have different net profit margins.

The question could be asked as to what would each have done had their market been identical to the refinery it is being compared with. Given the basis of identical facilities and effectiveness, it could be assumed each would have made exactly the same decision as the other did.

In addition, the Natref shareholders sacrifice profit at this individual site so as to maximise their overall profitability. TSA maximises its relatively low margin diesel production at Natref and purchases the balance of its petrol demand from Synfuels at attractive prices, and so maximise their profitability. Similarly does Sasol reduce petrol production at Natref and maximise the lower margin diesel product so as to optimise its overall product offering and profitability. It would however reflect poorly on Natref profitability.

The principle being demonstrated is that the reigning industry, market and business situation strongly influences business decisions, and as such business performance results. It is thus not possible to normalise differences in market situations, specifically product slate and prices, through simply applying a common set of product prices to those products actually produced in a certain period.

One way to address this inherent difference is to assume a standard price and unlimited market for the respective products, and then to apply the actual technical performance achieved by each specific site for the period under consideration, and calculate the resultant crude slate, product slate and volumes, and associated net margin so as to compare apples with apples. This would provide a basis for performance given different conditions than actually experienced. If the objective is to determine whether own operation is of pacesetter standard, this approach could be of value. Still it does not address issues such as Natref's unique flow diagram and associated higher operating costs required to address the absence of a bunker fuel oil market.

At best this remains a theoretical comparison, which does not influence investors' bank accounts.

An alternative approach would be to define the actual financial performance of the refinery. Investors invest in businesses to yield a profit on their investments. Standard investment indicators could thus serve as benchmarking basis. Unfortunately this refinery is not separately listed with its own stock price. Also as indicated earlier this refinery could be operated at reduced profitability so as to maximise overall profitability.

4.3. Benchmarking financial performance

Due to the inherent differences between refineries, their markets and rules, their financial performance cannot be compared through merely applying standard product prices and standard replacement values for existing facilities. Each set of market and industry conditions drive different business, investment, and operating decisions that are aimed at maximising profitability.

Sufficient indicators exist for benchmarking technical performance between refineries. Indicators for comparison of overall financial performance are in a lesser stage of development. The benchmarking information available contains limited comparative information with regards to net financial performance. The comparisons that are included have certain inherent shortcomings, as will be analysed in this section.

The following factors are of importance to investors in an operating business:

- Profitability (ROI, ROCE, NPV, IRR, or MIRR.),
- Growth,
- Sustainability,
- Robustness.

4.3.1. Profitability

4.3.1.1. ROI / ROCE

Several definitions for Return-on-investment (ROI) are applied in industry. ROI is defined as follows for this evaluation:

$$ROI = \frac{\text{Net income} + \text{Interest expense (net of tax)}}{\text{Average total assets}}$$

(Libby, Libby & Short, 1998:711).

The intention of the "Return on total investment"-ratio is to evaluate to what extent management effectively utilise assets, independent of how assets were financed.

The net income will depend on the total sales, including the effect of product slate and the prices achieved for it. As indicated earlier these are strongly influenced by overall business optimisation, effectively parameters outside the control of the refinery, its strategies and its personnel. These include:

- The current excess production capacity in South Africa,
- Shareholder strategic action,
- Sasol's production capacity and slate,
- Sasol's market share,
- Synfuels' competitiveness, and
- Production of lower market value products at the refinery so as to maximise overall profit.

The current objective of benchmarking the performance of the refinery is:

- To evaluate whether the refinery is doing the best it could given its existing investment, market and industry,
- To determine whether the refinery is doing as well as it could given the "instructions/preferences/markets" of its shareholders,
- To define areas of improvement,
- To define realistic improvement targets,

- To define true "best practices" – this requires international benchmarking, and
- To motivate the workforce towards even better performance.

The objective of benchmarking in this case is not to define whether the refinery is utilising its capacity to the fullest, or what the impact would be if it would be used to capacity. Utilisation of the refinery is at the discretion of the shareholders whom optimise the bigger picture, and should be included in their performance evaluations.

ROI determines the ratio of net income to capital invested. In a situation where the refinery is under-utilised because of greater strategies, or where lower margin products are produced to maximise overall shareholder profit, it does not make sense to evaluate the refinery as if it is free to operate at maximum capacity and highest margin product slate.

Shareholder total business performance evaluation should however include the total ROI.

Should conditions change such that the shareholders do require the facility to operate at full capacity, then ROI would become a more relevant and valid indicator of performance, though standard product prices would still not be applicable.

TSA is currently operating its share of Natref at full capacity. Despite higher prices for petrol, it is maximising diesel production. This could be explained by the fact that Sasol through its Synfuels production has excess petrol, and that TSA is purchasing it at such prices that it makes business sense to swing TSA's production at Natref to a perceived reduced local profitability. This would reduce the perceived ROI on TSA's investment in Natref, but is not a true reflection of operation.

The inaccuracy of the message inherent in ROI based on standard product prices, valid in for example the Asia-Pacific, would be even greater due to differences in local business conditions.

To define a realistic ROI the correct value of products and feedstocks must be used.

It could be argued that each participant in a wide ROI benchmarking as executed by Solomon Associates could adapt its own ROI to reflect such local business conditions. This would however result in all players changing its own ratings, without the others being aware of it. The result is comparison of own customised results with a fictitious reference, thus limiting its usefulness.

What could be of more value to all participants in such an international benchmarking exercise is a comparison of true ROI, based on:

- Standardised calculation method provided by the benchmarking coordinator,
- Actual product sales income,
- Actual costs, and
- Standardised replacement value based on Utilised Equivalent Distillation capacity (UEDC).

Such information is currently not available, but the inclusion there-of in future benchmarking could be considered. This information would be quite sensitive and as such confidentiality will be critical.

The value added by the ability of the refinery to change its product slate to the benefit of the global profit optimisation of its shareholders is not reflected in the financial results of the refinery in isolation. It is proposed to evaluate by means of Linear-Programming Modelling (LP-model) studies the difference in net income for the refinery operating at a fixed throughput, but varying the production slate between maximum diesel and maximum petrol production, allowing crude type and production unit utilisation to be optimised. This would indicate the strategic value of being able to swing production towards maximum diesel. This value should be added to the income in any ROI calculation. This would require a study that is beyond the scope of this report.

Available benchmarked ROI results, based on standard product prices and standard equipment replacement value, indicated a ROI for Natref of –0.4% (Solomon, 2003a:D-1). Jordaan (2003:3) indicated that when applying actual differentials between imports and final products, the reported ROI increase to 1.59%. This elevates performance from fourth to second quartile. This clearly indicates that the standardised ROI as currently available creates more questions than it gives direction.

It is thus concluded that the ROI indicator will not contribute towards meeting the objectives of benchmarking the refinery's profitability performance given current conditions, and as such will not be recommended for use as performance indicator and goal setting.

ROI and ROCE differ only to the extent that ROCE includes operating capital. Directionally all the ROI arguments are valid for ROCE as well. Operating capital in isolation is included in benchmarking of specific aspects later in the report.

4.3.1.2. Refining margin

Since Natref is not in control of the volume of product that is sold, it could be considered whether some indicator could be used which is based on profit per unit produced.

Benchmarking information for refining margin is available. Refining margin, also called net margin, is defined as gross margin less total cash cost. It is thus equivalent to the "Net income" as applied in ROI, normalised to net income per unit produced.

The main shortcomings of this method are that fixed cost is allocated to a variable volume of production, of which the variation is not in control of the refinery and as such could not be applied as a performance parameter for refinery personnel. In addition, refining margin as such does not indicate how much value the refinery added. Investors are interested in the net income, and will base investment decisions on the return that could be achieved on their capital. Finally, all the comments valid for determining and comparing income for ROI are also valid for determining the and comparing refining margin.

Instead of refining margin, it is recommended that improvement in fixed cost and variable cost be driven and evaluated separately. In addition, since marginal sales depends on marginal cost of production, it is recommended to put more focus on marginal variable cost.

4.3.1.3. NPV, IRR, MIRR

NPV, IRR and MIRR are indicators used to determine the current value, potential return or profitability of a project or even of a business or facility such as Natref (Brigham & Ehrhardt, 2002:509). If management and personnel action, such as excellent operations and management, relevant and effective interventions and/or strategies, increase the profitability of the refinery, then its inherent value will increase. For a listed company this would translate in an increased stock price. Inversely, should the refinery achieve poor value addition, high operating costs, equipment breakdowns etc., its value adding would reduce resulting in its NPV, IRR and MIRR decreasing.

These indicators however all take into consideration the total investment made in the facility, regardless strategic action, as well as net income and cash flows and would thus directionally yield results similar as would ROI all else being equal. Inherently these calculations are just more sophisticated forms of ROI. NPV, IRR, and MIRR thus do not offer a better solution than ROI towards evaluating the performance of the refinery specifically.

These parameters could be used to value the inherent value of Natref, given expected future industry conditions. This is however not the objective of this evaluation.

4.3.1.4. Profit realisation

Natref's direct role in maximisation of the profitability of its operation lies in maximising the operating window for the shareholders, and in executing the optimal production plans of the shareholders. This input, given the market and industry conditions, could be evaluated through the following aspects:

- Production according to shareholder contracts
- Minimising average unit-cost
- Marginal production cost
- Accurate knowledge of marginal production
- Crude valorisation

a) Production according to shareholder contracts

It is critical that the refinery production is in line with the production planned by the shareholders, since these volumes are aligned with supply contracts. Especially over-production of petrol or under-production of diesel could result in big losses for the respective shareholders, since these products are respectively in over-supply and under-supply situations.

Performance is measured in terms of deviation between planned and actual production of the respective products.

b) Minimising average unit-cost

The shareholders' marketing teams have the objective of finding the highest volume and most profitable outlets for products from the refinery. For a given product demand, the refinery is expected to produce it as cost-effectively as possible. Effectively this implies that minimising input cost for a given production would maximise profit. By addressing the cost per unit product produced, the effect of the following inefficiencies would be reflected:

- Crude type,
- Product losses,
- Poor yields,
- Excessive reprocessing,
- Too expensive processing materials (catalysts and chemicals),
- Excessive labour costs,
- Ineffective production choices (unit A vs. unit B), and
- Sub-optimal production planning and scheduling.

Most of these aspects could be individually benchmarked with international standards. However, the synergistic impact of optimising these parameters collectively offers more value than optimising them individually. For example, it might make more sense to purchase a more expensive crude that would yield more diesel than would a cheaper crude with a higher petrol yield.

An evaluation methodology is thus required that would assist in evaluating the effectiveness of collective optimisation.

This could be achieved through comparing the actual cost of production over a selected period with the optimum considered achievable, for a given product volume and slate. The optimum production cost achievable given all the processing options is determined via a mathematical model of the refinery, depicting the implications of different processing options and optimising their utilisation through linear-programming (LP) techniques.

The LP-model typically over-optimise since all constraints of real life are not programmed into its decision matrix, and due to this evaluation being applied retro-actively, i.e. perfect knowledge of the past is available where-as actual operations and planning there-of have to predict the future. By comparing the optimum result of the LP with actual results, a good indication could be achieved of actual performance. The current target is to achieve 98% of the LP-estimated optimum. The 98% is not based on benchmarked performance, but is considered stretching since it is similar to the accuracy of the LP-model. It should be attempted to benchmark accuracy of the LP model with other refineries.

LP model results however are strongly dependent on the constraints imposed and options allowed. Care should be taken as to the choice of constraints and operating window allowed in the benchmarking run.

It does happen that the refinery cannot produce the required committed production, e.g. due to equipment failures, poor catalyst management, or production of off-specification products. In such cases the production and market demand is out of balance, and the refinery actually forfeits potential sales, income and profit, whilst production costs might have reduced – when a unit is shut down there is no production cost. Even if the production cost is not influenced by such an event, the loss in profit is far in excess of the impact on production cost. Considering cost only does not represent the full picture of actual profit realisation.

People in general are more motivated through measuring profits, i.e. a positive orientation, rather than costs, a negative orientation. It is thus proposed to measure profit generated relative to the optimum possible, since it includes cost but also any improvements, and because it is a positive orientation.

Defining the profit realised is complicated by the fact that the prices achieved for products vary from contract to contract. The two shareholders not only negotiate contracts and prices with third parties, but also with each other. These contract prices are thus highly sensitive and confidential, and as such are not available for refinery personnel. The prices used to drive the LP model are thus merely indicative; typically BFP prices are used. The profits calculated from these prices thus do not necessarily indicate the true picture.

Different prices should be applied for marginal production. These prices should be based either on actual selling value, alternatively it could be based on the fact that there is an excess of petrol available in the market. The marginal selling price for petrol could be assumed as being at nil refining margin, alternatively export margin, whilst the marginal diesel production could be assumed to be at petrol or diesel BFP, whichever is highest.

It is thus important that profit generated or forfeited, as a percentage of potential be measured, and that deviations from the optimum, such as throughputs, yields and costs, be identified and quantified. This concept is currently implemented and measured as the Profit Index.

c) Marginal production cost

In an unregulated market sustainable importing of products into the South African market can only make sense when products could be purchased on open international markets and delivered in South Africa at prices lower than it could be delivered from Natref gate. Since such imports would result in Natref cutting back on production, it would be competing with Natref's marginal production cost.

In the current regulated South African industry, importing of products is not allowed unless domestic production facilities cannot supply such product. Natref is thus protected from international competition in the short term.

As discussed earlier, other South African producer-distributors would cut back own production to purchase product from Natref only when offered at a price that would allow such a producer-distributor to still gain its full refining margin, thus eroding Natref's marginal profit to only the extent that its marginal cost is better than that of such a producer-distributor. Sasol is currently operating Natref close to minimum allowable throughput. This implies that some of the Natref production is sold at such reduced prices.

Reducing the marginal production cost would impact the profit margin on Sasol's marginal production immensely: assume the marginal product is sold at a net refining margin of 1$/bbl, then reducing the marginal production cost by 0.25$/bbl would increase marginal profit by 25%.

Once Sasol's share of Natref is operated beyond minimum, then such sales would no longer be forced, but would be at the discretion of Sasol. In such a scenario reduced marginal production cost would enable higher sales volumes providing it being better than the marginal production cost of competitors.

Minimisation of marginal production cost is thus a critical performance aspect for Natref.

d) Accurate knowledge of marginal production cost

Buyers and sellers propose and accept contracts based on estimates of the marginal cost of production. It is fundamental that the better their information regarding their costs, the better contracts they can negotiate.

e) Crude valorisation information

Crude purchase decisions are based on its valorisation, i.e. the estimated production expected out of such a crude, combined with the value of such production. Crude cost represent ± 90% of the overall production cost, and is thus a key aspect in the profitability of the refinery.

The value of any crude, as well as the marginal production cost is not one fixed value, but depends primarily on the product slate required, the throughput of the refinery, the type of crude being processed and the processing option selected. Since each shareholder purchases its own crudes, have different product slate preferences, operate the refinery at different throughputs, and for each shareholders these change from scenario to scenario, it is not possible to calculate a standard cost of production. There are an infinite number of combinations and scenarios.

The way this information, including crude valorisation, production cost optimisation, and marginal production cost, is made available to the shareholders is through the use of the LP model. The model is compiled and maintained by the refinery, and then applied by the shareholders to determine what would be the best course of action.

The accuracy, flexibility, and ease of use of the LP model would thus be of critical importance for the shareholders, and should thus be included as a strategic performance factor for the refinery.

4.3.2. Growth

The refinery is part of a commodity-based industry, with a world wide over capacity. All players are continuously improving their performance through better technology and better execution and operation:

- Effectiveness - better choices, management, knowledge, contracts, partnerships; and
- Efficiency – productivity, reliability, and losses.

Although performance in a given benchmark study might be good, be assured at the next comparison competitors could be expected to have improved. It generally seems that those performing best, are also improving the most.

It is thus critical that a general culture of continuous improvement be created, and that management direct efforts such that would yield best value. Growth, or improvement, should thus be considered a refinery performance aspect.

Although focus areas for growth should vary over time, it would be beneficial to standardise measurement of growth to enable evaluation there-of over the longer term.

The Profit Potential Index is proposed as tool measure the combined impact of all improvement effort. For example when improvements are made to reduce energy consumption, this index will show the net impact there-of. Similarly for improvements such as improved diesel-to-petrol-ratio, hydrogen recovery, reduced hydrogen demand, new catalysts, better availability, reduced fixed costs, better yields, higher productivity, and reduced operating capital.

The Profit Potential Index is calculated by means of the LP model and is typically applied over a year period. The profit estimate from a base case LP model is compared with that of an updated LP model, the latter including all improvements that were implemented in the year.

Key is that this index should reflect the impact of all relevant improvements over a year period. Updating of the LP should thus be accurate, and must include aspects such as fixed costs.

4.3.3. Sustainability

Sustainability of profit is of key importance to shareholders. Sustainability is determined by aspects such as:

- Resource availability,
- Safety of operations,
- Environmental impact, and
- Profitability.

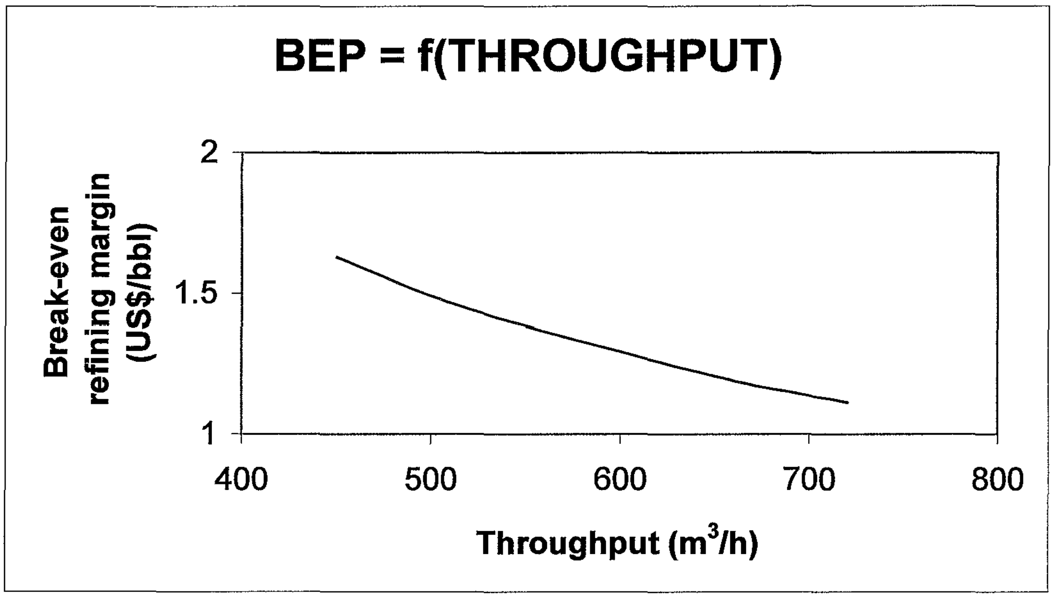
These aspects are beyond the scope of this investigation.

4.3.4. Robustness

Robustness is an indication of the extent to which variations in industry conditions impact profitability. A general measurement for this is the breakeven point (BEP), i.e. that gross refining margin for which the refinery gross margin just covers cash costs.

BEP depends on refinery throughput, gross refining margin, fixed operating cost, and variable operating cost:

Figure 4.1: Break-even point vs. throughput



The break-even line as presented in figure 4.1 indicates that the required gross margin to break even reduces as throughput is increased. Reducing the cash cost will result in shifting the break-even line downwards, i.e. requiring a lower gross margin for break-even. Reduced cash cost and increased utilisation renders the refinery income sheet more robust towards changes in industry conditions.

Currently the gross margin is far beyond break-even. However, international and Asia-Pacific margins vary between \$1-\$6/bbl, depending on local conditions. Since the current gross margin is so much higher than the BEP margin, it will be proposed to drive the elements of cash cost separately. Driving of the BEP specifically will thus not be included in the proposed performance targets.

4.4. Summary of key performance parameters

For the current industry situation and conditions, the following overall profitability performance parameters would give the best indication of Natref's overall business performance:

Table 4.1: Summary of Performance Parameters

	Primary parameters	Aspects included
1	Profit realisation	• LP model accuracy (volumes, yields, qualities, costs) • Execution • Minimisation of petrol-to-diesel ratio • Ability to increase production volumes on short notice • Capacity maximisation • Minimum sustainable capacity • Accurate marginal values • Accurate marginal costs
2	Average production cost	• BEP
3	Average variable cost	
4	Marginal variable cost	• Marginal sales competitiveness
5	Average fixed cost	
6	Availability and reliability	
7	Continuous improvement	
8	Capital employed minimisation	• New investments ≥ WACC + 5% • Renewal maintenance and SHE capital optimised • Optimisation of operating capital

4.5. Benchmarking key performance parameters

The performance with regards to the key performance parameters identified was analysed based on benchmarking information available from the most recent survey done by Solomon (2003a:D-1).

4.5.1. Profit realisation

Profit realisation, as an indicator of the integrated result of all input towards maximising refinery business performance, is the only key performance aspect for which Solomon Associates does not offer a benchmark. Yet this is one of the most important performance aspects.

The Profit Index is a recent measurement, developed internally by Natref. Solomon (2003a:II-13) has surveyed the number of refineries employing LP models to optimise performance, but no benchmarking information is available with regards to the accuracy and application of such LP models. No other information is available regarding the measuring of actual vs. potential integrated refinery performance.

It could be considered in the longer term to implement this measurement in the wider TOTAL Group, as well as in other South African facilities. The author is of opinion that such a measurement would not be practical as a general industry benchmarking parameter since there are just too many variables that need be normalised. It could however be applied in a smaller group such as the other South African facilities since these facilities are under joint management, and subject to the same industry conditions.

In the absence of benchmarking information, it is proposed to identify relevant good practices and so maximise performance in this regard.

The following best practices should be considered for driving profitability through the Profit Index:

- LP model accuracy demonstrated with regards to relevant aspects:
    - Overall product yields & qualities,
    - Total variable cost,
    - Marginal variable cost

- Process of identification of deviations between that considered realistically possible vs. that actually achieved to be:
    - o Comprehensive,
    - o Credible, and
    - o Accepted by refinery personnel
- Must be quantifiable on as short as possible periods, minimum frequency monthly so that positive and corrective action plans could be developed as a result there-of,
- Must consider all aspects within the control of the refinery.

Although not part of the scope of this study, the same methodology and principles could be applied by the Shareholders to evaluate those aspects within their control.

4.5.2. Variable production cost

Variable production cost refers to the variable cost of production for each of the products in c/l or $/bbl, and include only those costs that would change if any of these product volumes change.

Natref and most other refineries are configured such that each unit produces a variety of products, and the yield of any specific type of product could be varied through varying the operating conditions and throughputs in the respective processing units. Although the operating cost per production unit is known, the costing systems are not configured such that the average individual cost of production for petrol, diesel and jet fuel respectively are known. Only the combined average cost of production is known.

The LP model could be applied to define the marginal cost of production for each of the respective products.

Benchmarking information is available only for the average cost of production, and is expressed per unit crude processed. Since all refineries have different configurations, different objectives and different product yields, the average cost of production per unit crude processed would yield misleading results. Solomon (2003b:19) has thus developed the concept of Utilised Equivalent Distillation Capacity (UEDC) and Peer Groups that puts comparison of production costs on a more comparable basis.

Benchmarking information is also available for the following basic cost contributors:

- Crude oil,
- Catalyst and chemicals,
- Energy,
- Utilities, and
- Other volume related costs.

Solomon (2003b:33) has devised standardisation factors for comparison of these parameters. For confidentiality purposes these definitions are not divulged here, but are available from Solomon Associates.

Since crude selection is not done by the refinery but is managed by the shareholders themselves, crude costs are not quantified in this evaluation.

Table 4.2: Variable operating costs (Solomon, 2003a:D-1)

All USc/UEDC	**Peer**	**RSA**	**Natref**	**Δ (Peer)**		**Δ (RSA)**	
Energy	16.7	20.6	20.2	3.5	18%	-0.4	-2%
Anti-knock	0	0	0	0	0%	0	0%
Catalyst	1.1	1.2	2.2	1.1	6%	1	4%
Chemicals	0.8	0.7	0.7	-0.1	-1%	0	0%
Royalties	0	0	0.1	0.1	1%	0.1	0%
Demurrage	0.1	0.1	0.2	0.1	1%	0.1	0%
Utilities	0.7	0.4	0.2	-0.5	-3%	-0.2	-1%
TOTAL	19.4	23	23.6	4.2	22%	0.6	3%

For the purpose of this evaluation "Anti-knock compound" expenses were reduced to nil to all participants. This was done for two reasons:

- The use of anti-knock compounds increase refinery profitability and as such are beneficial to refinery economics, but have potentially negative side-effects. Since none of the Asia-Pacific peers are allowed to use anti-knock compounds, and South African legislation will soon result in phasing out the majority there-of, there is no sense in including it in cost comparisons.

- Anti-knock compounds currently add strategic value in the sense of petrol production capacity, and should be used as long as possible. The configuration of the LP model allows optimisation of the unit consumption there-of. The cost there-of is thus justified, but should not be considered when comparing with international refineries.

4.5.2.1. Average variable production cost

Natref's variable operating cost is 22% higher than that of its Asia-Pacific peers, and 3% lower than the other South African refineries. The highest single deviation lies in energy related costs; in Table 4.2 it is indicated that energy costs represent 18% out of 22% of the variable cost deviation, i.e. energy accounts for 83% of the variable cost deviation. The main other negative deviation lies in catalyst costs.

4.5.2.2. Energy

Energy cost represents 86% of both Natref's and the peer group's variable cost, and 57% of Natref total cash cost, but only 48% of peer group total cash cost. Whilst this appears acceptable, the amount of energy used by Natref is much higher than in the peer group, as is depicted in Table 4.3:

Table 4.3: Analysis of Natref energy consumption (Solomon, 2003a:D-1)

	Peer	**RSA (including Natref)**	**RSA (excluding Natref)**	**Natref**
EII* (%)	86	108	105	117
Natref EII ranking	16th of 16	4th of 4		
Total energy USc/UEDC	16.7	20.6	20.7	20.2
		(% of base)	(% of base)	(% of base)
Volume energy	Base	126%	122%	136%
Cost of energy	Base	98%	102%	89%
Total energy	Base	123%	124%	121%

*EII = Energy Intensity Index is a proprietary benchmarking index used for normalising energy consumption in different refineries (Solomon, 2003b:26).

The energy consumption deviation could be broken down into a volume element and a cost element:

Total deviation = volume deviation * cost deviation

At the time of the benchmarking Natref was using 36% more energy than its Asia-Pacific peers, and 14% more energy than the other three South African refineries. At the same time Natref's energy expense was 21% higher than its Asia-Pacific peers, whilst this expense was marginally lower than did other South African refineries incur. Natref thus obtains its energy at lower unit cost than its Asia-Pacific peers (-11%) and the other South African refineries (-3%).

Natref thus has a competitive edge in terms of energy cost, probably due to the low cost of electricity in South Africa and its proximity to coal based industries, but is performing poorly in terms of volume of energy consumed.

Natref's energy consumption performance is poorest in the Asia-Pacific and South Africa. Since Natref is consuming so much more volume energy than its peers, and due to the high contribution there-of to variable cost, this is an area of potential improvement.
Natref must improve energy volume consumption to 97 EII points to render its total energy expense equal to the average of its Asia-Pacific peers in 2002. It is anticipated that this peer group will improve its average performance by 1 EII point per year, an average Asia-Pacific EII of 92 can thus be expected for 2007. It is interesting to observe that the best EII performance in the peer group in 2002 was an EII of 70 – still much beyond the target set for Natref for 2007.

Natref has recently achieved an EII around 110. To achieve 92 EII by end of June 2007 requires reducing the EII by 6 points per year (basis 80% utilisation):

Table 4.4: EII improvement target

April to June 2005 average EII	104
April to June 2006 average EII	98
April to June 2007 average EII	92

Projects and initiatives required to reduce the EII to the target stated must comply with the investment payback target of WACC+5%. In the light of the relatively low unit cost of energy at Natref, it can be expected that it may be difficult to achieve WACC+5%. It is thus proposed that it be allowed that energy projects cross-subsidize each other, i.e. that the annual composite return on energy investment yield WACC+5%.

Reducing the energy consumption to the target of 92 EII will reduce the variable operating cost by 3.3 USc/bbl, or 15%. This would result in reducing the overall operating cost by 10%.

4.5.2.3. Catalyst

Natref's catalyst costs exceed that of both Asia-Pacific peers and South African refineries by approximately 1USc/bbl or 6% of variable costs.

At Natref all catalysts are selected on a strictly profit-competitive basis, i.e. before a catalyst is purchased it is made sure that its value addition exceeds those of all other options. Selecting catalysts with higher prices than those with lowest cost are confirmed to exceed the required WACC+5%, and typically do so by far. In addition, catalyst price competitiveness is confirmed by benchmarking catalyst prices with other refineries in the TOTAL-group of refineries.

Since the existing systems are sufficient to ensure that the unit price of catalyst is competitive, the remaining possibility is that unit consumption of catalyst is higher than in the peer group.

A possible explanation for the perceived high catalyst cost is that the benchmarking is based on amount of crude processed through the refinery, rather than on volume and type of products. Since Natref is an inland refinery, with no profitable outlet for fuel oil, Natref was equipped with conversion processes that convert fuel oil to products that are in demand in the local market.

The white product yield, i.e. petrol, diesel, and jet fuel, at Natref is around 92%, whilst it is around 70-75% for typical refineries (Solomon, 2003a:D-1). This is a drastic difference. High white product yield not only requires high capital investment, but also high catalyst costs per unit crude processed. A way of benchmarking this would be to compare catalyst costs per unit white product produced. Alternatively catalyst cost per unit feedstock, corrected for quality, for a specific process unit could be compared.

It is thus concluded that there is a fundamental explanation for the higher than peer catalyst expenses incurred by Natref, and that routine catalyst selection processes make sufficient provision for competitiveness with regards to catalyst expenses. No strategic objective regarding catalyst expense improvements is thus recommended.

4.5.2.4. Purchased utilities - Hydrogen

The benchmarking information indicates that Natref incur lower expenses than the peer group in the category "Utilities". This is partly due to specific South African conditions, and Natref's proximity to other petrochemical and coal based industries.

Natref and the general South African industry are currently not yet subject to strict requirements regarding diesel product qualities. More stringent specifications will be required as from 2006. A major impact is expected in terms of variable operating cost, specifically in the form of hydrogen cost.

Hydrogen will no longer be an optional import used to reduce operating costs, but will be required in order to produce sale-able products. It is expected that up to 6,000 nm3/h hydrogen will have to be imported at a cost of R10,000 to R14,000 per tonne, increasing the variable cost by 1.5 – 2 USc/bbl, i.e. ± 10% of the variable cost excluding crude cost.

All else constant, this would increase the variable cost to 132% of the Asia-Pacific peer group. The hydrogen cost of other South African refineries are not expected to increase considerably since their base-line hydrogen consumptions are all relatively low due to their not having hydro-conversion units like the Distillate Hydro Cracker (DHC) and Reduced Crude Desulphurisation unit (RCD). They would thus probably extract the additional hydrogen from their fuel gas pools.

The hydrogen requirement of the refinery is modelled in the LP. The LP will thus indicate the optimal solution with regards to hydrogen utilisation, and as such will be included in the evaluation of the Profit Index.

Another way of benchmarking optimisation of hydrogen in the refinery is to compare the hydrogen losses, i.e. the amount of hydrogen let down to fuel gas and other systems as a percentage of total hydrogen demand, with that of other refineries. This parameter is not available as part of the existing benchmarking information, but Solomon Associates could be approached to include it. Alternatively it could be considered to benchmark this parameter in the other owned facilities and TOTAL-group.

The price being paid should also be benchmarked. Although such information is not available from Solomon Associates, it could be obtained from other chemical centres in the world, or via TOTAL.

4.5.2.5. Remaining volume related costs

The remaining variable operating costs all are small percentages of variable operating cost, or were found to be competitive with the Asia-Pacific peer group.

4.5.3. Marginal variable cost

The primary components of variable cost are:

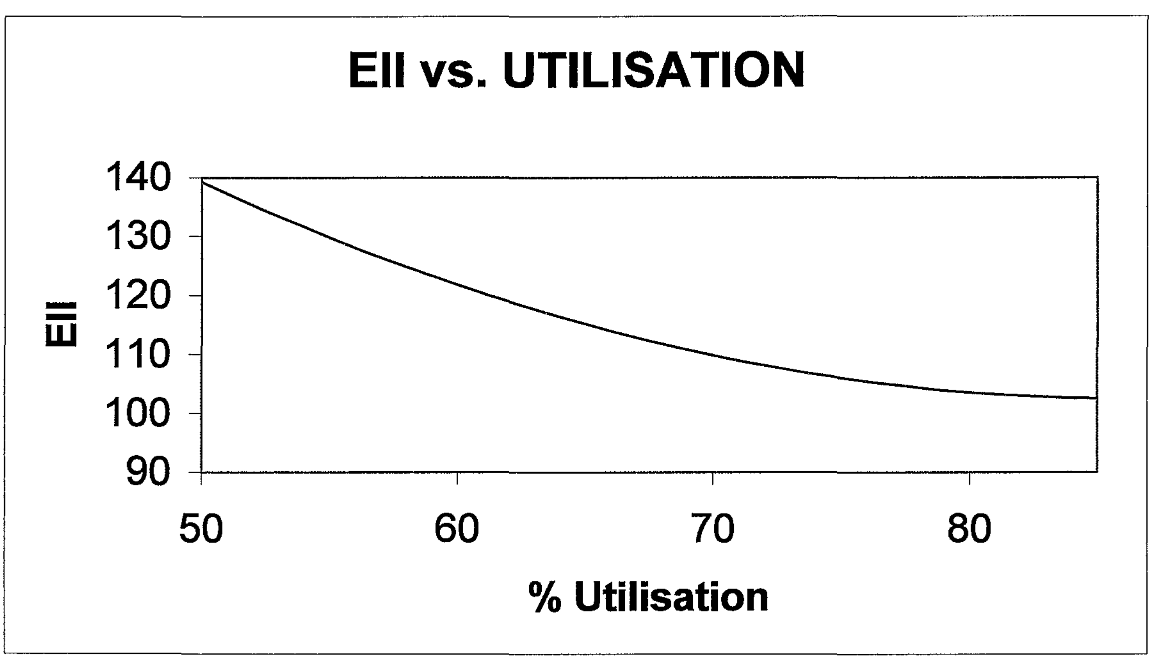
- Energy
- Catalyst
- Hydrogen
- Crude cost

These will thus form the bulk of marginal variable cost.

4.5.3.1. Marginal energy costs

The 2004 energy consumption vs. throughput curve, based on empirical data, is as follows:

Figure 4.2: EII vs. UTILISATION (Natref, 2004:4)



Two main observations are made:

- Energy efficiency increase as utilisation is increased, and
- The relationship is not linear.

Since the relationship is not a straight line, it could be concluded that energy consumption is not a simple combination of a certain amount of fixed energy consumption and a standard variable component, which would be described by the following formula:

$$EII = a*throughput + fixed\ component$$

Instead the energy consumption is described by the following non-linear equation:

$$EII = a*throughput^3 + b*throughput^2 + c*throughput + d$$

The reason for this non-linearity is most likely due to the overall refinery EII being a combination of different process unit EII's. Since the utilisation of the individual units vary according to the situation of the day, this empirical equation suffers quite a big standard deviation for overall energy consumption.

It is possible to define energy consumption relationships for all the processing units separately. Calculating the refinery marginal energy consumption based on individual unit utilisation will result in a more accurate estimation of marginal energy consumption, and in so-doing will facilitate better decisions with regards to marginal product offerings. This aspect is also pertinent to the shareholders utilising the refinery in different ways.

From figure 4.2 it can visually be observed that the increase in energy required as the throughput increase becomes smaller as throughput is increased. this could be ascribed to energy consumption for each processing unit having a fixed component. This aspect should be included in the energy modelling per unit.

Key however is the fact that marginal energy consumption is lower than the average consumption. Average energy costs represent approximately 86% of the variable cost, and as such could reduced marginal energy cost influence product offerings and make-or-buy decisions.

Available benchmarking information does not cater for marginal energy consumption, only average consumption is available. However, by configuring the calculation of the marginal energy consumption from basic principles in the LP, all users of the LP are empowered to calculate the correct energy cost, and thus use the correct marginal cost for decision-making.

It can be concluded that since energy represent approximately 86% of the variable cost excluding crude cost, marginal energy cost could influence decision-making and as such should be more accurately represented in decision-making tools.

4.5.3.2. Marginal catalyst cost

Marginal catalyst cost is not only influenced by throughput, but also by feed quality and operating severity. In terms of the cost accounting systems applied at Natref, catalyst cost is mostly written-off based on unit throughput, and is so represented in the LP. This system does thus not appreciate the true production cost, but the error so induced is so small that it could be considered acceptable. Catalyst cost represent 2.2 USc/bbl UEDC, which translates to $0.21/bbl, or around 4% of the refining gross margin. This is too small to materially influence processing decisions.

4.5.3.3. Marginal hydrogen cost

Increasing production beyond a certain threshold will result in starting to import hydrogen. Since import cost for hydrogen is relatively high, this could influence decisions. The marginal cost of the hydrogen is however known, and is stable over a given period. The impact of changing between zero import and import could thus be evaluated via application of the LP model.

Accuracy of the representation of hydrogen consumption in the LP model should be considered.

In order to evaluate the true value of imported hydrogen, it is critical that the marginal value of production be accurate.

4.5.3.4. Marginal crude valorisation

Of all the marginal costs, crude valorisation is the most variable and could have the biggest impact. It is thus of paramount importance that the different crudes and their valorisation be correctly represented in the LP-model. This could be measured through measuring LP-model accuracy as described earlier.

It is concluded that the marginal cost of production could be significantly different than the average cost of production, specifically due to the marginal nature of energy consumption, hydrogen import and crude selection. It should thus be ensured that the marginal characteristics of these elements be included in decision-making tools and in decision-making processes.

4.5.4. Fixed production cost

Fixed production cost refers to those costs that would remain the same in the short term regardless variations in production. These costs include:

- Personnel costs,
- Maintenance costs,
- Rates and taxes,
- Insurance,
- Environmental expenses, and
- Services.

The same principles as for variable cost benchmarking have been applied to benchmarking of fixed costs:

Table 4.5: Fixed cost benchmarking data (Solomon, 2003a:D-1)

All USc/UEDC	**Peer**	**RSA**	**Natref**	**Δ (Peer)**		**Δ (RSA)**	
Personnel	7.8	5.3	4.2	-3.6	-24%	-1.1	-9%
Maintenance	1.1	1.7	1.2	0.1	1%	-0.5	-4%
T&I adjustment	2.2	1.7	0.6	-1.6	-11%	-1.1	-9%
Contract services	1.6	1.2	0.8	-0.8	-5%	-0.4	-3%
Equipment rental	0.3	0.1	0.1	-0.2	-1%	0	0%
Property taxes	0.8	0.3	0.1	-0.7	-5%	-0.2	-2%
Insurance	0.3	0.7	1.4	1.1	7%	0.7	6%
Environmental	0.4	0.1	0.1	-0.3	-2%	0	0%
Other	0.6	0.8	0.6	0	0%	-0.2	-2%
TOTAL	15.1	11.9	9.1	-6.0	-40%	-2.8	-24%

Note: This fixed cost was based on Natref operating at full capacity (720 m^3/h = 109,000 barrels per day).

Since fixed cost is independent of throughput, the following fixed costs could thus be expected in absolute terms for the period covered in the benchmarking survey (2002):

Table 4.6: Absolute fixed cost based on benchmarking data

	Peer	**RSA**	**Natref**
Throughput (kUEDC)	1,311	986	1,034
Fixed cost ($million/a)	72	43	34
USc/UEDC @ 650 m3/h			10.1

For the period when the benchmarking was done, Natref's fixed cost was very competitive, both relative to its Asia-Pacific peer group and the South African refineries. It should however be kept in mind that throughput will be reduced in 2006 to cater for the more stringent product specifications. Fixed cost by definition will remain unchanged, except for specific management interventions. The fixed cost per unit throughput will thus increase. Estimates indicate it will increase by approximately 1 USc/UEDC (or 11%). This still leaves Natref relatively competitive in terms of fixed costs.

4.5.4.1. Personnel costs

The biggest fixed cost component is personnel costs, representing roughly 52% of the peer group fixed costs, and 46% of Natref fixed costs. Natref's personnel costs rated 24% lower than that of the peer group, and 9% lower than other South African refineries.

In addition to personnel costs, personnel numbers have also been evaluated:

Table 4.7: Personnel cost benchmarking data (Solomon, 2003a:D-1)

	Peer	**RSA**	**Natref**	**Δ (Peer)**		**Δ (RSA)**	
Personnel index (work hours / 100 EDC)	94.7	168.1	136.0	41.3	44%	-32.1	-19%
Equivalent personnel (per 100k EDC)	49.1	87.7	74.4	25.3	52%	-13.3	-15%
Personnel cost index (US$/EDC)	29.0	20.1	15.2	-13.8	-48%	-4.9	-24%
Personnel cost (USc/UEDC)	7.8	5.3	4.2	-3.6	-24%	-1.1	-9%

Two indexes indicate that Natref's absolute personnel costs are low, varying between –24% and –48% of peer group. These same indexes indicate Natref's personnel costs to be between –9% and –24% of other South African refineries' average costs. This indicates that personnel costs for South African refineries generally are lower than that in the Asia-Pacific area.

When considering number of personnel, the benchmarking data presents two indexes that indicate that both Natref and South African refineries in general employ higher number of employees than its Asia-Pacific counterparts. Natref has similar complexity (9.5 vs. 9.2) than the peer group, thus the difference in number of employees cannot be ascribed to the complexity of the refinery. The crude capacity of both Natref and the average of the South African refineries fall just inside the capacity range of the peer group and are thus directionally small relative to the average of the peer group. Being smaller would directionally require more personnel per unit capacity. However when comparing these indexes with the next smaller peer group the same trend is observed, although personnel number indexes do improve by approximately 20%. It is also observed that Natref incurs relatively low costs for "Other contract services". This could indicate that its Asia-Pacific peers make more use of outsourcing and so reduce the number of employees in permanent service. However the definition for "Work hours" includes outsourced labour hours, and thus do not aid in explaining the higher number of work hours used in Natref and South African refineries generally.

Natref's and the average of the other South African refineries' labour cost benchmarking is strongly impacted by the R/$ exchange rate. Since personnel costs are primarily in Rand terms, when the Rand strengthens, personnel costs would increase. At the time of the benchmarking the exchange rate was R10.541/$. Given the current exchange rate of R6.50/$, Natref's labour cost competitiveness decreases drastically:

Table 4.8: Impact of R/$ exchange rate on personnel costs – R6.50/$

All USc/UEDC	**Peer**	**RSA**	**Natref**	**Δ (Peer)**		**Δ (RSA)**	
Personnel	7.8	8.6	6.8	-1.0	-7%	-1.8	-12%
TOTAL	15.1	15.2	11.7	-3.4	-23%	-3.5	-23%

Natref's competitive advantage of lower labour cost is off-set by its higher than peer labour intensiveness, and is at risk of strengthening of the R/$ exchange rate. Optimising of labour hours could further strengthen and ensure Natref's competitiveness.

Natref however is marginally more competitive than the average of the South African refineries in terms of personnel numbers.

4.5.4.2. Insurance

Natref's insurance cost is the only fixed cost that exceeds those of its peer group and that of the other RSA refineries. Natref's insurance cost is more than double that of its peer group and of the other RSA refineries. Since the relative complexities are not that much different, there must be another reason for this high cost, and as such it should be investigated and motivated.

In general it could be concluded that Natref's fixed costs are very competitive, but it could be under risk of the R/$ exchange rate since most fixed costs are incurred in Rand. Efforts should be directed to maintain this advantage, specifically in $ terms. It is thus stated as strategic objective that the fixed cost in Rand terms should be contained within Production Price Index (PPI) -1%.

4.5.5. Average production cost

Average production cost equals fixed cost plus variable cost:

Table 4.9: Average production cost benchmarking data

All USc/UEDC	**Peer**	**RSA**	**Natref**	**Δ (Peer)**		**Δ (RSA)**	
Variable cost	19.4	23.0	25.6*	6.2	18%	2.6	8%
Fixed costs	15.1	10.4**	10.1*	-5.0	-14%	-0.3	-1%
Average production cost	34.5	33.4	35.7	1.2	3%	2.3	7%

* Includes projected reduced crude rate (1 USc/UEDC) and increased hydrogen consumption (2 USc/UEDC).

** Includes projected reduction (1.5 USc/UEDC) in fixed costs due to increased throughputs following termination of the Main Supply Agreement.

Since all refineries will be impacted directionally equivalent by a strengthening Rand, the impact there-of is not included in this table.

Given the 2002 benchmarking conditions, Natref's average production cost is approximately 5% better than its Asia-Pacific peers and than that of the South Africa average. However, the combination of the termination of the Main Supply Agreement, the strengthened R/$ exchange rate and the new product specifications will result in Natref's average production cost to be 3% lower than its Asia-Pacific peer group, and 7% lower than the average of the South African refineries.

Whilst the fixed cost is relatively competitive, the variable cost is estimated to be 8% higher than that of the South African average. The biggest contributor to high variable costs is energy consumption.

The fact that Natref is performing poorly in terms of variable cost is non-supportive of being able to increase throughput – it is indicative that marginal variable cost is higher than that of other South African refineries, making it impossible to compete with their marginal production cost. This assumption should be verified since the true marginal variable cost is currently not known.

The production cost must be reduced by 10% to match the average of other South African refineries. Decreasing the energy consumption to 92 EII would reduce the variable cost by 4 USc/UEDC, and the total production cost by 13%.

Reducing the total production cost by 10% is thus not an unrealistic target. It is thus proposed to state as another strategic performance target the reduction of total production cost by 10% over the next three years.

4.5.6. Refinery availability and reliability

Natref achieved 3rd quartile performance in the 2002 Benchmarking study with regards to availability and reliability:

Table 4.10: Refinery availability performance relative to peer group (Solomon, 2003a:D-1)

	First quartile		**Second quartile**		**Third quartile**		**Natref**
	Top	Bottom	Top	Bottom	Top	Bottom	
Mechanical availability (Reliability)	98.1	97.7	97.7	96.7	96.7	96.2	**96.3**
Operational availability	97.6	96.7	96.7	96.2	96.2	95.6	**96.0**

Since refinery availability is critical from both immediate profitability and strategic perspectives, first quartile performance should be targeted. The minimum target for the 2007 financial year should thus be a mechanical availability of 97.7% and operational availability of 96.7%, which would put these performance aspects in the first quartile.

4.5.7. LP-model accuracy

As stated earlier LP model accuracy was not benchmarked. Natref has been evaluating LP model accuracy in terms of volumes and yields. This comparison to date did not include qualities.

The historical accuracy measurement reported an accuracy of around 15 USc/bbl or 1.6 USc/UEDC for the overall modelling of the refinery. This inaccuracy represents <10% of the variable cost, which in comparison with a margin of $5-10/bbl, represents a very small error.

It is thus proposed that an accuracy target of 15 USc/bbl be maintained for LP model accuracy, including the effect of volumes, yields, and qualities.

4.5.8. Capital employed

4.5.8.1. Economically justifiable investments

New investments IRR $\geq$ WACC + 5%

New investments are governed through normal investment process, no additional performance targets are required.

4.5.8.2. Not-directly-economically-justifiable investments

Solomon Associates does not include any benchmarking of any so-called renewal maintenance or SHE investments. Since not-directly-economically-justifiable capital currently forms a big part of the capital expenditure, it is advised that some measure of comparison be developed. TOTAL-group statistics could be applied for this purpose. It is proposed that this be included as a strategic performance parameter.

4.5.8.3. Optimisation of operating capital

Natref's requirement for operating capital compares as follows:

Table 4.11: Operating capital benchmarking data (Solomon, 2003a:D-1)

	Peer	RSA	Natref
Hydrocarbon inventory cost (USc/UEDC)	1.7	1.4	1.1
Maintenance material % of replacement value	0.7*	-	1.0

* TOTAL Group target

Since these parameters compare relatively favourable, no specific performance goals in this regard will be recommended.

5. SUMMARY OF CONCLUSIONS

5.1. Business and technical performance in perspective

- Optimal profit performance is subject to the combination of:
    - Optimal integration, and
    - Optimal relative performance

  of the contributing functional roles. Over-emphasis of one role relative to another inevitably results in lower than achievable long-term profitability.

  Benchmarking of functional technical performance provides an indication of performance of mission critical technical functions, whilst benchmarking of overall financial performance provides an indication of:
    - The combined effectiveness of functional activities, i.e.
        - The effectiveness of integration of functional activities, and
        - The relative emphasis placed on functional activities.
    - The performance of mission critical functional activities.

  As such both business performance and technical performance should be benchmarked, and performance targets for both set.

5.2. Implications of the industry situation

- Sasol operates Natref at minimum capacity, whilst TSA maximises utilisation of its share of Natref:
    - The termination of the Main Supply Agreement combined with the excess of refining capacity in the country, results in Sasol having more production capacity than market share. Sasol thus operate with idle capacity.
    - Since the profit margin achieved by Synfuels is so much better than that of Natref, Sasol will maximise production at Synfuels at the expense of Natref throughput.

- Sasol is obliged to sell petrol at a discount relative to the BFP:
    - The high petrol-to-diesel ratio inherent to the current Synfuels configuration puts Sasol's product offering out of balance with market demand.
    - Petrol export opportunities are limited by logistics.
    - Other producers can alter their product slates to maximise the production of higher margin products. Since petrol typically has a better margin than diesel, this flexibility is to the disadvantage of Sasol.

- The marginal price for petrol production in Sasol's share of Natref is between export alternative and nil refining margin:
    - Other producer-distributors would only cut back own production if offered product at a price that offset their refining margin.
    - Should Sasol manage to transport product to an export facility, e.g. through fungible exchange, export parity pricing could be achieved.

- The marginal value of diesel is higher than the marginal value of petrol for all producer-distributors:
    - If any producer could increase diesel production at the expense of petrol production, it could purchase more petrol at discount relative to the BFP whilst still gaining the refining margin on diesel.

- Although the value of marginal diesel production is higher than that of petrol, diesel cannot be sold for more than the BFP.

- Natref's continuous full utilisation cannot be guaranteed despite expected future market growth:
    - It could be argued that as demand grows, the excess refining capacity in South Africa would reduce up to the point that all South African production facilities are fully utilised.
    - Once the other producers are at maximum production, the need for Sasol to offer discounts on petrol will terminate and industry will have to purchase Sasol's full available petrol production at BFP. At that point would Sasol be able to also sell its Natref production at full refining margin.

- Industry could potentially prevent such a situation by expanding production capacity according to market growth, and through ensuring that the additional capacity have the flexibility of either producing petrol or diesel, so that favourable prices could be negotiated with Sasol. Alternatively, industry could use this potential capability to negotiate better margins on purchases from Sasol.

- Natref utilisation is not optimised in isolation. The shareholders optimise Natref's contribution to maximise their respective profitabilities. Both Sasol and TSA are maximising the production of diesel at Natref despite it having a lower BFP than petrol.

  This implies that Natref's profitability cannot be measured by merely applying average product prices such as BFP or Asia-Pacific standard prices, to its production.

5.3. Maximisation of Natref profitability

It is concluded that the following performance aspects and practices are key in maximising Natref profit maximisation in the next three years:

- Natref's direct role in maximisation of the profitability of operation lies in maximising the operating window for the shareholders, and in executing the optimal production plans of the shareholders. This input, given the market and industry conditions, could be evaluated through the following aspects:
  - Production according to shareholder contracts,
  - Average unit-cost,
  - Marginal production cost,
  - Accurate knowledge of marginal production cost, and
  - Crude valorisation.

- It is critical that the refinery production is in line with the production planned by the shareholders:
    - These volumes are aligned with supply contracts.
    - Especially over-production of petrol or under-production of diesel could result in big losses for the respective shareholders, since these products are respectively in over-supply and under-supply situations.
    - Performance is measured in terms of deviation between planned and actual production of the respective products.
    - Implied is good refinery availability and reliability.

- The average unit-cost is minimised through application of the LP model in a planning mode and an evaluation mode:
    - The shareholders' marketing teams have the objective of finding the highest volume and most profitable outlets for products from the refinery.
    - For a given product demand slate, the refinery is expected to produce it as cost-effectively as possible. Effectively minimising input cost for a given production would maximise profit.
    - This is measured via the Profit Index.

- Defining the true optimal production solution requires that the LP model be:
    - Accurate, and
    - Applied appropriately.

- The accuracy of the LP model is defined in USc/bbl and is targeted to be 15 USc/bbl. Accuracy is required in terms of:
    - Volumes produced,
    - Qualities of products and intermediates,
    - Yields,
    - Average and marginal operating cost, including energy, hydrogen and catalyst consumption.

- LP model results are strongly dependent on the constraints imposed, options allowed and prices used. Care should be taken as to the choice of prices, constraints, and operating window allowed in the benchmarking run.

- As indicated before, the value of neither diesel nor petrol is any longer as per BFP. It is critical to have accurate knowledge regarding the marginal cost of production so as to ensure optimal buy-or-produce decisions and optimal selling prices. To ensure the LP results are valid, it is required that:
    - Marginal prices be used in the LP, and
    - Marginal production cost be used for decision-making.

- Increasing throughput ultimately implies competing with the marginal production cost of competitors, both South African and internationally. Reducing marginal production cost would render Natref more competitive to win tenders. This concept could be extended to marginal profit, i.e. to also include the effect of marginal yields.

- Marginal profit is primarily influenced by the following:
    - Marginal income:
        - Marginal prices,
        - Marginal crude valorisation, and
        - Marginal yields.
    - Marginal costs:
        - Marginal energy cost,
        - Marginal catalyst cost,
        - Marginal hydrogen consumption, and
        - Marginal crude costs.

- Marginal energy consumption varies considerably with throughput. Since energy represents 86% of the variable cost, marginal energy consumption could influence decision-making and as such should be accurately and fundamentally correctly represented in the LP.

  Energy representation should be based on a per process unit basis, so that different utilisations' impact on operating cost be reflected correctly.

- The LP model could be considered the backbone towards optimisation of the refinery. As such the LP should be:
    - Representative of all processing options,
    - Accurate, and
    - Easy to use.

5.4. Benchmarking Natref performance

- Benchmarking of technical aspects of the refinery is relatively easy, and lot's of information and benchmarking indexes are available. However, evaluating the integrated performance of the refinery is much more challenging. There are just too many differences between refineries, specifically their business environments, to effectively compare their business performance.

  Ideally the share price would be a good indication of a refinery's business performance. However few refineries are separately listed, Natref specifically is not separately listed, making this option not possible.

  The benchmarking data offers ROI and refining margin as indicators of integrated performance measurement. The refinery has developed its own measurement, the Profit Index, for evaluating profit realisation. An additional but similar measurement of profit growth, the Profit Potential Index is recommended.

- ROI was evaluated and found to not be suitable for measuring the refinery performance or potential:
    - Approximately 50% of the refineries in the 2002 benchmarking were reported to have $\leq$ 0% ROI. This is not considered realistic. Worldwide investment decisions are based on certain technical expectations that are routinely verified on commissioning the facilities so purchased. These expectations are by exception not achieved. This implies that the profit targets are typically met, and that the majority of ROI's following a project should be within acceptable ranges, for Natref $IRR_{required} \geq WACC + 5\%$, unless market demand/conditions did not realise as expected.

- The general poor ROI results from the benchmarking probably indicate something completely different than general poor refinery performance. It could point to:
    - Over-capacity in industry,
    - A change in industry profitability, e.g. impact of environmental regulation, engine technology, or changed preferences for respective refining products, or
    - A non-representative calculation standard applied.

  Both over-capacity and negative changes in industry profitability would limit entrance of new players or construction of new refineries, and would result in closure of refineries with the lowest true profitability, rather than those with lowest standardised profitability.
- Calculating ROI requires the income generated at the facility under evaluation as input. Since the true value of any type of production is so much influenced by local conditions and opportunities, the use of one standard value per product does not reliably reflect the income decisions made, and would thus not yield a realistic ROI. Crude oil costs represent a major percentage of the input cost, but actual prices paid are not readily disclosed. Standard crude prices assumed could also impact true profitability strongly.
- Natref's situation of maximising diesel production despite it having a lower value than other products so as to maximise shareholder profit, demonstrates that the true value of production rather than standard prices should be used in evaluating ROI.
- As a sensitivity the ROI as presented in the benchmarking data was corrected with more accurate local prices. This increased the perceived profitability performance of Natref from 4^{th} to 2^{nd} quartile. This is clearly not a reliable indicator of performance.
- ROI also require capital invested as an input.
    - True capital invested varies a lot between refineries due to the time value and tax implications there-of.
    - By assuming that the value of the facilities is simply equivalent to the replacement value there-of, it is assumed that the same investment decisions would be made again would it be possible.

This is not true. For example, Natref's recent expansion was based on maximisation of petrol production. The situation at date is completely different, petrol production being minimised. Obviously the expansion decisions and investment would be different for such a scenario. The same is valid for all producers.

- o Existing investments are irreversible. Very little could thus be done to reduce the denominator ("divisor") in the ROI calculation. The only scope for improvement lies in the turnover and cost of production.

It is thus concluded that ROI is not a good parameter for evaluating short-term performance of the Natref refinery.

- Refining margin is a parameter which is applied in an attempt to normalise out the effect of capacity utilisation, since capacity utilisation is considered in the control of the shareholders and greater industry influences. Refining margin however remains dependent on selling prices achieved, and fixed cost is allocated to the volume sold. Although refinery personnel can influence refining margin, refining margin also varies due to influences outside the control of refinery personnel. It is recommended that the refinery's input on maximising refining margin be driven through the Profit Index, and reduction of fixed cost, variable cost and marginal cost respectively.

- The Profit Index is currently applied at Natref to evaluate profit realisation. The Profit Index is defined as the ratio of actual profit to the optimum considered possible as defined by the LP model. The target assumed for the Profit Index is 98%, which is similar to the accuracy of the LP model and thus considered stretching.

When calculating the Profit Index, the impact of primary deviations, both positive and negative, from the optimal retro-active solution should be identified and managed:

- o Production costs e.g. energy and hydrogen,
- o Product yields, and
- o Production unit availability.

The following best practices are required for driving profitability through the Profit realisation index:

- LP model accuracy demonstrated with regards to relevant aspects:
- Process of identification of deviations between that considered realistically possible vs. that actually achieved to be:
  - Comprehensive,
  - Credible, and
  - Accepted by refinery personnel
- Must be quantifiable on as short as possible periods, minimum frequency monthly so that positive and corrective action plans could be developed as a result there-of,
- Must consider all aspects within the control of the refinery.

Although not part of the scope of this study, the same methodology and principles could be applied by the Shareholders to evaluate those aspects within their control.

- The Profit Potential Index is proposed as measurement of continuous improvement, and is intended to define the combined impact of all improvement effort. For example when improvements are made to reduce energy consumption, this index will show the net impact there-of. Similarly for improvements such as improved diesel-to-petrol-ratio, hydrogen recovery, reduced hydrogen demand, new catalysts, better availability, reduced fixed costs, better yields, higher productivity, or reduced operating capital.

  Key is that this index should reflect the impact of all relevant improvements over a year period.

- Return on additional capital invested is optimised through ensuring that:
  - Economically justifiable projects meet profitability hurdle rate,
  - Not directly economically justifiable capital such as SHERQ projects and renewal maintenance is optimised both in terms of need there-of and cost there-of,
  - Working capital is limited and justified.

5.5. Benchmarking results

- No conceptually acceptable benchmarking information on the over-all profitability of the refinery is available. The best alternative is application of the Profit Index and Profit Potential Index.

  The Profit Index is targeted at 98%, which is considered stretching but achievable.

  The Profit Potential Index is targeted at ≥3% per annum. Growth in profitability of 3% per annum, given the industry situation, is quite ambitious and as such considered a stretching performance goal.

- The variable cost incurred by Natref and the other South African refineries is substantially higher (± 22%) than that incurred in the peer-group:
  - The primary deviation is energy consumption, for which both Natref and the South Africa–average consumption is ± 21% higher than that of the peer group, and accounts for 18% of the total deviation in variable cost of 22%.

    In terms of amount of energy, Natref consumes 36% more than the peer group (worst performance in group), but its unit cost of energy is only 89% of the peer group. In terms of units of energy consumption Natref's performance is the worst in the whole peer group.

    The low price of energy is a competitive advantage for Natref, but is off-set by poor unit consumption.

  - The secondary contributor to higher than peer variable cost lies in catalyst expenses, for which Natref consumption is double that of the peer group, representing 6% of the total variable cost deviation of 22%.

    The relatively high catalyst expense could be fundamentally explained by Natref's high white product yield, which in turn is driven by location and absence of fuel oil markets. Routine catalyst selection processes are sufficient to optimise catalyst expenses. No strategic action regarding catalyst expense improvements is thus recommended.

- Natref must improve energy volume consumption to 97 EII points to render its total energy expense equal to the projected 2007 average of its Asia-Pacific peers. The best EII performance in the peer group in 2002 was an EII of 70 – still much beyond the target set for Natref for 2007.

Natref has recently achieved EII around 110. To achieve 92 EII by end of June 2007 requires reducing the EII by 6 points per year:

Table 4.4: EII improvement target

April to June 2005 average EII	104
April to June 2006 average EII	98
April to June 2007 average EII	92

Projects required to reduce the EII to the target stated must comply with the investment payback target of WACC+5%. In the light of the relatively low unit cost of energy at Natref, it can be expected that it may be difficult to achieve WACC+5%. It is thus proposed that it be allowed that energy projects cross-subsidize each other, i.e. that the annual composite return on energy investment yield WACC+5%.

- Natref's fixed cost expenses were 40% lower than the average of the peer-group:
  - The primary contributor for this is personnel expense where Natref's expenses are 24% less than peer group. This is despite the fact that Natref's personnel index compares badly with that of the peer group, having between 40-50% higher personnel requirements. The perceived good performance is however strongly dependent on R/$ exchange rate. Personnel index is thus another area of potential for Natref.
  - Natref also performed well in terms of the T&I adjustment, indicating good performance with regards to run length between planned unit shutdowns.
  - The only aspect of fixed costs where Natref was not well rated was for insurance cost. The cost incurred was more than double that of its peer group and of the other South African refineries. Since the relative complexities are not that much different, there must be another reason for this high cost, and as such it should be investigated and motivated.

- The total cash cost, i.e. the combined fixed and variable cost, is 3% and 7% higher than that of the peer group average and other South African refineries respectively. This performance will deteriorate due to the termination of the Main Supply Agreement, clean fuels legislation, and a strengthening Rand.
  The production cost must be reduced by 10% to match the average of other South African refineries, including the effect of MSA and new product specifications included. Decreasing the energy consumption to 92 EII would reduce the variable cost by 4 USc/UEDC, and the total production cost by 13%.

  Reducing the total production cost by 10% is thus not an unrealistic target. It is thus proposed to state as another strategic performance target the reduction of total production cost by 10%.

- Refinery availability and reliability is critical towards maximising turnover. Natref's performance in the 2002 benchmarking was rated as 3rd quartile with regards to availability and reliability:

  Since refinery throughput and stability is so critical, from both immediate profitability and strategic perspectives, first quartile performance should be targeted. The minimum target for the 2007 financial year should thus be a mechanical availability of 97.7% and operational availability of 96.7%, which would put these performance aspects in the first quartile.

5.6. Crude slate optimisation

- Crude cost represent ± 90% of the overall production cost, and is thus a key aspect in the profitability of the refinery:
  - Yet the refinery has only indirect input in optimising the crude slate, specifically through managing the LP model.
  - Crude purchase decisions are based on its valorisation, i.e. the estimated production expected out of such a crude, combined with the value of such production.
  - The value of any crude depends on the product slate required, the throughput of the refinery, the type of crude being processed and the processing option selected.

- Since each shareholder purchases their own crude, have different product slate preferences, operate the refinery at different throughputs, and for each shareholder these change from scenario to scenario, it is not possible to calculate a standard value for each crude. There are an infinite number of combinations and scenarios.
- The way this information, including crude valorisation, production cost optimisation, and marginal production cost, is made available to the shareholders is through the use of the LP model.

The accuracy, flexibility, and ease of use of the LP model would thus be of critical importance for the shareholders. The refinery should ensure that this limited input, i.e. the number of crudes represented in the LP, and the accuracy there-of, is optimised.

Consideration should also be given towards greater input in defining the optimal crude slate.

One route is through defining the optimality of chosen crudes for the combined operation of the two shareholders. The greatest shortcoming in evaluating crude selection is the availability of crude prices. The current practice between the two shareholders is one of non-disclosure of actual crude prices. More openness in this regard would not only enable each shareholder to negotiate better crude prices, but would enable true evaluation of crude processing decisions.

Another route could be that each shareholder individually retro-actively evaluate their crude selection, and define the deviation from optimal profit in USc/bbl. This evaluation would highlight opportunities to each shareholder itself. Communicating this result to the refinery and the other shareholder will enable benchmarking with the other shareholder, and will create understanding towards strategies and opportunities with refinery personnel.

5.7. R/$ Exchange rate

In the 2002 benchmarking study (Solomon, 2003a:D-1), the R/$ exchange rate was R10.54/$. This benefited Natref benchmarked performance in terms of Rand expenses, e.g. personnel costs. Given the current strong performance of the Rand, it could be expected that such parameters will show deteriorated performance in future benchmarking relative to the costs of peer-group. It must however be considered that all South African producers are subject to the influence of a stronger Rand exchange rate.

5.8. Engen-merger

In general the arguments stated carry for the proposed Engen-merger as well. In the event that the merger takes place, the Engen facility would become one of the production facilities in the decision matrix. Synfuels would remain the lowest cost producer, and its production would be maximised at the expense of the combined Natref/Engen production. Production at Natref and Engen respectively will be based on the marginal profit gained from the respective productions. A big change however is direct access gained to export logistics, which could be used to limit prices to export alternative and could be used to increase the throughput at the Natref and Engen refineries.

6. RECOMMENDATIONS

6.1. Performance targets

It is recommended that the following refinery-wide performance targets be included in the three-year performance improvement plan:

6.1.1. Profit Index ≥ 98%

The Profit Index is subject to:

- Achieving a LP model accuracy of 15USc/bbl,
- Application of marginal product values,
- Application of true bulk product values, and
- A comprehensive, credible, and accepted process for defining the Profit Index.

6.1.2. Total cash cost, excluding crude price effects, to be reduced by PPI-10% by June 2007, i.e. 3.3% annually. Dollar costs and Rand costs to be considered separately.

6.1.3. Fixed costs in absolute terms to grow at PPI-1% composite up to June 2007. Dollar costs and Rand costs to be considered separately.

6.1.4. EII to be reduced by 6 points per year. This will result in a 92 EII by June 2007 (basis 80% utilisation):

- Apr – Jun 2005: 104 EII
- Apr – Jun 2006: 98 EII
- Apr – Jun 2007: 92 EII

6.1.5. Mechanical availability ≥ 97.7%:

- Jun 2005: 96.7%
- Jun 2006: 97.2%
- Jun 2007: 97.7%

6.1.6. Operational availability ≥ 96.7%:

- Jun 2005: 95.7%
- Jun 2006: 96.2%
- Jun 2007: 96.7%

6.1.7. Profit Potential Index growth ≥ 3% per annum.

6.2. ROI and Refining margin

It is recommended that ROI and refining margin not be applied as refinery performance parameters for the period under consideration.

6.3. Profit maximisation practices

In addition, the following practices are recommended to improve the net profitability and value addition of the refinery and team:

6.3.1. New parameters should be developed to enable true benchmarking of profitability between refineries in different situations. Ideally these parameters must be included in the benchmarking done by Solomon Associates so as to maximise the width of the benchmarking.

6.3.2. Since additional sales volumes depend to a large extent on marginal production cost, additional focus should be placed on using, defining, and driving marginal production cost.

6.3.3. Modelling of energy consumption in the LP model must be revised to a per-process-facility basis, combined with base and marginal consumption. This will facilitate improved accuracy in estimating marginal energy consumption.

6.3.4. Since not-directly-justifiable capital represents a large percentage of the annual capital budget, it is recommended that not-directly-justifiable capital expenditure be benchmarked.

6.3.5. Since variations in the R/$ exchange rate influence comparative results strongly, it is recommended that $ expenses and Rand expenses be categorised in the costing system so that the impact of changes in the exchange rate could be effectively identified and interpreted.

6.3.6. Due to the large contribution of crude cost to the overall processing cost, consideration should be given towards greater input in ensuring the optimality of crude processing decisions:

- Firstly the refinery should ensure that its current limited input, i.e. number of crudes represented in the LP, and accuracy of the LP, is optimised,
- Consideration should also be given towards greater input in defining the optimal crude slate. Possible approaches are:
    - Natref retroactively evaluating the optimality of crudes chosen,
    - Shareholders retroactively evaluate their own crude selection, and define and communicate the deviation from optimal profit.

It is recommended that a combination of these two options be implemented.

6.3.7. The Profit Index methodology and principles could be applied by the Shareholders to evaluate those aspects within their control.

Given these key performance aspects, its associated interim and three-year performance targets and supporting profit maximisation practices, it is recommended that specific persons be made responsible for driving achievement of the targets. Strategies, implementation plans, resources required and progress measurement for realising the targets have to be compiled and implemented under guidance of the drivers so appointed. Since three years pass so quickly, it is recommended that appointment of the drivers be completed within one month, and that they in turn present the relevant strategies, implementation plans and resources required within three months after their appointment.

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