Electricity Pricing and Supply

With special attention to the impact on employment and income distribution

Final Report

Project Team

Dr Miriam Altman
Executive Director
Centre for Poverty, Employment and Growth
Human Sciences Research Council (HSRC)

Howard Harris, Andries van der Linde, Dave Fleming
WSP Energy Group Africa

Prof. Rob Davies
Dirk van Seventer
Research Associates
Centre for Poverty, Employment and Growth, HSRC

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Produced by: Dr Miriam Altman, Prof. Rob Davies, Howard Harris, Andries van der Linde, Dave Fleming
Contact: Dr Miriam Altman, Executive Director: CPEG, HSRC
E-mail: maltman@hsrc.ac.za
Tel: +27 12 302 2402

Contents

Tables

Figures

Acronyms

BUSA	Business Unity South Africa
CCGT	Combined cycle gas turbine
CFL	Compact fluorescent light/bulb
CIP	Critical Infrastructure Programme
COFIT	Co-generation feed-in tariff
CPI	Consumer Price Index
CSIR	Council for Scientific and Industrial Research
CTCIP	Clothing and Textile Competitiveness Improvement Programme
DBSA	Development Bank of Southern Africa
DoE	Department of Energy
DME	Department of Minerals and Energy
DSM	Demand side management
DTI	Department of Trade and Industry
ECS	Energy Conservation Scheme
EE	Energy efficiency
EEMP	Energy Efficient Motors Programme
EESP	Energy Efficiency Stimulation Programme
EIP	Enterprise Investment Programme
EITT	Economic Impact Task Team (of the NERT)
EIUG	Energy Intensive Users' Group
FBE	Free basic electricity
GDP	Gross Domestic Product
GJ	GigaJoules
GW	Gigawatt
GWh	Gigawatt Hour
HSRC	Human Sciences Research Council
HVAC	Heating, ventilation and air conditioning
IDC	Industrial Development Corporation
IPP	Independent power producer
IRP2010	Integrated Resource Plan 2010
kVA	Kilovolt Ampere
kW	Kilowatt
kWh	Kilowatt Hour
LED	Light-emitting diode
LRMC	Long- run margin cost
MW	Megawatt
MWh	Megawatt Hour
MTRM Plan	Medium Term Risk Mitigation Plan
MYPD	NERSA Multi-Year Price Determination
NERSA	National Energy Regulator of South Africa
NERT	National Electricity Response Team
NRF	National Research Foundation
OCGT	Open cycle gas turbine
PCP	Power Conservation Programme
PII	Partnership in Industrial Innovation Programme
R&D	Research and development
RAB	Regulatory Asset Base
RE	Renewable energy
REFIT	Renewable energy feed-in tariff
REPSO	Renewable Energy Project Support Office
SAM	Social Accounting Matrix (Quantec 2010)
SARS	South African Revenue Service
SASID	South African Standardized Industry Database
SDC	Swiss Development Corporation
SIC	Standard Industrial Classification

SMMEs	Small, medium and microenterprises
SPII	Support Programme for Industrial Innovation
StatsSA	Statistics South Africa
SWH	Solar water heater/ solar water heating
THRIP	Technology and Human Resources for Industry Programme
UNIDO	United Nations Industrial Development Organization
Tj	Terajoule

Executive summary

Electricity has historically been cheap in South Africa and, until recent times, plentiful. Industries that are energy-intensive such as smelters have been encouraged, and there has been little incentive for energy efficiency. Rolling blackouts in 2008 brought the true state of electricity supply to public attention, with serious implications for the economy arising just at the onset of the global economic crisis. Most seriously affected were firms supplied directly by Eskom, especially the smelters and the mines.

In 2008, the Human Sciences Research Council (HSRC) prepared independent recommendations on an appropriate price path for electricity charged by Eskom, keeping in mind the needs of both the economy and Eskom itself. The context was one of electricity shortages, mostly caused by underinvestment and poor management of coal stocks. It became clearer to the public and policy makers that some critical decisions were needed to overcome these challenges. This included decisions required by the National Energy Regulator of South Africa (NERSA) on the electricity price. The Presidency and the National Electricity Response Team (NERT) required support to form a view on an appropriate approach to raising the price to cover costs. This was regarded as an important contribution by an institute that does not have a vested interest in the outcome.

Since then circumstances have changed, especially with the global economic slowdown. In addition, new information is continuously coming to light in a context that has, until recently, been characterised by very limited knowledge-sharing. Further, it appears that South Africa's 'electricity crisis' will not go away soon. In 2008, when the electricity shortages came to light, there were deep concerns about the effect on potential economic growth. There was a respite as the pressure on electricity supply waned due to the global economic recession in 2009 and 2010. From a peak of 21 780GWh in July 2007, electricity consumption fell dramatically to a low point of 18 668GWh, but recovered to 21 316GWh by July 2010 (Stats SA 2009–2010).

There have been questions about the approach to rationing electricity and its price. The HSRC study in 2008 recommended that electricity not be rationed, but instead that the price should increase over time in a way that sets expectations and therefore encourages firms and households to improve efficiency. The policy approach has included the announcement and implementation of a known price path over three-year periods (although not always implemented as announced by municipalities), 'carrots' (incentives for improved efficiency), and 'sticks' (disincentives such as the Power Conservation Programme). Industry rationing is part of the policy mix, requiring a trade-off between existing operations, expansions and new investments.

It has taken some time to implement these policy elements, especially those related to sticks and carrots, and so this study in part aimed to explore the extent to which firms implemented efficiency improvements since the electricity crisis, and what their plans are going forward. We wanted to find out which policy elements have most impact on behaviour.

In terms of economic impact, improving energy efficiency could have a major impact on promoting productivity growth, even if there were no supply shortages. However, in the context of the shortages, the faster firms adapt and improve energy efficiency, the less the impact of shortages will be on price levels, output and employment. There is a real concern that rising electricity prices will encourage firms to instead shut down production or contain expansion, with associated downstream impacts on economic growth and employment. In addition, industry informants say they are currently rationed in a number of ways. The implications for employment outcomes should be assessed.

There are a range of recent policies that may impact on energy use and efficiency. These include the Multi-Year Price Determination (MYPD), reviewed annually by NERSA; the feed-in tariffs that would be paid by Eskom to co-generators and independent power producers (IPPs) (which are usually renewable energy sources); the introduction of measures to promote energy savings; the approach to rationing electricity when there are shortages; the extent to which firms generate their own energy; and, finally, future plans for the mix of electricity generation sources as proposed in the Department of Energy (DoE)'s draft Integrated Resource Plan (IRP2010). The National Economic Development and Labour Council (NEDLAC) recently completed a detailed document reviewing approaches to pricing for the poor (NEDLAC 2010).

The Integrated Resource Plan 2010 (DoE 2010a) was issued for comment in October 2010. Its aim is to 'determine long term electricity demand, and detail how this demand should be met in terms of generating capacity, type, timing and cost' (DoE 2010a, p. 1). Seventeen scenarios are compared and ranked based on their costs, impact on climate change mitigation, localisation and job creation potential, regional development impacts, diversity of energy sources and security of supply and energy efficiency. The document proposes a 'Revised Balanced Scenario' for energy mix. This would involve a mix of new generating capacity to be installed after the current coal 'build'. The additional generating capacity would be comprised mainly of renewables (33%) and nuclear power (25%), complemented by gas-fired generating facilities.

This report updates this work done in 2008 to take account of changed circumstances and improved knowledge to make it more accurate. The aim is to see how changed circumstances might influence Eskom's price and policy choices, and how the chosen price path might affect the economy, employment and incomes.

A critical component of this analysis is to explore the potential impact on poor households. In this, we reflect on the distributional impact of policy choices in respect of electricity. Often this is understood to mean the direct impact of rising electricity prices paid by the poor. Yet this is only one half of the challenge. The other half relates to employment creation, and price increases created indirectly where the price of goods normally bought by poor households rise disproportionately as firms pass on their electricity price increases.

The first part of the project focused on updating our work on the potential impact of the price path on the economy, employment and distribution of income. In this, we faced a critical challenge as we had deep concerns about the quality of energy data currently available (see Appendix 1b).

The second part of the project updated our work on industrial responses. It is now three years since the initial load-shedding events of 2008, shortages are still felt, and further shortages are looming on the horizon. Government and Eskom have honed in on some policy offerings to encourage savings. Firms have now had time to respond, and more actors have factored in the inevitability of electricity price increases. We need to see how far companies have gone with respect to changes in their expectations and consider how this may have affected their plans for the future. Three industry focus groups were held to canvass experience and perceptions and to validate sector trends, especially in the mining, manufacturing and commercial sectors.

Finally, we updated our financial model to build a view to 2025 in order to consider the likely impact of electricity pricing on Eskom's sustainability going forward.

Some of the critical points which emerge in this report are summarised below.

- NERSA ruled in 2010 that the nominal electricity price should rise by about 25% per annum over the coming three years covered by MYPD2 (the second price determination).

- We modelled the impact of a once-off price increase of 35%, which was what Eskom asked for in November 2009. The impact on Gross Domestic Product (GDP) would be very small, approximately -0.1%. The producer price index would rise by 1.3% more than it would otherwise, and this would raise the cost of a representative basket of South African exports by 0.9%. At first glance, this result might seem surprising. But it must be remembered that electricity accounts for only 1.1% of all costs in services and manufacturing. Electricity contributes 2% or less to total costs in 72 out of 94 sectors in the economy. There are ten sectors where electricity accounts for about 4% of costs or more, such as chemicals, non-ferrous metals, general hardware, textiles, tyres, gold mining, and accommodation.

- We looked at the impact of a once-off 25% increase in the electricity price. In this case, the Consumer Price Index (CPI) for all households rises by 0.88%, with 0.53 % coming from direct effects and 0.35% from indirect effects. The impact is greater on poor households than on rich ones. This is driven almost entirely by the direct impact, which in turn is driven by the relative shares of total expenditure on electricity. Thus the richest households allocate 0.8% of their expenditure to electricity, so the 25% price rise raises their expenditure by 0.2%. By contrast, the poorest households spend 5.4% of expenditure on electricity, so the 25% increase raises their expenditure by 1.35%. Against this, the indirect effects are relatively uniform across household groups, contributing 0.40% to the CPI increase for the poorest and 0.32% to that for the richest.

- In its 2010 MYPD2 ruling, NERSA provided guidelines for acceptable tariff revision for municipalities. NERSA has surveyed municipal prices and this review process has shown that many municipalities are raising the electricity price well beyond this ruling. We drew a sample of 25 municipalities and found that their electricity tariffs for small firms rose by 39% to 90% over the period from October 2008 to November 2010. Based on Treasury and NERSA guidlelines, it would be expected that municipal electricity rates might have increased by 49% to 59% over this period. Twelve (12) of these municipalities raised their small business tariff by 60% to 90% over this period. In addition, the starting price is already considerably more than that charged directly by Eskom. Half of the municipalities reviewed charged more than 150% of the Eskom rate. For example, in November 2010, Eskom charged 49c per kWh to small businesses, whereas Cape Town, Johannesburg (City Power), and Ethekweni respectively charged 77c, 88c, and 84 c per kWh. Perhaps reflecting the character of its energy intensive business in Ekurhuleni, the rate was lower than many of the others at 63c per kWh. The municipalities rely quite heavily on cross-subsidies from electricity revenue. However, these increases may have the impact of slowing investment and employment growth, especially in weaker regions.

- In terms of pricing and services for the poorest households, there has been some debate about whether municipalities are applying guidelines in respect of free basic electricity or on pricing. We called a sample of 44 municipalities and found only 10 providing free basic electricity. We also scanned tariffs for low-income consumers in these same municipalities (with information provided by NERSA). The tariffs for those consuming less than 50kWh per month varied between 41c/kWh and 91c/kWh, but mostly fell into the range of about 60c to 75c. The tariffs for those consuming 51kWh to 150kWh/month ranged from 42c to 92c/kWh, although mostly they charged between 65c and 85c. NERSA began gathering information on municipal pricing in 2010, and should do the same for the provision of free basic electricity. This is long overdue and the regulator should be encouraged to sustain this survey.

- The WSP Energy Group Africa/ Human Sciences Research Council (WSP/HSRC) model of Eskom's financial status under different scenarios was further revised for this project, to update assumptions in a changing economic environment, to account for policy changes, and to extend it to 2025. The IRP2010 base assumptions are used, such as plant costs, operating costs, load factors, etc. The research team engaged with Eskom and an expert roundtable was held in October 2010 in respect of assumptions on the inputs to the model. In addition, the model now offers: an industry-wide financial model of Eskom and IPPs to show viability of different options/paths; a long-run margin cost comparison; extensive user input fields for scenario planning; and result outputs that are easy for many stakeholders to relate to. The test of the model was the closeness to the IRP2010 outcome on pricing, which we found to be strong.

Two scenarios were produced, which compare the IRP2010 balanced scenario with the introduction of some 4 500MW of independent wind generation, and a pricing progression of five increases each of 25% from 2010 and subsequent years. The alternative scenario adds an extra 700MW of wind as early as can be achieved to alleviate short-term power shortages. We also assume there is an extra co-generation of 1 460MW via a COFIT [Co-generation Feed-In Tariff] programme based on pricing equal to the long-run marginal cost for new coal. Finally, we assume the earlier retirement of one coal unit.

Eskom targets financial ratios appropriate for a public listed company, and it is worth asking if these are the appropriate ones for a state-owned monopoly with certainty of demand. Nevertheless, the focus of our results is on whether the proposed price increases would enable Eskom to achieve stated targets of profitability, interest cover and debt:equity ratios. Eskom is targeting an interest cover of 3.0 and debt:equity ratios below 200%.

The IRP2010 scenario has the real compound price of electricity rising by 265% between 2008 and 2019. The unit price increases to R1.20 by 2019. Interest-bearing debt peaks in 2014 at R275 billion and falls to R90 billion by 2020. This price increase would result in losses after tax and interest until 2012, whereafter net profit rises to R82 billion by 2020. Interest cover rises to 2.0 by 2013 and reaches 5.5 by 2018. The debt:equity ratio falls to below 200% by 2014, and to extremely low levels thereafter. It would appear that these price increases very quickly return Eskom to its required ratios within a very short space of time. A judgement is needed in respect of whether this pace of recovery warrants the very large annual price increases being introduced. It does certainly seem that the price should be reduced in real terms from 2016.

In the alternative scenario, interest-bearing debt peaks in 2014 at R270 billion, and falls to R215 billion by 2018. Profit after tax and interest is negative in 2012, but rises above R10 billion in every subsequent year, reaching R51 billion in 2018. Interest cover is above 2.0 in most years and reaches 3.0 by 2016. The debt:equity ratio falls below 200 by 2014, and to extremely low levels quite quickly.

- Economic and employment growth are likely to be hampered by electricity availability, at least until 2016. The Medium-Term Risk Mitigation (MTRM) Plan was issued to promote discussion in respect of options for electricity security to 2017. The Plan shows a potential shortfall that would mostly be filled by the feeding in of independent power producers and by co-generation. However, the IPPs and co-generators are being signed up too slowly to fill the gap timeously. Should the gap in electricity supply not be filled, as seems likely, rationing will be necessary. There is a trade-off between supplying existing businesses, business expansions, or new investments. Currently, the simplest route is to ration highly energy-intensive companies directly supplied by Eskom, generally the smelters and the mines. Government faces a legal challenge as it cannot legally deny a new investor access to electricity. However, our focus groups showed that, in practice, the municipalities are delaying approval for new connections to large new investments and expansions. The slow sign up of cogenerators and independent producers will lead to a heavy reliance on the Energy Conservation Scheme and associated rationing going forward. While energy efficiency may rise as a result, in this short period it is more likely that this rationing will lead to lower than potential output. This will most certainly dampen potential growth and employment at a time when it is sorely needed. This approach is most certainly not consistent with the aims of the Growth Plan, and will make it virtually impossible to achieve its targets. This is explained by the compound employment and output growth – if growth is constrained for 5 years.

- A central policy question asks why the process of procuring energy and efforts to promote energy efficiency have proceeded so slowly. It does appear that the economy and employment will be dramatically constrained at least until 2016, unless more meaningful steps are taken. The steps to be taken are known, so the problems may lie in the process of decision making. While not the subject of this study, a number of concerns can be proposed based on extensive interaction with different stakeholders. The first challenge for rapid and meaningful action seems to lie in the complex and dispersed decision making structures in government, with the Department of Energy setting policy, Nersa regulating, the Department of Public Enterpises as the shareholder, and dti or Treasury having some responsibility for energy efficiency incentives and Eskom financing. The second set of issues relate to the role Eskom plays. It is currently a crucial source of information for decision making, and yet is also a monopoly provider. It is meant to expand the base of energy generation, but at the same time sign on external providers and encourage energy efficiency. It may be conflicted in this role, since it is an investor and provider, but also is meant to be responsible for drawing in competing generators and promote energy saving. Third, Eskom has stated a concern in being able to sign long term power purchasing agreements in the context of three year pricing determinations by Nersa. In turn, independent suppliers are not incentivised to enter the market without long term certainty that the power will be purchased, since currently Eskom is a monopsony as well as a monopoly. There are plans to move power procurement out of Eskom and into an Independent Systems Marketing Operator (ISMO). This is informally being done for REFIT purchases from the DoE but with oversight of DoE and Treasury. It is intended that the ISMO would procure and sign up the independent producers. A long term approach to pricing, giving an approach for a minimum of ten years is nevertheless required to offer certainty.
- Improving energy efficiency is one way to reduce pressure and ensure more energy is available. Certainly, the IRP2010 and the Risk Mitigation Plan rely heavily on improved energy efficiency. This would be beneficial as, in 2007, SA ranked 34th out of 128 countries in terms of energy to GDP ratios. This intensity arises as a result of the industrial composition, as well as energy inefficiency. The evidence points to firms having already introduced energy efficiency measures prior to the major price increases and the blackouts. We wanted to see whether firms are reacting more forcefully now that the challenges and opportunities are clearer. We held focus groups with three sectors (namely energy intensive users, mixed industries including agriculture, and property). While the energy intensive users are understandably well coordinated and clearly representing their interests, other sectors are aware of the issues but not nearly as well represented. Some common issues arise such as whether firms will cut back operations in response to price increases and rationing, or whether they will adopt more efficient processes and technology. The investment costs have to be weighed up against the challenges experienced in the economic downturn, especially in low margin industries such as agriculture. The property sector has a special challenge as owners and managers are not the end users, and an estimated 40% of electricity usage is controlled by the tenant. In SA, properties change hands regularly, and the lease periods also tend to be short by international standards: this reduces the incentive to invest in energy efficient measures. Municipal shortages are slowing down new and expanded investments: many municipalities find they are unable to supply large investments. The diffusion of knowledge on process and physical technologies for energy efficiency will be of benefit. The Energy Services Companies (ESCO's) are meant to assist in this regard, however some respondents believed they were too vested as they were sometimes linked to vendors.
- There are a number of policies that could impact on improving energy efficiency – some carrots and some sticks. In the first instance, the rising price will have an impact, potentially reducing consumption by 15% according to the IRP2010 (Table 18). A suite of tax and cash incentives have been introduced, but still have to be tested. The broad range of relevant incentives are reviewed in secton 10 of the report. In 2010, the dti announced the a tax allowance incentive (Section 12 i) aimed at supporting new and expanded investments in manufacturing. This can

include an upgrade involving clearner production technology or improved energy efficiency. The value of this incentive could be as much as 35% to 55% of an investment. A new energy saving tax allowance investment incentive (Section 12 L) is still to be introduced, but it is said that it will be calculated on the basis of the amoung to energy saved. These incentives are to be welcomed, although they are being introduced at a slow pace. Incentives often require some time for diffusion, and this can take a number of years. Smaller manufacturing firms can already benefit from the dti's Enterprise Investment Programme, which can cover a substantial portion of the capital costs in a new or expanded investment. Of course, there are other programmes such as Eskom's Demand Side Management programme. Support will be needed for a wider range of industries, including property and accommodation. The dti will need to actively promote the effective use of these incentives, ideally in conjunction with technical support and knowledge diffusion in respect of new physical and process technologies. While a strong Rand works in favour of new technology adoption, the economic downturn mitigates against new investment and expansions.

- The National Treasury issued a discussion document in December 2010 proposing the introduction of a tax on CO2 emissions. It proposes that a tax of "R75 per ton of CO2, with an increase to about R200 per ton CO2 (at 2005 prices) would be both feasible and appropriate to achieve the desired behavioural changes and emissions-reduction targets" (National Treasury 2010). The document says that a carbon tax of R200 per ton CO2 would translate into an additional electricity price increase of 20c per kWh. If the tax started at R75 per ton, it might be presumed to translate into an additional electricity price increase of 7.5c per kWh. The burden of reducing emissions should naturally fall on the largest contributors to the problem, and Eskom certainly falls into this category. Eskom generates 47.6 % of SA's CO2 emissions. However, the context is one where the price of electricity is already being raised substantially, and a tax of 2c/kWh had already been introduced in July 2009. The price increases will in themselves encourage energy efficiency. An additional price increase, which is not aimed at solving the energy security challenge, will make SA's economic and employment growth objectives more distant. In this instance, it may be more sensible to guide the balance of energy investments, whether in coal, nuclear or renewables, going forward through the IRP process, rather than to raise the price.

- Data from the Department of Energy shows that many industries were already improving their energy efficiency, even in the context of low prices and prior to the energy crisis in 2008. This effort to reduce energy usage became more intense and explicitly discussed from the period of the 2008 rolling blackouts with the aim of enabling Eskom to stabilise the grid. There is uncertainty about the cause of the drop in energy intensity. In this report, possible reasons indicated in the data are considered. Below, we review more specific possible contributors to changing behaviour in electricity consumption. Eskom and the Department of Energy are relying heavily on the possible improvements in the efficiency of electricity use, as part of the overall IRP2010 and Risk Mitigation Plan to 2017. Voluntary reductions in energy usage continue to be implemented in 2010 by some industries prepared or able to cut back on production. The sacrifice of some industries is at the present time enabling the supply of other industries. Some firms say they are not in a position to implement expansion plans as result of a lack of availability of an electrical connection. Eskom expects that its Demand Side Management (DSM) programme will have brought about the reduction in demand by approximately 1 000MW between 2008 and the end of 2010. The adequacy of accelerated DSM savings to ameliorate a serious electricity supply shortage is explored, and the value of other generation measures proposed in the MTRM Plan are highlighted below.

- From an economic perspective, and in terms of the impact on poor households, a move toward greater levels of energy efficiency and a lower energy usage per unit measure of national output would be a contributor to generating a labour bias in the economy. Productivity and efficiency improvements can encourage growth and employment. South Africa's energy intensity biases the economy towards capital-intensive investments. Firms might improve their efficiency in response to the substantial price increases, or they might take advantage of the emerging support measures available to improve their technology or processes. However, as noted, if electricity consumption is reduced as a result of containment of output, expansions or new investments, this will have a negative knock-on effect on potential growth and job creation.

- Therefore, Eskom pricing is currently not the most critical issue affecting employment and incomes going forward. This is because a regularised price path has been determined that does not follow the original requests for large once-off leaps. The impact on GDP and employment for each increase is relatively small. Two critical issues stand out for attention: the first is the extent to which municipalities comply with NERSA rulings on price determinations. Second, is the security of power supply. These two factors could pose ***the most critical physical barriers to new investment, growth and employment.*** This is what should be receiving the lion's share of attention.
- Tracking energy intensity across the economy will be an essential part of monitoring of behaviour change. Yet the data gathered by the Department of Energy does not currently seem to reflect trends correctly. Our view on this emerged from a first scan of the figures, but also as a result of the interaction with firms. It is recommended that more reliable electricity consumption data be gathered.

1 Introduction

In 2008, the HSRC prepared independent recommendations on an appropriate price path for electricity charged by Eskom, keeping in mind the needs of both the economy and Eskom itself. The context was one of electricity shortages, mostly caused by underinvestment and poor management of coal stocks. It became clearer to the public and policy makers that some critical decisions were needed to overcome these challenges. This included decisions required by the regulator, NERSA, on the electricity price. The Presidency and the National Electricity Response Team required support to form a view on the appropriate approach to raising the price to cover costs. This was regarded as an important contribution by an institute that does not have a vested interest in the outcome.

Since then circumstances have changed, especially with the global economic slowdown. In addition, new information is continuously coming to light in a context that has, until recently, been characterised by very limited knowledge-sharing. Further, it appears that South Africa's 'electricity crisis' will not go away soon.

This report updates this work done in 2008, taking account of changed circumstances and improved knowledge to make it more accurate. The aim is to see how changed circumstances might influence Eskom's price and policy choices and how any price path might affect the economy, employment and incomes.

A critical component of this analysis is to explore the potential contribution of decisions being made in the electricity sector on government's objective of sustainably reducing unemployment and poverty. Often this is understood to mean the direct impact of rising electricity prices paid by the poor. Yet this is only one half of the challenge. The other half relates to employment creation, and price increases created indirectly where the price of goods normally bought by poor households rise disproportionately as firms pass on their electricity price increases.

In this report, we do not invest substantial effort in analysing direct impacts, since NEDLAC produced a detailed report to review the approach to pricing for the poor in early 2010 (NEDLAC 2010). Instead our effort focuses on analysing the indirect impacts which are more poorly understood. This relates to how low-income households might be affected in their role as consumers of wage goods and as workers.

The first part of the project focused on updating our work on the potential impact of the price path on the economy, employment and distribution of income. We faced a critical challenge in doing this, as we had concerns about the quality of energy data currently available (see Appendix 1b).

The second part of the project updated our work on industry's response. It is now three years since the initial load-shedding events of 2008, shortages are still felt, and further shortages are looming on the horizon. Government and Eskom have honed in some policy offerings to encourage savings. Firms have now had time to respond, and more actors have factored in the inevitability of electricity price increases. We need to see how far companies have gone in this respect, changes in their expectations, and their plans for the future. Three industry focus group meetings were held to canvass experience and perceptions and to validate sector trends, with a special emphasis on energy-intensive activities such as mining, smelting, manufacturing and property[1].

Finally, we updated our financial model to build a view to 2025, to assess thoughts about electricity pricing and its impact on Eskom's sustainability going forward. We compare two scenarios, based on the IRP 2010 balanced scenario, with an alternative that has a more rapid introduction of renewables, and a different price path.

Section 2 of this report offers an overview of the electricity supply context and its potential impact on the economy and on employment and poverty. Section 3 asks whether the electricity price increases proposed in the IRP2010 are needed by Eskom. It reviews findings from our financial model to offer independent analysis of the implications for Eskom's financial ratios of the IRP 2010 price proposals, and compares that with two scenarios. Section 4 reviews trends in electricity consumption. Section 5 looks at the potential for improved energy efficiency going forward, which is meant to be a core solution in achieving energy security. Section 6 concludes. There are substantial appendices to this report, which support each section. The report is arranged in this way to make its reading more straightforward. Readers interested in accessing more background information or technical information can refer to these appendices. In order, they cover some of the assumptions in the financial modelling, a review of candidate renewable energy sources and their relevance for supplying different industries, a review of energy efficiency promotion policies and incentives, the approach taken to modelling the impact of electricity and energy pricing on employment and poverty, some additional tables, and a list of participants in our focus groups.

[1] The project team had originally planned to prepare a small industry survey, involving a mailed questionnaire. However, it was advised that the experience on response rates was very poor and that we would obtain stronger insights by holding industry focus groups. We received support from Business Unity South Africa in doing so, as well as other industry groupings such as SAPOA and the EIUG. The list of participants is found in Appendix 6.

2 The link between electricity supply, its pricing and poverty reduction goals

2.1 The policy context

Since the 2008 'load shedding' or rolling blackouts, companies and the general population experienced the reality of electricity shortages for the first time. Simultaneously, pricing reviews by the regulator, NERSA, were being undertaken to meet its regulatory requirements, and Eskom was submitting requests for very large price increases. Then there have been added concerns raised about the quality of Eskom's management. This combination has generated considerable heat, further ignited by each price increase request submitted by Eskom and the proceedings of NERSA's public hearings on the application. It is worth unbundling the issues, especially in order to identify potential socio-economic impacts.

In 2008, subsequent to a ruling by NERSA for a 14.2% electricity price increase, Eskom made a further submission seeking a 100% real price increase over the course of 2008/9 and 2009/10, and then for the price to rise 'marginally above inflation' thereafter. At that time, NERSA instead ruled that a further 13.3% would be implemented, resulting in an annual price increase of 27.5% (or a compounded 29.4% for the year as noted in Table 1. It further noted that the price should be expected to rise by 20% to 25% annually over the subsequent three years. There was a further submission by Eskom in 2009 seeking a price increase of 45% per annum for three year (although it later reduced this request to 35% per annum). NERSA ruled that the MYPD2, the second Multi-Year Price Determination, which is meant to lay the three-year path for the electricity price, permitted the electricity price to rise by 24.8%, 25.1% and 25.9% in each successive year starting in 2010. The price path is shown in Figure 1.

Table 1: Price of electricity price as per current NERSA ruling and IRP 2010

Year ending	Mar-08	Mar-09	Mar-10	Mar-11	Mar-12	Mar-13	Mar-14	Mar-15	Mar-16	Mar-17	Mar 18
	As ruled by NERSA						As proposed in IRP2010		If price then rose by an inflation estimate		
Application - price increase (%)	5.9	29.4	31.3	24.8	25.8	25.9	26.0	26.0	6.0	6.0	6.0
Real compounded price increase (%)	100	119.4	148.2	176.5	211.4	253.5	304.2	365.0	365.0	365.0	365.0
Price at year end (R/KWh)	0.19	0.24	0.32	0.40	0.50	0.64	0.80	1.01	1.07	1.13	1.20
Effective revenue earnings (R/KWh)	0.19	0.22	0.30	0.36	0.46	0.58	0.74	0.94	1.03	1.10	1.16

While Eskom has not received the price increases initially requested, prices are certainly rising well above inflation. How does one make sense of this, in a context where there is an urgent need to address the challenges of a recessionary economy, unemployment and poverty?

Eskom's stated objective was to cover the cost of its expansion programme; rising primary energy costs – coal and liquid fuel in particular; DSM and power conservation programmes; and the need to ensure its financial sustainability in light of having been put on 'credit watch'.

The reality is that major investments are needed to ensure secure electricity supply, both for necessary maintenance and for new generating capacity. Current policy sees Eskom as the main supplier of that capacity. Generally, when companies engage in major new investments, they rely substantially on a shareholder injection and on financial reserves built up over time. The electricity price was kept artificially low for many years as part of South Africa's industrial policy.

Figure 1 shows how the real electricity price fell from 1983 to 2002. The real electricity price in 2008 matched that of 1976. This is the context in which Eskom was unable to build up sufficient reserves to cover the costs of maintenance, replacement or new capacity.

Given the history, there appear to be legitimate reasons for fairly large price increases that are more reflective of the actual cost of producing, transmitting and distributing electricity. However, there are also very serious objections to such an approach. First, Eskom is a monopoly, with no competition to push it to a technological or efficiency frontier. Nor is there sufficient independent analysis to effectively challenge Eskom assertions of its actual costs. Could efficiency improvements reduce costs dramatically, thereby diminishing pressure on the consumer? Nobody outside of Eskom can say for sure. Nor do we definitely know whether Eskom pays sufficient attention to reducing its costs and improving its efficiency. Second, about 10% of Eskom's supply goes to exports and directly to large companies, especially in mining and smelting. These pricing arrangements are not regulated and the agreements are confidential. We do not know to what extent ordinary people might be subsidising these users. Third, there was very limited debate until recently about the future of energy in South Africa in respect of sources and technologies. The availability of information has improved markedly since 2009, and yet a range of important investment decisions had already been locked in. Fourth, there could be an alternative mix of public and private provision which could reduce pressure on Eskom.

In October 2010, the Department of Energy issued a draft Integrated Resource Plan that sets out a long-term electricity plan for South Africa (DoE 2010a and 2010b). Its aim is to 'determine long term electricity demand, and detail how this demand should be met in terms of generating capacity, type, timing and cost' (DoE 2010a, p. 1). Seventeen scenarios are compared and ranked based on their costs, impact on climate change mitigation, localisation and job creation potential, regional development impacts, diversity of energy sources and security of supply and energy efficiency. The document proposes a 'Revised Balanced Scenario' for the energy mix. This would involve a mix of new generating capacity to be installed after the current coal 'build'. It is envisaged that the proportion of electricity supplied by coal-fired generation could fall from the current 86% to less than 50% over the coming 20 years. The additional generating capacity would be comprised mainly of renewables(33%) and nuclear power (25%), complemented by gas-fired generating facilities. Nuclear power is given special prominence, potentially offering an additional 9 600MW from 2023, or one quarter of new generating capacity. The Medium Term Risk Mitigation Plan was issued as a response to a shorter term question: what might be the shortages to 2016 and how might they be addressed?

The IRP2010 is quite comprehensive in its approach, but essentially adopts an engineering approach to optimisation: forecast economic growth rates, derive from this a path for energy demand, then use an optimising programme to determine the least cost mix of energy, given costs of capacity expansion in each type, issues related to emissions, and so forth. This focuses on the engineering and business tradeoffs, and does give consideration to least cost. However, it does not capture economy-wide impacts. These are discussed below, and in Appendix 4.

Currently there are three main ways of distributing electricity: via Eskom, via municipalities and where firms generate and supply their own power. From the consumers' perspective, the main concerns in respect to electricity are its price and the quantity and reliability of its supply. These concerns are addressed below.

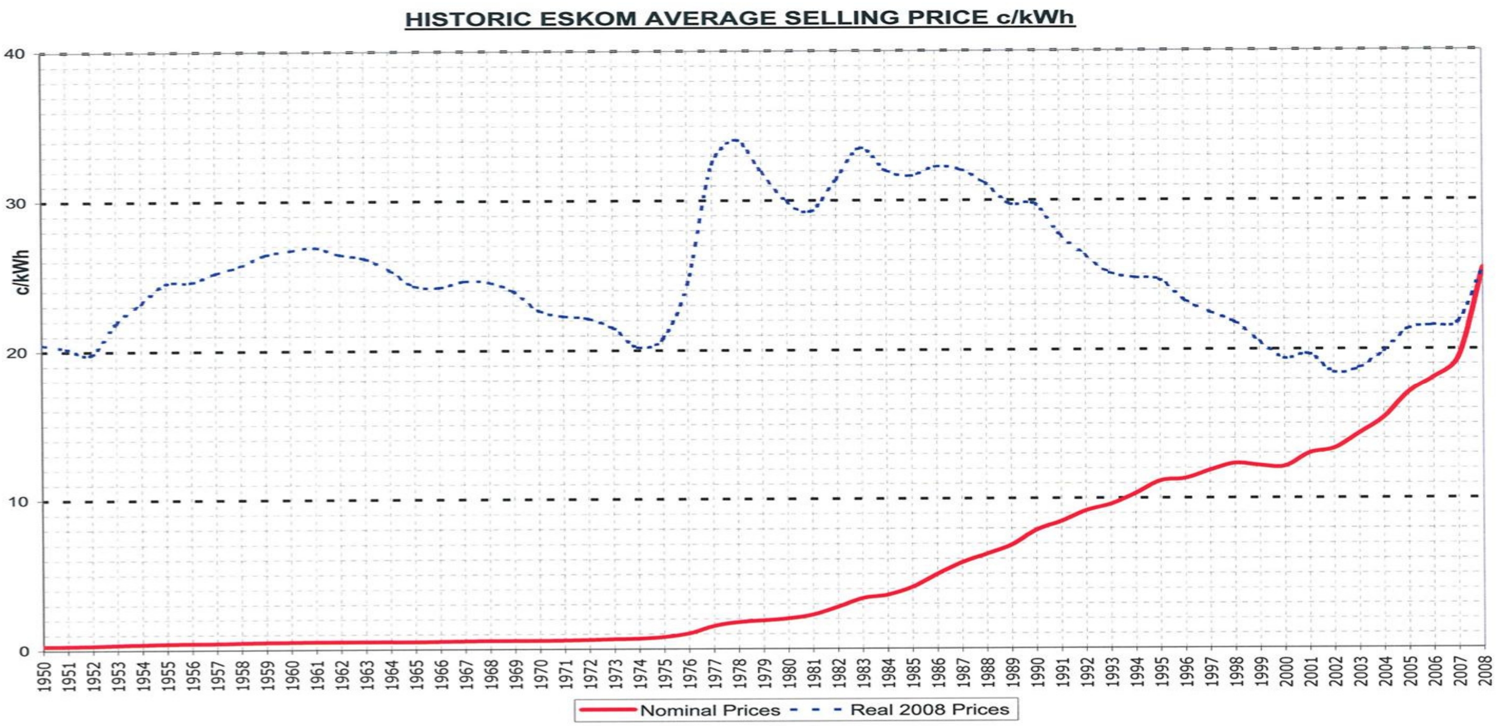

Figure 1: Average Eskom prices (c/kWh), 1950–2008

Source: www.nersa.org.za

2.2 What might be the impact of electricity price increases on the economy?

The research team modelled the impact of a once-off price increase of 35%, which was what Eskom asked for in November 2009. The impact on GDP would be very small, approximately -0.1%. The producer price index would rise by 1.3% more than it would otherwise, and this would raise the cost of a representative basket of South African exports by 0.9%. At first glance, this result might seem surprising. But it must be remembered that electricity accounts for only 1.1% of all costs in services and manufacturing. Electricity contributes 2% or less to total costs in 72 out of 94 sectors in the economy. There are ten sectors where electricity accounts for about 4% of costs or more, such as chemicals, non-ferrous metals, general hardware, textiles, tyres, gold mining, and accommodation (see Appendix 4).

So what might be the impact of the actual determination? The smelters have separate agreements that are not regulated, and so they are not affected by the NERSA decision. Some industries are supplied directly by Eskom, and they will pay the full increase. Other industries are supplied by municipalities. The level of tariff increase applied by municipalities and electricity distribution entities is subject to the control of, and review by, NERSA.

In its 2010 MYPD2 ruling, NERSA provided guidelines as to acceptable tariff revision for municipalities, namely that municipalities are allowed to increase their electricity prices by only about 15% to 16% each year. While industries supplied directly by Eskom face a higher increase, they would be paying about half the price paid by municipality-supplied businesses – an average of about 42c per kilowatt hour versus about 91c to 96c per kilowatt hour. For most industries, this should not have had a major impact on costs, although it will hopefully spur energy-saving behaviour. However, the energy-intensive industries will be hard-hit and will require adjustment support. Municipalities that intended to raise their electricity prices more quickly than 15% to 16% a year were required to make representations to NERSA.

In reality, the application of NERSA's ruling on this matter has been very uneven. NERSA has surveyed municipal prices and this review process has shown that many municipalities are raising the electricity price well beyond what its ruling permits. In 2010, a large number of these entities were called upon to justify increases which exceeded the NERSA guideline.

In 2008/9, Eskom was awarded an increase of 19 %, and we are not aware of municipal guideline issued at that time. The combination of guidelines from National Treasury and Nersa led municipalities to raise their electricity rates by 25% to 34% in 2009/10, and then by 22% and 19% respectively in 2010/11.[2] Hence, it might be expected that the compound growth in municipality electricity prices would have ranged between 49% to 59% from 2008 to 2010.

The research team drew a sample of 25 municipalities and found that their electricity tariffs for small firms rose by 39% to 90% over the period from October 2008 to November 2010 (see Table 2). Twelve (12) of these municipalities raised their small business tariff by 60% to 90% over this period.

The range of tariffs applicable is surprisingly wide, given that these are all compiled by the same set of rules; rules which require prices to be cost-reflective. Half of the sample shown in Table 2 charge over

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[2] National Treasury issued an Annexure to MFMA Circular No.48 providing updated information to municipalities for the preparation of their 2009/10 budgets. As a NERSA guideline had not been issued, Treasury advised that municipalities should budget for a 34 per cent nominal and 25 per cent real increase in bulk electricity tariffs. The unintended consequence was that municipalities implemented either rate. Based on this circular, NERSA approved two sets of municipal tariff guideline and benchmarks for the 2010/11 financial year (i.e. 19% and 22%). The 19% guideline and benchmarks referred to those municipalities that implemented 34% in 2009/10. The 22% guideline and benchmarks referred to those municipalities that implemented 25% in 2009/10 (see NERSA 2010c).

50% as much as Eskom rates. For example, in November 2010, Eskom charged 49c per kWh to small businesses, whereas Cape Town, Johannesburg (City Power), and Ethekweni respectively charged 77c, 88c, and 84 c per kWh. Perhaps reflecting the character of its energy intensive business in Ekurhuleni, the rate was lower than many of the others at 63c per kWh.

The municipalities rely quite heavily on cross-subsidies from electricity revenue. However, these increases may have the impact of slowing investment and employment growth, especially in weaker regions.

Table 2: Sample of typical small business commercial tariffs

Municipality	R/kWh Sep-08	R/kWh Nov-10	% increase (Sept 08 to Nov 10)
City of Cape Town	0.4855	0.7766	160%
Ethekwini	0.5227	0.8429	61%
City Power (Johannesburg)	0.5029	0.8791	75%
Ekurhuleni	0.4030	0.6340	57%
Eskom	0.3363	0.4942	47%
Tshwane	0.4340	0.6900	59%
Buffelo	0.5461	0.8748	60%
Emfuleni	0.4967	0.7921	59%
Bela-Bela	0.3400	0.6474	90%
Groblersdal	0.4380	0.6950	59%
Upington	0.4463	0.7541	69%
Port Elizabeth	0.5479	0.8356	53%
Ficksburg	0.3900	0.6100	56%
Umtshezi	0.3400	0.4710	39%
Tzaneen	0.3115	0.5571	79%
Steve Tshwete	0.2733	0.4168	53%
Oudtshoorn	0.3859	0.5900	53%
Mosselbaai	0.3440	0.5200	51%
Matzikama	0.5000	0.8700	74%
Langeberg	0.4300	0.6210	44%
Knysna	0.4240	0.7600	79%
Umtata	0.4690	0.8800	88%
Kroonstad	0.5406	0.8600	59%
Sasolburg	0.4740	0.7965	68%
Manguang	0.3965	0.7100	79%
Mogale City	0.471	0.7379	57%

Source: NERSA website – www.nersa.org.za

Inordinate price increases affect both households and firms. In respect of employment, the price increases hit energy-intensive firms especially hard, e.g. companies active in mining, metals, and even firms in the accommodation sector. Table 3 shows that electricity accounts for 4% or more in total turnover in 11 sectors (out of 95). Table 4 shows the 20 sectors that account for 80% of electricity purchases in South Africa.

Table 3: The cost structure of top electricity-intensive industries in South Africa

		Cost structures (%)					
		Intermediates		Wages	Gross operating surplus	Taxes/ subsidies	Total
		Excl. electricity	Electricity				
		[1]	[2]	[3]	[4]	[5]	[6]
1	Non-ferrous metals	57.8	11.1	5.8	25.0	0.3	100.0
2	General hardware	55.1	6.8	24.3	13.1	0.7	100.0
3	Knitting mills	66.7	6.1	18.0	9.1	0.0	100.0
4	Other textiles	69.7	5.5	17.6	7.3	-0.1	100.0
5	Tyres	70.6	5.3	17.7	7.1	-0.7	100.0
6	Water	59.9	4.9	11.0	25.1	-0.9	100.0
7	Electricity	40.5	4.9	20.8	33.1	0.7	100.0
8	Gold	34.4	4.8	32.2	27.6	1.0	100.0
9	Soap	76.0	4.1	9.4	10.4	0.1	100.0
10	Pharmaceuticals	74.5	4.0	9.8	11.5	0.1	100.0
11	Accommodation	57.7	4.0	15.1	22.1	1.1	100.0
12	Fish	49.1	2.8	22.7	24.7	0.7	100.0
13	Other chemicals	70.4	2.5	19.0	7.6	0.5	100.0
14	Treated metals	62.2	2.4	26.1	8.4	0.8	100.0
15	Gears	66.0	2.3	27.5	3.5	0.7	100.0
16	Lifting equipment	81.4	2.3	9.9	5.9	0.4	100.0
17	Machine tools	58.1	2.1	30.7	8.7	0.3	100.0
18	Cement	47.4	2.1	5.3	45.0	0.2	100.0
19	Office machinery	71.4	2.0	14.8	11.2	0.6	100.0

Source: Excerpt from Altman et al. (2008), Table 3.

Table 4: The largest users of electricity in South Africa

Rank	Sector	Share	Cumulative share
1	Non-ferrous metals	11.3	11.3
2	Gold	8.0	19.3
3	Electricity	7.2	26.5
4	Transport services	6.7	33.2
5	Trade	5.6	38.8
6	Other mining	4.9	43.7
7	Petroleum	4.2	48.0
8	Accommodation	4.1	52.1
9	Communications	3.9	56.0
10	Soap	2.9	58.9
11	Pharmaceuticals	2.9	61.7
12	Real estate	2.7	64.4

Rank	Sector	Share	Cumulative share
13	Iron and steel	2.5	66.9
14	Water	2.4	69.3
15	Activities/ services	2.0	71.3
16	Meat	1.9	73.2
17	Coal	1.9	75.1
18	Agriculture	1.8	76.9
19	General government	1.6	78.5
20	Insurance	1.6	80.2

Source: Excerpt from Altman et al. (2008), Table 4.

2.3 What is the impact on unemployment and poverty reduction objectives?

Most of the debate in respect of the effect on the poor focuses on the direct impacts – the prices they pay for electricity. But at least one half of the impact can be attributed to indirect impacts.

2.3.1 Direct impacts of electricity pricing on poor households

The research team investigated the impact of a once-off 25% increase in the electricity price. In this case, the CPI for all households rises by 0.88%, with 0.53 % coming from direct effects and 0.35% from indirect effects. The impact is greater on poor households than on rich ones because they spend a greater proportion of their total expenditure on electricity. The richest households spend 0.8% of their expenditure on electricity, so the 25% price rise raises expenditure by 0.2%. By contrast, the poorest households spend 5.4% of expenditure on electricity, so the 25% increase raises expenditure by 1.35%. Against this, the indirect effects are relatively uniform across household groups, contributing 0.40% to the CPI increase for the poorest and 0.32% to that for the richest (see Appendix 4).

There are some basic principles that should be applied to supplying electricity in South Africa:

- Economic efficiency should be achieved with universal access;
- Pricing and tariffs should be globally competitive, cost-reflective and affordable; and
- The regulatory framework should be stable, predictable, transparent and just.

Only specifically approved cross-subsidies, direct subsidies, levies and surcharges may be instituted. In a context of deep poverty and inequality, the electricity supply industry is required to address socio-political needs, and these measures are required to be transparent and in the process of becoming cost-reflective. Licensees are required to establish and publicise the average level of cross-subsidy between customer categories.

Poor households are supplied with electricity either directly through Eskom or through municipalities. Eskom's 'Homelight Tariffs' for poor households are kept low and, according to NERSA rulings, are supposed to rise at a slower rate than the full price increase the regulator has awarded in recent years. NERSA guidelines say that municipalities are meant to keep prices low for poor households, subsidised by richer customers. Alternatively, Eskom is supposed to keep prices low for municipalities that are unable to achieve this because they lack a customer base that would provide adequate cross-subsidisation (see, for example, NERSA 2008). Whether or not this approach is implemented requires investigation.

Government electricity pricing policy specifies that licensees should provide qualifying low-income customers with a single 'life line' electricity tariff, with no fixed charge or connection fee, with current capacity limited to 20 Amps. The tariff is intended to be cost-reflective, with the break-even point being

350kWh per month per household for a 20 Amp supply. Where local authorities wish to provide free electricity in excess of the amount subsidised by the Department of Energy (currently 50kWh per month), such an amount must by funded by municipal revenue.

The 2010 NERSA ruling provided for a much lower increase for poor households. About half of all households, mostly poor ones, are directly supplied by Eskom. Their prices fall in 2010/11, and will rise by a maximum of 13.5% per annum in 2011/12 and 2012/13. The other group of households are supplied by municipalities. They are meant to pay increases of about 15% to 16% per annum for the next three years. On average, electricity accounts for 1.7% of household expenditure.

Low-income residential tariffs – some evidence

This report does not delve in detail about directly addressing the needs of poor households, since a major study on this matter was prepared for NEDLAC in early 2010 (NEDLAC 2010). However, new information has come to light and is shared below.

The municipal tariffs applied in some major metropolitan areas indicate that electricity for residential use is not cheap when compared to business rates.

Low income households are also meant to benefit from basic free services of 50kWh per month. There has been some anecdotal contention that the free basic electricity was not being provided uniformly. Until now, this has not been monitored so it has been difficult to say how widespread this problem might be. NERSA introduced the first monitoring of municipalities in 2010.

In terms of pricing and services for the poorest households, there has been some debate about whether municipalities are applying guidelines in respect of free basic electricity or on pricing. We called a sample of 44 municipalities and found only 10 providing free basic electricity (Table 5). We also scanned tariffs for low-income consumers in these same municipalities (with information provided by NERSA). The tariffs for those consuming less than 50kWh per month varied between 41c/kWh to 91c/kWh, but mostly fell into the range of about 60c to 75c. The tariffs for those consuming 51 to 150kWh/month ranged from 42c to 92c/kWh, although mostly they charged between 65c and 85c.

The tariffs need to be cost-reflective, and are not meant to cross-subsidise other municipal costs. It is not expected that there would be uniform rates across all municipalities. However, some investigation is needed to explain the large variations found.

Table 5: Schedule of lowest residential tariffs as per NERSA approval (2009/10)

Municipality	kWh0-50-65	kWh 51-150	kWh151-450	Over 450kWh	Free electricity
Cape Town	0.000	58.110	70.470	70.470	First 50kWh
Ethekwini	0.000	65.330	65.330	65.330	First 65kWh
Tshwane	0.000	88.300	88.300	88.300	First 50kWh
Umtshezi	0.000	82.000	82.000	82.000	First 50kWh
Lesedi	0.000	72.000	72.000	72.000	First 50kWh
City Power (Johannesburg)	62.360	66.670	66.670	66.670	None
Ekurhuleni	82.200	82.200	82.200	82.200	None
Ladysmith	64.050	64.050	64.050	64.050	None
Kokstad	74.330	74.330	74.330	74.330	None
Matatiele	73.000	73.000	73.000	73.000	None
Mzunduzi	41.953	41.953	41.953	41.953	None
Newcastle	57.860	57.860	57.860	57.860	None

Midvaal	78.390	78.390	78.390	78.390	None
Mogale City	78.490	78.490	74.490	74.490	None
Randfontein	76.000	76.000	76.000	76.000	None
Buffelo	86.304	86.304	86.304	86.304	None
Ndlambe	74.000	74.000	74.000	74.000	None
Port Elizabeth	74.840	74.840	74.840	74.840	None
Gamagara	79.500	79.500	79.500	79.500	None
Nama Khoi	80.000	80.000	80.000	80.000	None
Phokwane	91.910	91.910	91.910	91.910	None
Sol-Plaatjie	83.260	83.260	83.260	83.260	None
Middelburg	41.680	41.680	41.680	41.680	None
Bitou	62.000	62.000	62.000	62.000	None
George	0.000	63.960	63.960	63.960	First 80kWh
Hessequa	0.000	74.200	74.200	74.200	First 50kWh
Knysna	0.000	63.000	63.000	63.000	First 50kWh
Matzikama	87.000	87.000	87.000	87.000	None
Mosselbay	63.700	63.700	63.700	63.700	First 20kWh
Stellenbosch	86.540	86.540	86.540	86.540	None
Theewaterkloof	85.830	85.830	85.830	85.830	None
	kWh 0-50	**kWh 51-350**	**kWh 351-600**	**kWh over 600**	**Free electricity**
Abaqulusi	60.00	64.00	79.00	93.00	None
Eskom	62.360	66.670	87.040	95.460	None
Abaqulusi	60.000	64.000	79.000	93.000	None
Nquthu	60.000	64.000	79.000	79.000	None
Merafong	60.000	63.000	75.000	85.000	None
Goven Mbeki	60.000	64.000	75.000	90.000	None
Mbombela	60.000	62.000	77.000	93.000	None
Msukaligwa	62.000	65.000	75.000	90.000	None
Lydenburg	60.000	62.000	77.000	90.000	None
Witzenberg	59.700	63.000	75.000	86.000	None
	kWh 0-50	**kWh 51-300**	**kWh 301-500**	**kWh over 500**	**Free electricity**
Kungwini	0.000	134.000	78.000	78.000	First 50kWh
Breede Valley	52.632	52.632	52.632	80.702	None
	kWh 0-50	**kWh 51-200**	**kWh over 200**		
Elias Motsehedi	47.400	58.800	69.700		

Source: www.nersa.org.za; Information on free basic electricity gained through calls to municipalities by the WSP team.

The Free Basic Electricity grant does not reach all poor households. There are many pro-poor municipal tariffs similar to the Eskom Homelight tariffs for which the FREE BASIC ELECTRICITY subsidy option is often not available (NEDLAC 2010). It is estimated that about R4 billion per annum will be needed in future to cover the cost of providing 50kWh per month of free basic electricity to 4 million households.[3] Whether this cost includes better-off consumers who are getting the free basic electricity along with all others is not clear. This practice of not providing free basic electricity needs to be addressed. Some part of the problem may be due to technical metering limitations.

The electrification grant has not yet reached all poor households. There were 3.4 million households (25%) without electricity at the time of writing of the NEDLAC report. It is estimated that about R60 billion is needed to connect these households.[4]

Certainly, ensuring uniform free services and municipal pricing closer to the NERSA ruling would directly benefit poor households. It is recommended that these issues be addressed, and also that the monitoring of municipalities be done annually.

Poor households can be buffered from price shocks without having a major impact on overall revenue collection, partly because their share of electricity consumption is small, perhaps around 4% of total sales at most. The NEDLAC report asserts that there is substantial illegal offtake from the grid, in which case some poor households may be using more electricity than official figures indicate. Assuming that the majority of poor households can be drawn into using legal connections and consumption, long-term financial viability could be raised through a price cross-subsidy or through direct support from National Treasury. Policy makers seek to reduce electricity consumption amongst higher-income households and the business sector.They could be encouraged to seeking to raise poor household electricity consumption as ways of promoting equity, improved health status and enhanced economic participation.

2.3.2 Indirect impacts of electricity provision on low income households

The current report focuses more on indirect impacts that affect the poor as consumers and workers. Poor households might face rising prices of basic items as producers and retailers pass on their costs to consumers. We found that the impact of the direct and indirect effects are approximately equal in magnitude. We also found that poor households are disproportionately affected by inflation caused by electricity price increases. For example, if the electricity price rises by 25%, the consumer price index for poor households could rise by 1.3% as opposed to 0.8% for rich households (see Table 14). About two-thirds of the increase for poor households would be experienced directly because they pay more for electricity. But one-third would be indirect: even if poor households received free electricity, their cost of living would rise by 0.4% as a result of firms passing on the electricity price increases to consumers. Poor households could also be affected by job losses. We estimate that an electricity price increase of 35% could lead to a fall in total employment of between 0.24% and 0.60%. This amounts to about 25 000 to 50 000 jobs (out of 13 million working people), with the worst losses expected among less skilled workers (see Appendix 4).

Raising the price should enable Eskom to invest and cover its operating costs, but should also encourage consumers to improve efficiency. It will also encourage energy purchases by Eskom. However, there are concerns about physical capacity and potential shortfalls in electricity supply, especially between 2011 and 2016. This is laid out in the Risk Mitigation Plan for Electricity (MTRM 2010). If not filled, these gaps will pose a physical constraint on economic growth and therefore on job creation. This is discussed in more detail in section 5 of this report).

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[3] Assuming Eskom's generation cost doubles in the three years from about 30c/kWh to 60c/kWh, and 50% of connections are eligible. Note that 4 million households refer to households who already have electricity connections, but do not receive free basic electricity, over and above the 3.4 million unserved households.

[4] 2009/10 rands. In 2010/11, R2.7 billion will be spent on providing 150 000 connections.

Anticipated supply shortages 2010 to 2016

There is a high likelihood of electricity supply shortages, at least to 2016. There is also evidence that electricity is being rationed at present, thereby constraining potential growth, output and employment. This appears to particularly affect firms directly supplied by Eskom such as the mines and smelters, but also large expansions and new investments that require supply from municipalities. This acts as a binding constraint on the ability to achieve growth and employment goals, especially in activities that promote dynamism. This is a critical concern, exacerbating high unemployment and slow economic growth. For example, the mining industry claims that they are operating at about 10% below capacity due to rationing. This affects not only mining employment, but also the extensive supplier base into the mining industry.

Three main factors contribute to supply shortages and insecurity. The first is shortages in electricity generation. This is discussed in section section 5. The Medium Term Risk Mitigation Plan shows the potential shortages for each year, and suggests approaches to filling the gap. Progress appears slow in implementing these recommendations. The second is related to gaps in electricity distribution infrastructure investments by municipalities, leading to brown-outs. This issue lies beyond the scope of this study, but the reader is referred to a forthcoming report by EDI on this matter. The third is related to the extent that actions to improve energy efficiency might reduce pressure in the medium term. This is discussed in section 5 and appendix 3.

A shortage of electricity, coupled with dramatic increases in municipal electricity prices, will form a physical barrier to economic and much-needed employment growth, especially in sectors that are energy-intensive such as accommodation, property, mining, manufacturing and food storage.

3 The link between the electricity price and Eskom financial sustainability

In 2008, the HSRC and WSP began a process of modelling Eskom's finances to enable an independent commentary of pricing proposals. This has been reported on in Altman et al. (2008) and Altman (2009). Eskom is in the unenviable position of needing to pursue a very large build and maintenance programme in a context where it can rely on neither cash reserves (since electricity prices were too low, nor a major injection by its shareholder (namely the state). Guarantees have finally been promised by the Treasury in 2010 for the debt being raised in the market.

While sympathetic to this challenge, there was concern over the years of the very limited information made available by Eskom. In addition, there has been very little debate about the investment choices being pursued, whether in relation to the approach to coal-fired power, or to the mix of energy sources. In the past year, this situation has begun to turn, with greater communication by Eskom, and with some dialogue in respect of the energy mix going forward. There still seems to be little discussion about the choice of coal-fired plants, as these investments appear to be locked in.

The HSRC/WSP model of the electricity industry has been developed for the purpose of checking the solvency and health of Eskom's business balance sheets, and testing their projected financial strength and adequacy for taking on the massive expenditures in power generation which the South African economy will require up to 2025 and beyond.

Using the HSRC/WSP model, recommendations were made to NERSA and the NERT in respect of the appropriate price path for electricity over the price determinations of 2008 (MYPD1) and 2010 (MYPD2).

The model was further revised for this project to update assumptions in a changing economic environment, to account for policy changes, and to extend it to 2025. We assume a 2% efficiency saving off personnel costs in existing business in each year from 2010 to 2013[5]. The IRP2010 base assumptions are used, such as plant costs, operating costs and load factors. There has been engagement with Eskom and an expert roundtable was held in October 2010 about the assumptions in respect of the inputs to the model. Eskom has specifically advised on the asset base assumptions. In addition, the model now offers:

- an industry-wide financial model of Eskom and IPPs to show the viability of different options/paths
- a long-run marginal cost comparison
- extensive user input fields for scenario planning, and
- result outputs that are easy for many stakeholders to relate to.

The test of the model was the closeness to the IRP2010 outcome on pricing, which we found to be strong. The reader is guided to Appendix 1 where further comments on the model are available.

The IRP2010 does not reflect on the implications of its proposals for Eskom's financial status. Below we propose what these impacts might be, based on two scenarios.

[5] We have built in the following annual real cost escalations on existing business: 2% pa on personnel, 5% pa on maintenance, 4% pa for DSM, 17% for cost of cover, so that existing business operating expenditure rises by 3% pa over the period modeled (from 2010 forward). New business opex is calculated to rise by 3% pa in real terms. These estimates need interrogation, and could changes to them could dramatically alter the results.

Two scenarios were produced, which compare the IRP2010 balanced scenario with the introduction of some 4 500MW of wind generation from independent producers, and an extra 1 460 MW cogeneration (Table 6). The alternative scenario adds an extra 700MW of wind as early as can be achieved to alleviate short-term power shortages. We also assume there is an extra co-generation of 1 460MW via a COFIT programme where pricing is the same as for the long-run marginal cost for new coal generating capacity. Finally, we assume the earlier retirement of one coal unit.[6]

Eskom targets financial ratios appropriate for a public listed company, and it is worth asking if these are the appropriate ones for a state-owned monopoly with certainty of demand. The focus of our results is on whether the proposed price increases would enable Eskom to achieve stated targets of profitability, interest cover and debt:equity ratios. Eskom is targeting an interest cover of 3.0 and debt:equity ratios below 200%.

The IRP2010 scenario has the real compound price of electricity rising by 265% between 2008 and 2019. The unit price increases to R1.20 by 2019. Interest-bearing debt peaks in 2014 at R275 billion and falls to R90 billion by 2020. This price increase would result in losses after tax and interest until 2012, whereafter net profit rises to R82 billion by 2020. Interest cover rises to 2.0 by 2013 and reaches 5.5 by 2018. The debt:equity ratio falls to below 200% by 2014, and to extremely low levels thereafter. It would appear that these price increases very quickly return Eskom to its required ratios within a very short space of time. A judgement is needed in respect of whether this pace of recovery warrants the very large annual price increases being introduced. It does certainly seem that the price should be reduced in real terms from 2016.

The IRP2010 has been modelled and the Revised Balanced Scenario is stated by the IRP team to be closest to meeting their likely requirements: firstly, meeting national power needs; secondly satisfying (or not actually satisfying) aspirational national targets for greenhouse gas emission reductions; and, thirdly, that the development takes place at a cost which is affordable to the nation.

It is confirmed that the IRP2010 Revised Balanced Scenario will reasonably satisfy the first of these objectives in the longer term. However, the financial position of Eskom is predicted in the HSRC/WSP model to be excessively cash-positive, having repaid most financing debt during the period to 2024/5. It is unlikely that the intention of the South African government is for Eskom to acquire a large cash balance in this exercise. A judgement is needed in respect of whether this pace of Eskom's financial recovery warrants the very large annual price increases being introduced. The intention is that there is a large price increase to 2016, and then reductions in real terms. The proposed price path may therefore be sub-optimal, because it does not defer the costs of repaying the loan over the entire period that the added generation capacity will be available to future energy users. This causes excessive pressure for South African producers and contains employment growth more than necessary. A slower rise in prices may be sufficient.

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[6] NERSA's determination of MYPD2 in the second quarter of 2010 gave certainty to electricity prices for three years. NERSA's announcement of the REFIT tariffs now underpins these generation sources economically since a small parcel of renewable resource-based generation will be purchased by Eskom (and the price recovered in the general tariff). The progression of electricity price increases is meant to underpin the expansion of electricity generation in South Africa, whether funding Eskom's expansion, or its purchase of power by other parties. The proportion of renewable energies allowed or provided for will cause an increase in overall average electricity pricing.

In the alternative scenario, interest-bearing debt peaks in 2014 at R270 billion, and falls to R215 billion by 2018. Profit after tax and interest is negative in 2012, but rises above R10 billion in every subsequent year, reaching R51 billion in 2018. Interest cover is above 2.0 in most years and reaches 3.0 by 2016. The debt:equity ratio falls below 200 by 2014, and to extremely low levels quite quickly.

The HSRC/WSP model indicates that a more moderate price increase, say of 18% pa in 2013/4 and 2014/5 may well serve Eskom adequately, instead of the assumed 26% in the IRP proposals. This would provide sufficient finance to undertake the build programmes, at a level of borrowings that can be managed and sustained. There would be an argument for reducing electricity prices in real terms for a few years thereafter. Some consideration should be devoted to expected operating cost increases in existing and new plant. We have built in fairly generous assumptions, and it is hoped that Eskom will introduce substantial efficiency improvements.

Table 6: Comparison of IRP 2010 Revised Balanced Scenario to 'Higher Renewable & Cogen' Alternative (to 2018)

	2007/8	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17	2017/18
Stated price increase (%)	5.9	29.4	31.3	24.8	25.8	25.9	26.0	6.0	6.0	6.0	6.0
Real compounded price increase (%)	100.0	119.4	148.2	176.5	211.4	253.5	304.2	365.0	365.0	365.0	365.0
Price at year end – real (2010 Rand) (R/KWh)			0,28	0,36	0,43	0,52	0,62	0,74	0,77	0,77	0,77
Price at year end (R/KWh)	0.19	0.24	0.32	0.40	0.50	0.64	0.80	1.01	1.07	1.13	1.20
Effective revenue earnings (R/KWh)	0.19	0.22	0.30	0.36	0.46	0.58	0.74	0.94	1.03	1.10	1.16
IRP 2010 Revised Balanced Scenario											
Total assets (Rbn)	116	128	194	284	384	479	538	598	652	699	741
Interest bearing debt (Rbn)	51	52	83	141	200	254	275	274	252	214	155
Net profit after interest and tax (%)	5	2	1	-13	-3	14	11	33	45	50	58
Net profit before tax to Turnover (%)	10,9	-3,1	2,1	-18,5	-2,9	11,8	7,9	18,7	22,7	23,2	24,8
Net profit before tax to Total Assets (%)	4,2	-1,3	0,8	-6,2	-1,0	4,0	2,8	7,6	9,6	9,8	10,9
Interest times covered by Cash Flow	2,9	-1,1	2,6	1,5	1,6	2,0	2,1	2,9	3,4	4,1	5,5
Weighted Average Cost Capital prior year (%)	7,9	5,6	-0,4	1,4	-4,8	0,6	5,6	7,5	12,2	13,8	13,4
Debt:Equity ratio (%)	78	95	172	243	267	232	195	145	104	73	46
Interest bearing debt as a % of Total Assets	43,8	40,8	42,6	49,7	52,0	53,1	51,2	45,8	38,7	30,6	20,9
More renewables and cogen progression											
Total assets (Rbn)	116	128	194	284	385	479	530	583	640	703	774
Interest bearing debt (Rbn)	51	52	83	141	200	255	270	265	251	234	215
Net profit after interest and tax (%)	5	2	1	-13	-3	13	9	30	41	47	51
Net profit before tax to Turnover (%)	10,9	-3,1	2,1	-18,5	-2,9	11,4	6,9	17,5	21,5	22,8	22,8
Net profit before tax to Total Assets (%)	4,2	-1,3	0,8	-6,2	-1,0	3,8	2,4	7,1	9,0	9,3	9,1
Interest times covered by Cash Flow	2,9	-1,1	2,6	1,5	1,6	2,0	2,0	2,8	3,4	3,9	4,6
Weighted Average Cost Capital prior year (%)	7,9	5,6	-0,4	1,4	-4,8	0,6	5,4	7,2	11,8	13,1	12,9
Debt:Equity ratio (%)	78	95	172	243	267	233	194	145	107	80	61
Interest bearing debt as a % of Total Assets	43,8	40,8	42,6	49,7	52,0	53,3	50,9	45,5	39,2	33,2	27,7

Source: WSP/HSRC financial model

4 Trends in electricity and energy consumption

4.1 Trends in energy consumption and intensity, according to the data

Efforts to ensure energy security of supply have considerable reliance on improved energy efficiency. A reflection on current and past behaviour by firms may inform how they might move forward. Improvements in energy efficiency in the past may indicate on-going commitment to these improvements. However, they could also show that firms may have reached a limit of the easier efficiency improvements, and that future improvements might be more elusive or expensive.

The available data shows that there has been a 13% reduction of energy intensity in the national economy to 0.129GWh/R billion over the five-year period to 2009 (IRP2010).

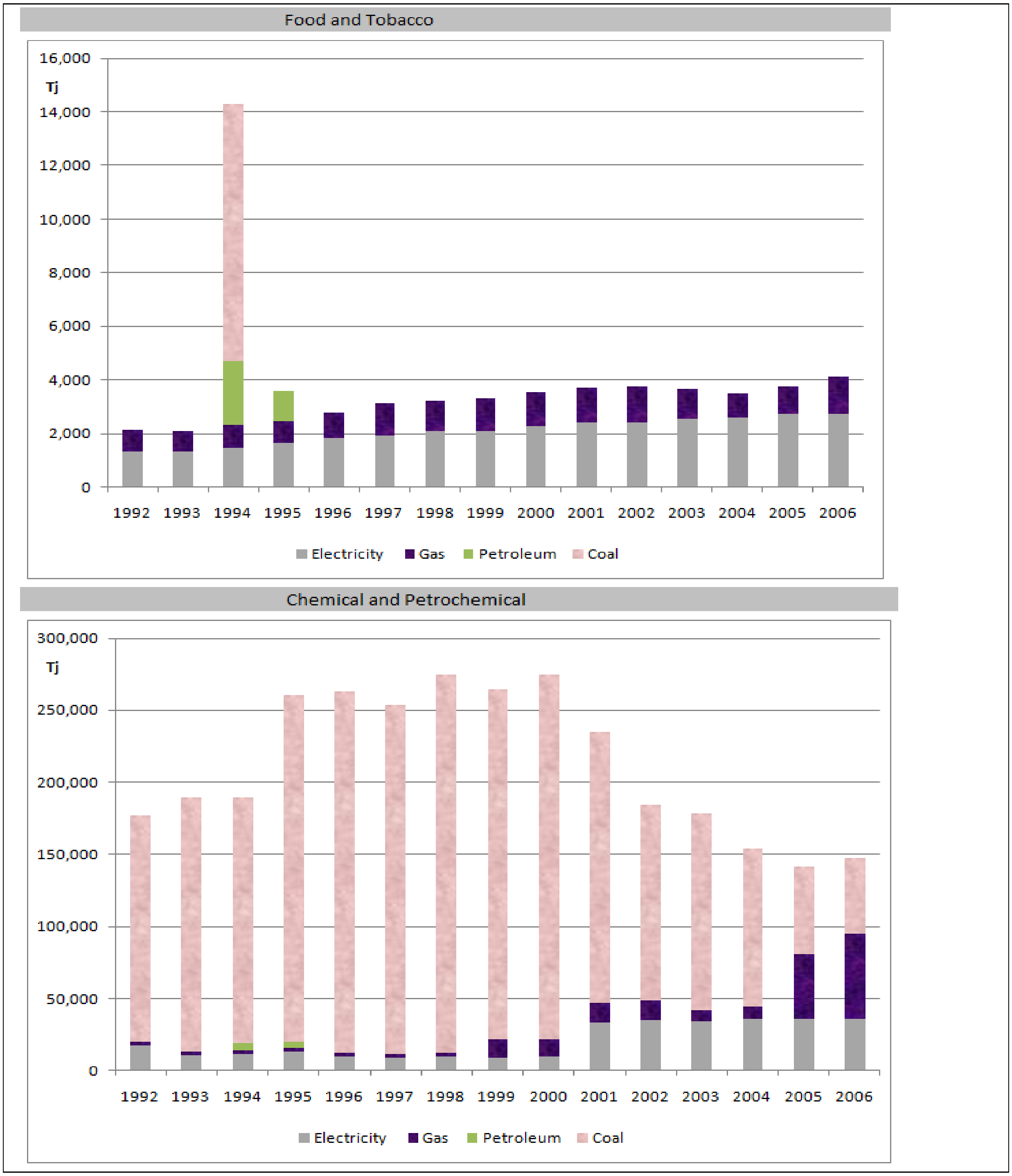
The information on energy intensity prepared for this report relies on data drawn from the Department of Energy, Statistics South Africa (which we were told relies substantially on DoE data) and output and capital investment data available from Quantec, an independent data provider. It must be noted that while we present trends shown by the available data, there are some serious concerns, which are discussed in Appendix 1b. There are many anomalies only some of which are presented here. Some verification of the data is needed, and the quality improved and checked. This is especially important in a context where there is an intention to reduce energy intensity and a need to monitor progress against that objective.

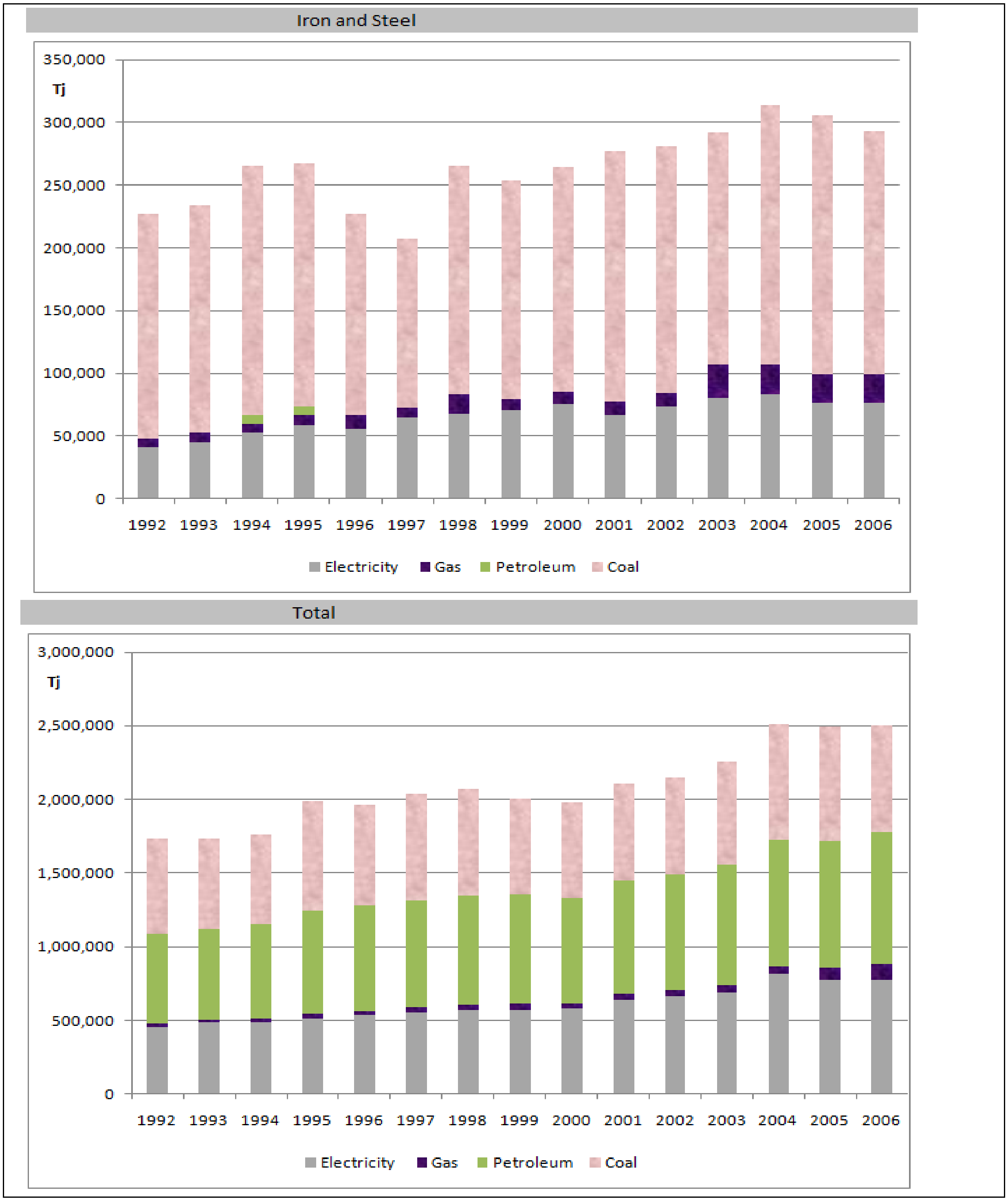
Trends in energy intensity can be explored for South Africa using DoE energy balances data for the period 1992–2006 (DoE various dates). Four energy types (electricity, gas, petroleum and coal) can be identified for a limited number of industries, namely electricity, gas, petroleum and coal. We are interested in all four, since we want to know not only about the use of electricity, but also whether users are shifting to alternative energy forms. Energy use has been converted into the common Tj (terajoule) denominator. A cursory glance at this data reveals high volatility with some industries reporting five-fold increases in energy use from one year to the next followed by a similar decline in the following year. Figure 2 shows rising consumption for electricity in the Food and Tobacco industry, and a strange leap in the use of coal in 1994 that may simply reflect a data anomaly.

The data shows dramatic expansions in the consumption of coal in the Chemicals and Petrochemical industries in the 1990s, but then a switch towards gas towards the end of the period which may be associated with the use of gas as feedstock by Sasol.

According to the data, the Iron and Steel industry energy intensity has risen. Coal remains the preferred (albeit declining) source of energy but with increased shares for electricity and gas, a stable share for petroleum. While considering growth in the total volume of energy is useful, the main question is whether it has grown slower or faster than output.

Figure 2: Energy use for selected industries and all industries





Source: DoE energy balances. Note: Total is all industries and excludes residential and 'non-energy use'.

At any point in time the energy intensity of an industry can be characterised by the volume of energy per unit of output. The national average energy intensity is equal to the sum of the industry energy intensities weighted by their share in national output. *Changes* in the national average energy intensity can then come about either because industry energy intensities have changed, or because industry output composition has changed, or both. In Table 7, a decomposition of change in energy intensity over the 10-year period is presented. In order to reduce some of the volatility in the data, the change between the annual average of the three years at the start and at the end of the 10-year period are considered. Energy use by industry is matched to output data from the Quantec South African Standardized Industry Database (SASID) according to the schedule reported in Appendix 1c.

The first two columns in Table 7 present energy use for the start and end of the period of observation followed by the matching gross value of production (in constant 2005 prices) in columns 3 and 4. Energy intensities for the two points of observation are shown in columns 5 and 6, the output shares of each of the industries in columns 7 and 8 and the change in the industries' energy intensity and output shares in columns 9 and 10. The last entry of column 9 suggests that the energy intensity of all industries has declined by 44% over the period. Industries that shared this trend are Agriculture, Chemicals, Iron and Steel and Transport. According to this data, the Mining and Non-Ferrous Metals industries reported an increase in energy intensity. We found this odd, as we would have expected the most energy-intensive firms (that is mining and smelting) to have been the leaders in achieving energy efficiency, since it affects them quite substantially. Our interaction with industrialists did call these findings into question, and this is reported below.

The decomposition of change in energy intensity is shown in the last four columns of the table. Starting with the composition effect in column 11, this is derived by multiplying the initial energy intensity (column 5) with the change in the change in output share (column 10). The second entry in column 11 shows that although the energy intensity in Mining has increased, its decline in output share create a negative impact on the overall energy intensity. On the other hand, Chemicals and Transport increased their share of output and this created a positive impact on the overall energy intensity. Summed across all industries, it can be seen in the last entry of column 11 that the total impact of changes in the composition of industry output had a small positive impact on the overall energy intensity. The structure of production has changed towards those industries with relatively high initial energy intensity.

Since the decomposition is additive, all entries in columns 11–13 can be summed to the overall change in energy intensity. Comparing the totals of columns 11–13 then reveals that the greatest contribution to the decline in the energy intensity is due to the technology effect in which the industries' changes in energy intensity (column 9) are multiplied by the initial output shares (column 8). In particular, the lower energy intensity in Chemicals and Transport have contributed to the overall decline in energy intensity with more modest contributions by Agriculture and Iron & Steel. The overall impact of industries across all effects on overall energy intensity can be examined in the last column. The largest contributions emanate from Chemicals, Transport, Agriculture, Mining (mainly due to lower output share as discussed before) and Iron & Steel. Unfortunately, due to data limitation, a large part of the change in the economy-wide energy intensity (almost 50%) is hidden in non-specified manufacturing and other industries.

This decomposition suggests that there is a limit to the change that can be generated by changing industry composition of output in that the national average can never fall below the least energy-intensive industry (although the average could shift towards the least energy intensive industry). The analysis shows that significant changes necessarily require changing the industries' energy intensity – that is through technical change. This technical change can be generated by substitution between energy and other inputs (i.e. energy inputs fall because of changes in relative prices) or by technical progress (i.e. energy inputs fall although relative prices are constant).

Table 7: DoE energy balances per unit of output, 1992–2006, Total Tj

		1	2	3	4	6		8		9	10	11	12	13	14
		Total energy use		Gross output		Energy intensity		Output shares		Change		Decomposition of change in energy intensity			
		TJ	TJ	Rm Constant 2005 prices		TJ per Rm									
		1995-7	2004-6	1995-7	2004-6	1995-7	2004-6	1995-7	2004-6	Energy intensity	Output shares	Composition effect	Technology effect	Cross effect	Total effect
1	Agriculture	85,832	73,302	63,482	84,983	1.35	0.86	3.2%	2.7%	-0.49	-0.6%	-0.01	-0.02	0.00	-0.02
2	Mining and Quarrying	159,170	198,949	173,043	188,088	0.92	1.06	8.8%	5.9%	0.14	-3.0%	-0.03	0.01	0.00	-0.02
3	Food and Tobacco	3,150	3,811	131,384	177,477	0.02	0.02	6.7%	5.6%	0.00	-1.2%	0.00	0.00	0.00	0.00
4	Textile and Leather	1,925	1,876	35,706	41,961	0.05	0.04	1.8%	1.3%	-0.01	-0.5%	0.00	0.00	0.00	0.00
5	Wood and Wood Products	2,589	1,060	13,432	21,255	0.19	0.05	0.7%	0.7%	-0.14	0.0%	0.00	0.00	0.00	0.00
6	Paper Pulp and Print	3,951	8,591	45,838	64,171	0.09	0.13	2.3%	2.0%	0.05	-0.3%	0.00	0.00	0.00	0.00
7	Chemical and Petrochems	259,277	147,813	131,318	249,693	1.97	0.59	6.7%	7.8%	-1.38	1.1%	0.02	-0.09	-0.02	-0.09
8	Non-Metallic Minerals	46,054	62,344	21,662	30,495	2.13	2.04	1.1%	1.0%	-0.08	-0.2%	0.00	0.00	0.00	0.00
9	Iron and Steel	233,947	304,228	78,768	128,167	2.97	2.37	4.0%	4.0%	-0.60	0.0%	0.00	-0.02	0.00	-0.02
10	Non-Ferrous Metals	42,505	66,280	21,010	27,933	2.02	2.37	1.1%	0.9%	0.35	-0.2%	0.00	0.00	0.00	0.00
11	Machinery	5,480	2,276	58,315	85,618	0.09	0.03	3.0%	2.7%	-0.07	-0.3%	0.00	0.00	0.00	0.00
12	Transport Equipment	218	322	64,331	148,788	0.00	0.00	3.3%	4.7%	0.00	1.4%	0.00	0.00	0.00	0.00
13	Non-specified (Industry)	252,573	304,540	39,685	56,154	6.36	5.42	2.0%	1.8%	-0.94	-0.3%	-0.02	-0.02	0.00	-0.03
14	Electricity														
15	Construction	13,422	16,061	98,609	147,196	0.14	0.11	5.0%	4.6%	-0.03	-0.4%	0.00	0.00	0.00	0.00
16	Commerce & Public Serv	115,363	197,257	483,309	923,380	0.24	0.21	24.7%	28.9%	-0.03	4.2%	0.01	-0.01	0.00	0.00
17	Transport Sector	570,377	712,030	143,105	309,984	3.99	2.30	7.3%	9.7%	-1.69	2.4%	0.10	-0.12	-0.04	-0.07
18	Non-specified (Other)	406,142	87,829	352,843	506,609	1.15	0.17	18.0%	15.9%	-0.98	-2.2%	-0.02	-0.18	0.02	-0.18
19	Total	2,201,975	2,188,569	1,955,840	3,191,950	1.13	0.69	100.0%	100.0%	-0.44	0.0%	0.04	-0.45	-0.03	-0.44

Source: DoE, various dates

Note: Total energy use is the sum of electricity, gas, petroleum and coal use in Tj.

Energy intensity can also be examined in terms of the capital stock of industries as it may be that energy use is fixed for the capital stock that is currently installed and can only be changed when new capital stock is installed. In terms of total capital stock, energy use has declined by 0.13. This is less than the change per unit of output. Energy intensity increased for industries such as Paper & Pulp, Iron & Steel, Non-Ferrous Metals and the Transport Sector. Agriculture, Wood, Chemicals and Machinery reported declines in energy consumption.

In Column 11 of Table 8, it can be seen that except for the Transport Sector, the composition of capital stock across industries is shifting away from high users of energy per unit of capital such as Agriculture, Mining, Chemicals and Iron & Steel. Unfortunately, all of this is offset by the Non-Specified

Manufacturing Industry. Similarly, the Non-Specified Industries spoil the picture for the technology effect reported in column 12, for without them the overall effect would have been positive, towards higher energy use. In particular, the per unit energy use in Mining and Metals has increased which is not quite counterbalanced by the decline in others such as Chemicals and Agriculture. Total energy intensity has remained more or less the same over the period of observation, mainly due to a a large negative cross-effect contribution of Non-Specified Manufacturing Industries. Thus, although the overall change in energy intensity (last entry in column 9 or 14) would not be much different with or without Non-Specified industries, the signs on the composition and technology effects would run in opposite directions.

Table 8: DoE energy balances, per unit of total capital stock, 1992–2006, Total Tj

		1	2	3	4	5	6	7	8	9	10	11	12	13	14
		Total energy use		Capital stock		Energy intensity		Total capital stock shares		Change		Decomposition of change in energy intensity			
		TJ	TJ	Rm Constant 2005 prices		TJ per Rm									
		1995-7	2004-6	1995-7	2004-6	1995-7	2004-6	1995-7	2004-6	Energy intensity	Total capital stock shares	Composition effect	Technology effect	Cross effect	Total effect
1	Agriculture	85,832	73,302	112,572	106,750	0.76	0.69	4.7%	3.9%	-0.08	-0.8%	-0.01	0.00	0.00	-0.01
2	Mining and Quarrying	159,170	198,949	209,084	224,871	0.76	0.88	8.8%	8.2%	0.12	-0.6%	0.00	0.01	0.00	0.01
3	Food and Tobacco	3,150	3,811	45,608	44,480	0.07	0.09	1.9%	1.6%	0.02	-0.3%	0.00	0.00	0.00	0.00
4	Textile and Leather	1,925	1,876	8,495	7,193	0.23	0.26	0.4%	0.3%	0.03	-0.1%	0.00	0.00	0.00	0.00
5	Wood and Wood Products	2,589	1,060	3,693	3,812	0.70	0.28	0.2%	0.1%	-0.42	0.0%	0.00	0.00	0.00	0.00
6	Paper Pulp and Print	3,951	8,591	16,172	18,216	0.24	0.47	0.7%	0.7%	0.23	0.0%	0.00	0.00	0.00	0.00
7	Chemical and Petrochems	259,277	147,813	155,349	177,547	1.67	0.83	6.5%	6.5%	-0.84	0.0%	0.00	-0.05	0.00	-0.05
8	Non-Metallic Minerals	46,054	62,344	18,727	19,905	2.46	3.13	0.8%	0.7%	0.67	-0.1%	0.00	0.01	0.00	0.00
9	Iron and Steel	233,947	304,228	48,693	41,445	4.80	7.34	2.0%	1.5%	2.54	-0.5%	-0.03	0.05	-0.01	0.01
10	Non-Ferrous Metals	42,505	66,280	22,393	24,844	1.90	2.67	0.9%	0.9%	0.77	0.0%	0.00	0.01	0.00	0.01
11	Machinery	5,480	2,276	11,954	12,487	0.46	0.18	0.5%	0.5%	-0.28	0.0%	0.00	0.00	0.00	0.00
12	Transport Equipment	218	322	16,426	29,414	0.01	0.01	0.7%	1.1%	0.00	0.4%	0.00	0.00	0.00	0.00
13	Non-specified (Industry)	252,573	304,540	4,271	10,498	59.14	29.01	0.2%	0.4%	-30.13	0.2%	0.12	-0.05	-0.06	0.01
14	Electricity														
15	Construction	13,422	16,061	11,170	20,073	1.20	0.80	0.5%	0.7%	-0.40	0.3%	0.00	0.00	0.00	0.00
16	Commerce & Public Serv	115,363	197,257	698,146	820,591	0.17	0.24	29.3%	29.9%	0.08	0.6%	0.00	0.02	0.00	0.02
17	Transport Sector	570,377	712,030	411,596	501,019	1.39	1.42	17.3%	18.3%	0.04	1.0%	0.01	0.01	0.00	0.02
18	Non-specified (Other)			589,047	677,684	0.00	0.00	24.7%	24.7%	0.00	0.0%	0.00	0.00	0.00	0.00
19	Total	1,795,833	2,100,740	2,383,395	2,740,830	0.75	0.77	100.0%	100.0%	0.01	0.0%	0.10	-0.01	-0.08	0.01

Source: DoE, various dates

Note: Total energy use is the sum of electricity, gas, petroleum and coal use in Tj.

An industry's capital stock includes plant, machinery and transport equipment as well as non-residential buildings and construction works. Since energy use technologies are not expected to change much with residential buildings and construction works, it may be useful to consider capital stock in plant, machinery and transport equipment only.

Table 9: DoE energy balances per unit of machinery capital stock, 1992–2006, Tj

		1	2	3	4	5	6	7	8	9	10	11	12	13	14
		Total Energy Use		Capital Stock		Energy Intensity		Mach Capital Stock Shares		Change		Decomposition of change in energy intensity			
		TJ	TJ	Rm Constant 2005 prices		TJ per Rm									
		1995-7	2004-6	1995-7	2004-6	1995-7	2004-6	1995-7	2004-6	Energy intensity	Mach capital stock shares	Composition effect	Technology effect	Cross effect	Total effect
1	Agriculture	85,832	73,302	18,404	17,202	4.66	4.26	4.2%	2.5%	-0.40	-1.7%	-0.08	-0.02	0.01	-0.09
2	Mining and Quarrying	159,170	198,949	52,205	85,478	3.05	2.33	12.0%	12.5%	-0.72	0.5%	0.01	-0.09	0.00	-0.08
3	Food and Tobacco	3,150	3,811	15,888	16,987	0.20	0.22	3.7%	2.5%	0.03	-1.2%	0.00	0.00	0.00	0.00
4	Textile and Leather	1,925	1,876	3,260	3,389	0.59	0.55	0.8%	0.5%	-0.04	-0.3%	0.00	0.00	0.00	0.00
5	Wood and Wood Products	2,589	1,060	1,263	1,821	2.05	0.58	0.3%	0.3%	-1.47	0.0%	0.00	0.00	0.00	0.00
6	Paper Pulp and Print	3,951	8,591	9,362	12,957	0.42	0.66	2.2%	1.9%	0.24	-0.3%	0.00	0.01	0.00	0.00
7	Chemical and Petrochems	259,277	147,813	29,373	73,423	8.83	2.01	6.8%	10.7%	-6.81	4.0%	0.35	-0.46	-0.27	-0.38
8	Non-Metallic Minerals	46,054	62,344	7,050	11,366	6.53	5.49	1.6%	1.7%	-1.05	0.0%	0.00	-0.02	0.00	-0.01
9	Iron and Steel	233,947	304,228	22,915	20,801	10.21	14.63	5.3%	3.0%	4.42	-2.2%	-0.23	0.23	-0.10	-0.09
10	Non-Ferrous Metals	42,505	66,280	9,051	10,205	4.70	6.50	2.1%	1.5%	1.80	-0.6%	-0.03	0.04	-0.01	0.00
11	Machinery	5,480	2,276	3,489	5,892	1.57	0.39	0.8%	0.9%	-1.18	0.1%	0.00	-0.01	0.00	-0.01
12	Transport Equipment	218	322	7,108	19,302	0.03	0.02	1.6%	2.8%	-0.01	1.2%	0.00	0.00	0.00	0.00
13	Non-specified (Industry)	252,573	304,540	1,325	7,493	190.56	40.64	0.3%	1.1%	-149.92	0.8%	1.51	-0.46	-1.18	-0.14
14	Electricity														
15	Construction	13,422	16,061	6,281	14,801	2.14	1.09	1.4%	2.2%	-1.05	0.7%	0.02	-0.02	-0.01	-0.01
16	Commerce & Public Serv	115,363	197,257	69,409	117,654	1.66	1.68	16.0%	17.2%	0.01	1.2%	0.02	0.00	0.00	0.02
17	Transport Sector	570,377	712,030	154,522	226,395	3.69	3.15	35.5%	33.1%	-0.55	-2.5%	-0.09	-0.19	0.01	-0.27
18	Non-specified (Other)			23,757	39,270	0.00	0.00	5.5%	5.7%	0.00	0.3%	0.00	0.00	0.00	0.00
19	Total	1,795,833	2,100,740	434,661	684,436	4.13	3.07	100.0%	100.0%	-1.06	0.0%	1.48	-0.98	-1.56	-1.06

Source: DoE, various dates

Note: Total energy use is the sum of electricity, gas, petroleum and coal use in Tj.

The overall energy intensity per unit of machinery and transport equipment capital stock installed has declined over the period of observation. This result is not dependent (although not shown) on whether Non-Specified Manufacturing Industries are included or not. However, it can easily be verified that the contribution of the latter is decisive for the outcome of the composition effect. Without 'Non-Specified', there would hardly be a composition effect meaning that the net effect of changes in the composition of machinery and transport equipment capital stock washed out an impact on the energy intensity. In particular, the large shift in composition towards relatively high energy users such as Chemicals was offset by declines in the basic metals. The technology effect is negative with large contributions by Chemicals and Transport, but with increases in energy intensity for the basic metals industries. There is a large cross effect which is mainly due to the Non-Specified Manufacturing Industries.

In summary, over the period of observation the energy intensity of South African industries has declined in terms of output or capital stock. It appears that there has been a shift in output and capital stock towards more energy-using industries. However, the technology effect is consistently pointing towards higher energy efficiency.

4.2 Industry feedback on energy trends

In October and November 2010, three focus group meetings were held to gain insights from industrialists and their representative organisations. Amongst other discussion points, the HSRC circulated industry insight pages presenting the data on their sector. This was meant to elicit feedback. Industry feedback is not scientific nor representative. However, it can give an indication of what is happening. This was especially important as, in some cases, the data did not represent trends we would have expected, and so we wanted to understand this. The industries and companies in attendance are listed in Appendix 2. Detailed minutes were kept of each focus group meeting.

4.2.1 Chemical and petrochemical energy intensity

The data shows that the Chemicals sector has consistently improved its energy efficiency since the mid-1990s. This is particularly caused by reductions in the use of coal. The data shows a rapid leap in the electricity intensity in 2001 and of gas in 2005 and 2006.

Given that Sasol is the biggest manufacturer of petro-chemical products, it may dominate other chemical manufacturers and dominate the sector statistics. As a chemical manufacturer, Sasol uses both coal and gas feedstock mix, and is a generator of 45% of its power requirement, as well as having extensive mining operations. It is noted that Sasol has switched from gas to coal in Sasolburg. This means the accuracy of the statistical information is important to the analysis. Factors identified as changing, such as mining activities being further away from the shaft, and moves from open pit to underground operations, could affect the impact of energy efficiency and energy intensity, and have had noticeable impact. The chemical sector saw a rise in electrical intensity in 2001 and a fall in the energy usage via coal, perhaps as result of the Pande field gas supply from Mozambique increasing.

Sasol has been growing, particularly with a move towards beneficiation for a greater mix of high value product (polymers and alpha-olefins). This would have caused higher energy intensity.

In Sasol's sustainability reports, its energy intensity has increased by 20% in the past two years. In 2003–2004 there was a view that its energy intensity was stable although capacity utilisation was high, so when consumption decreases, the energy intensity could have increased.

4.2.2 Steel manufacturing energy intensity

There is consistently falling energy intensity of output, but fast-rising energy intensity per unit of capital from 1997. Gas consumption is the main contributor to these trends, and electricity consumption comes second.

When raw product is sold direct to export markets with reduced beneficiation, then energy intensity will decrease. Plant design and installed capital equipment play a key role in energy intensity trends. A number of large engineering firms provide specialised services to other manufacturing or mining. When these sectors are booming, then engineering fabrication businesses are well-loaded and more efficient.

Cyclical influences can impact on energy intensity, as in 1999 to 2005 when plants were stranded with excess capacity. This improved in 2006 but hit a further down cycle in 2008. It is likely that there would be less energy efficiency in the years of downturn because the lower the production volumes, the higher energy intensity per unit. Where factories run 24 hours a day, they would be compelled to reduce output to a point where all energy efficiency is lost just to keep operations going. The recent downturn saw processes that had been running for decades being turned off and not re-commissioned. Generally the expected picture is that the lower the production, the greater the energy intensity as result of a continuing high base-load energy usage.

4.2.3 Mining sector energy intensity

The data shows that the mining industry energy intensity has risen slowly since the mid 1990s. The data shows that this trend has mostly been driven by coal and petroleum consumption and, to a much smaller extent, gas consumption since 2003. The intensity of electricity use has fallen slowly.

The mining sector is highly diverse. On the one hand, energy intensity in gold mining might increase due to having to mine deeper and into lower-yielding deposits. However, gold is not the growth sector. The mining sector overall has a strong incentive to introduce energy efficiency improvements. The industry participants at the focus group workshop confirmed that their perception is that the mining industry would have done so.

The focus group participants noted that energy use in mining does not vary substantially with output, and with shafts being shut down and mines running at below capacity, this may explain the electricity intensity found in the data. The participants also noted that coal has not been a growing source of energy to the mines, and that the data needs to be corrected.

Electricity and liquid fuels are the dominant energy carriers in mining. It was noted that ferrochrome smelter usage is not included in the mining figures. Coal usage could include beneficiation, and this data should be checked for accuracy.

Mechanisation processes are likely to use more fuel, namely petroleum rather than electricity. However, it is unlikely that gold mining is using more fuel, although this may be different for other bulk users.

4.2.4 Non-ferrous metals

The participants representing the Energy Intensive Users Group in our focus groups expressed the view that the aluminium and titanium producers have invested in energy-efficient technology since 1992, to the point where the Hillside smelter (converted from the old Bayside smelter) and the Mozal smelter are now the two most energy-efficient smelters in the world. There was therefore surprise that the data would show rising energy intensity per unit of output, and rising energy intensity per unit of capital stock since 1994. Another view expressed that the South African smelters' efficiency is low against global benchmarks. This would need to be shown, but if so, the data may be reflecting this. The focus group participants note that, unlike mines, energy use varies directly with changes in output: hence the smelters operating at less than capacity would not in itself lead to rising energy intensity. Moreover, the participants noted an expanded use of coal, which is not reflected in the data.

4.2.5 Measuring mining and smelting

The information available from the Chamber of Mines is aggregated, and individual members would have to be approached in order for more specific data to become available. Eskom has information regarding electricity usage for gold and platinum, which could be viewed in conjunction with output numbers to reach a relative correlation. It is sometimes a problem that smelters are included in the figures and at other times not, and the numbers could also be a combination of mining and beneficiation.

It would indeed be difficult to differentiate the usage in the mining sector overall. In some cases there is smelting on site, and such operations can be large. In such a case, the the distinction in the industrial classification between mining and smelting might be blurred. It is estimated that mining and smelting together accounts for 38–40% of all electricity usage. A further breakdown of energy usage is mining at 14% and industrial at 28%. Electricity redistributors such as metro municipalities account for 40%, and these will also have a strong industrial component within them. It is widely accepted that mining and industrial activity together accounts for 70% of consumption, with residential standing at 14%, and agricultural usage at 2%.

Focus group participants expressed concern that a standard approach be used for monitoring energy use by industry. At present, there are different definitions used by NERSA, DoE, StatsSA and the municipalities.

5 Insights on future energy availability and efficiency

5.1 Introduction

Electricity has historically been cheap in South Africa and, until recent times, plentiful. Industries that are energy intensive such as smelters have been encouraged, and there has been little incentive for energy efficiency. Rolling blackouts in 2008 brought the true state of electricity supply to public attention, with serious implications for the economy arising just at the onset of the global economic crisis. Most seriously affected were firms supplied directly by Eskom, especially the smelters and the mines.

Since then, there has been a question about the approach to electricity rationing and pricing. The HSRC study in 2008 recommended that electricity not be rationed, but instead that the price increase over time in a way that sets expectations and therefore encourages firms and households to improve efficiency. The policy approach has included the announcement and implementation of a known price path over three-year periods (although not always implemented as announced by municipalities), 'carrots' (incentives for improved efficiency), and 'sticks' (disincentives such as the Power Conservation Programme). Industry rationing is currently part of the policy mix, requiring a trade-off between existing operations, expansions and new investments.

There are also efforts to promote the expansion on non-Eskom generation. Examples include the determination of feed-in tariffs that would be paid by Eskom to co-generators and independent power producers (which are usually renewable energy sources); cases where firms generate their own energy; and, finally, future plans for the mix of electricity generation sources as proposed in the Department of Energy's draft Integrated Resource Plan (IRP2010).

It has taken some time to implement these policy elements, especially those related to sticks and carrots, and so this study in part aimed to explore the extent that firms implemented efficiency improvements since the electricity crisis, and what their plans are going forward. We want to know which policy elements have most impact on behaviour.

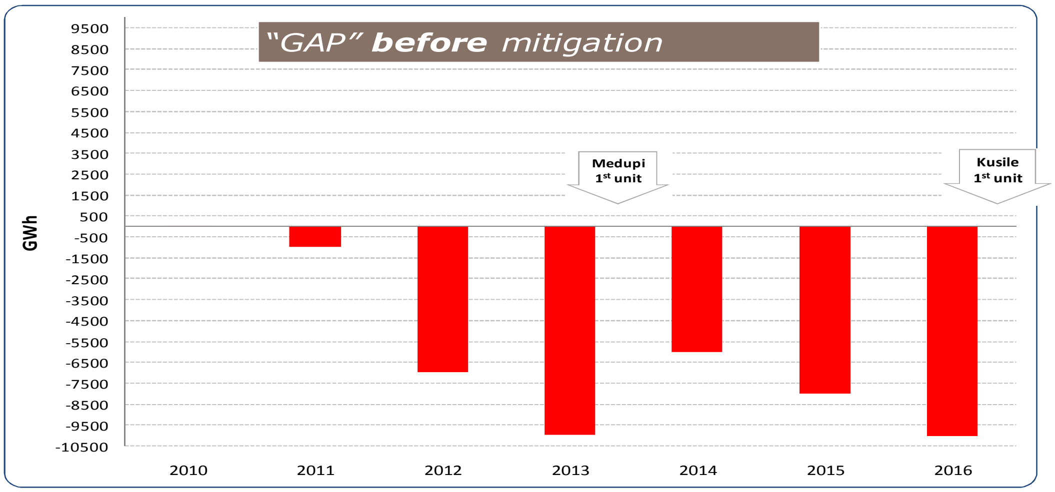
In terms of economic impact, improving energy efficiency could have a major impact on promoting productivity growth, even if there were no shortages. However, in the context of the shortages, the faster firms adapt and improve energy efficiency, the less impact of shortages on inflation, output and employment. There is a real concern that rising electricity prices will encourage firms to instead shut down production or contain expansion, with associated impacts on economic growth and employment. In addition, industry informants say they are currently rationed in a number of ways already: as a result, the economy is operating at below capacity. The implications for employment outcomes should be assessed, although this was beyond the scope of the present study.

5.2 Electricity supply

5.2.1 Potential electricity shortages to 2016

In 2008, when the electricity shortages came to light, there were deep concerns about the effect on potential economic growth. There was a respite, as the pressure on electricity supply waned due to the global economic recession in 2009 and 2010. From a peak of 21 780GWh in July 2007, electricity consumption fell dramatically to a low point of 18 668GWh, recovering to 21 316GWh by July 2010 (Stats SA 2009–2010). Demand for electricity is expected to grow by 5.2 % in 2010/11 (Eskom 2010).

The consequence of proceeding as at present is clearly illustrated in Figure 3 which shows an on-going shortfall in supply capacity starting in 2011 and progressing through to 2016. Various commentators have called for an exceptional effort to be made to bring additional generation into operation, or to effect savings in energy usage in excess of 10% in order to avoid a repetition of the rolling black-out scenario experienced in 2008.



2011 2012 2013 2014 2015 2016

Figure 3: Shortfall in electricity supply capacity to meet expected demand, prior to mitigation strategies, 2011 to 2016

Source: MTRM (2010)

Based on the current path, the total potential shortfall between 2011 and 2016 is estimated at **42 000GWh** over the full period ***or up to 10 000GWh in some years***. This assumes that Medupi Unit no. 1 is 12 months late (coming on line in December 2012); that Kusile Unit no. 1 is 24 months late; that there is no new non-Eskom generation; that there are no demand-side savings; and that the energy availability factor is less than 84.5% as Eskom will have to embark on major plant maintenance. In the near future, there is great concern about a shortfall equivalent to the output of a 1 000MW power station during 2012. We are not sure to what extent the projections take into account current shortfalls where firms are rationed. As noted, different levers may be used to help close the gap.

The reserve margin is expected to reach a low point in the years up to the commissioning of the first units of Mepudi Power Station in the financial year up to end March 2013 (as calculated in the HSRC/WSP model based on the Revised Balanced Scenario). A 15% reserve margin is achieved in 2015, rising thereafter to over 25% by 2023.

The calculation of the reserve margin is based on an overall load factor of 76.7% for all generating capacity. The WSP model indicates a low point reserve margin of below 7% in the year up to end March 2013.

Figure 4 is extracted from the Energy Security Master Plan for 2007–2025 (DME 2008). The MTRM plan document expresses concern that the risk of co-incident outages has risen over the period from 2005 to 2009, and that this trend may continue. In 2009, there was a capacity shortfall of 8000 MW for about 700 hours in the year.

The precise timing of the commissioning of the first unit of Medupi will be very important to the balance of electrical demand and supply, and contingency plans for businesses, public institutions and electricity-reliant consumers should be in place.

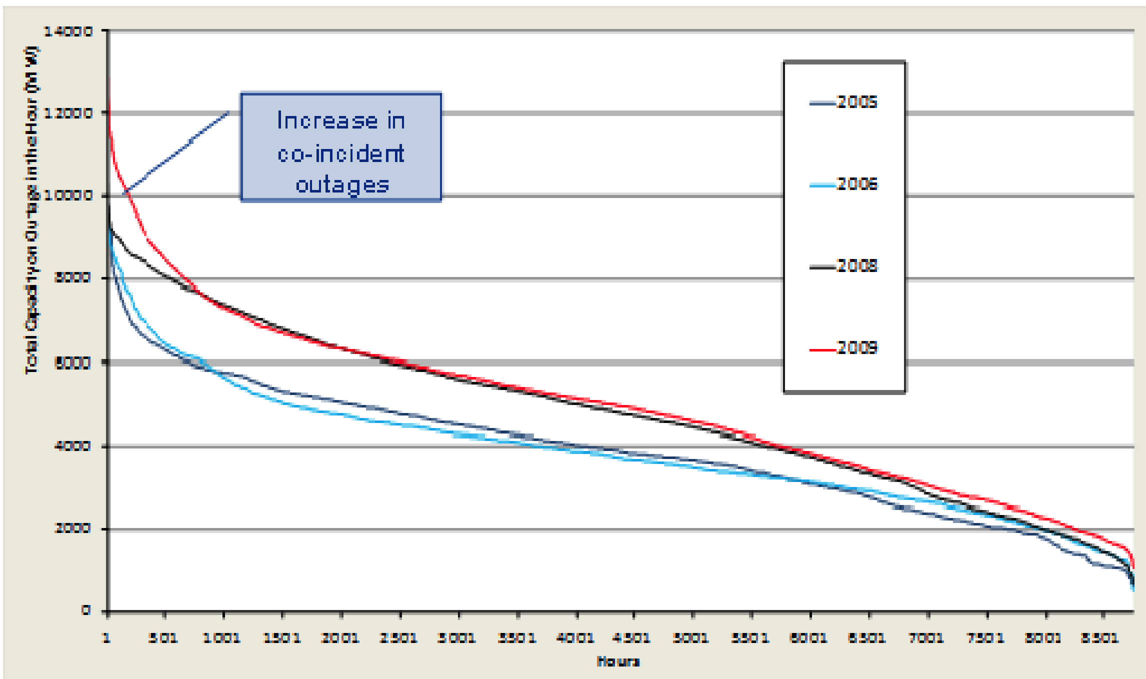


Figure 4: Eskom outage duration curve as extracted from the Energy Security Master Plan

Source: DME (2007).

The Medium Term Risk Mitigation Plan (MTRM) says that 'extraordinary measures are required' to fill this gap, and suggests that it could be done through both the introduction of new supply to the grid, as well as through energy saving. New non-Eskom supply could be drawn from 'own generation' (firms supplying their own needs) (22 500GWh); independent power producers (14 000GWh); co-generation (7 300GWh); and renewable energy producers (302GWh). It proposes that energy savings might be found through ‘efficient technology’ (12 000GWh), ‘efficiency projects’(7 000GWh), and ‘changed behaviour’ (400GWh).[7]

IPP opportunities are potentially sourced from regional imports, municipal generation, multi-site base load IPP programmes, co-generation, or from renewables such as wind, concentrated solar power, landfills, or hydro electricity.

In the medium term, regional imports could potentially be sourced from Zambia (1 000MW hydro), Botswana (1 200MW coal-fired), Namibia (1 000MW gas), and Mozambique (5 000MW coal-fired, gas and hydro). We are not certain about where negotiations currently stand in respect of these opportunities.

There could still be a shortfall of 5 000GWh in 2012 and 2013, and to address this, the MTRM plan proposes that ‘energy conservation’ measures be introduced. This would involve rationing the amount of energy a consumer could use in a month. Any amount consumed above that amount would be subject to a penalty charge.[8] As a last resort, the national power reduction protocol would be activated (NRS 048). It is also possible that diesel-fired peaking stations (open-cycle gas turbines – OCGTs), which are expensive to operate, will have to brought into operation at a scale beyond that currently allowed by NERSA.

The MTRM plan is vague about how it will precisely achieve the targets of meeting the shortfalls. During the period from the start of 2008 through to the end of 2010, some 2 560MW of electrical generating capacity will have been installed by way of the return to service programme and peaking plant open cycle gas turbine generation by Eskom. A further estimated 1 100MW of private generation will have been added, mainly in the form of back-up diesel generation for peak periods, according to a private communication with an industry source. Some new power providers have been signed on. In terms of the Medium-Term Power Purchase Programme (MTPP P), three agreements have been signed with IPPs, potentially bringing on capacity of 277MW. These include Sasol (240MW), SAPPI Saicor (24MW) and IPSA Newcastle (13MW). There are three other contracts under review for a further potential 99MW. Three more contracts are close to implementation with a total capacity of 99MW. There are also efforts by Eskom to ensure that the Kelvin power station (200MW) belonging to the City of Johannesburg is up and running. The procurement of renewable (through REFIT – the renewable energy feed-in tariff) is being managed by the Department of Energy directly with the aim of bringing on 1 025MW, but the progress is not clear. The Department of Energy also has to decide on the final Integrated Resource Plan (it is still in draft stage), which will help determine the implementation of the bigger IPP projects (e.g. the Mmabula, Xstrata, Anglo and Exxaro co-generation projects). These would be governed by the IRP, and do not fall within Eskom’s mandate. It appears that the Department of Energy also aims to introduce another diesel-fired peaking station, although the reasoning is unclear.

New management has been put in place to lead Eskom’s Demand Side Management programme, and it is hoped that it will begin to have greater impact on energy saving.

[7] The amounts in brackets are potential additions or savings over the full period 2011 to 2016.

[8] The energy conservation scheme requires users to maintain their monthly energy consumption below their individually determined allocation (Energy Cap) which is equal to the individuals prearranged ‘normalised reference energy consumption level’ less a publicised saving. The energy conservation scheme requires appropriate technology and systems which at this time only large users have in place. The scheme envisages a progressive roll-out starting with large users and bringing in smaller users as and when the required technology and systems are put in place.

From a timing perspective, there is concern that the procurement of new capacity is not moving at the required pace. It would be essential to hear concrete and specific statements, as well as quarterly reporting to the public about progress against these proposals.

The years 2011 through to 2016 will pose a significant challenge to electricity generators and consumers. For consumers, Eskom tends to cut power to the companies it provides directly, especially the smelters and the mines. It was reported late in 2010 that aluminium smelters are routinely being subjected to load-shedding up to the maximum allowed in terms of the supply contracts, meaning that shortages of power are already being experienced.[9] It is also reported that some mines are operating at below capacity due to electricity shortages. Our interactions in the industry focus groups confirmed that firms are already experiencing rationing. The mines and smelters directly supplied by Eskom were asked to cut their electricity consumption by 10%, and it is not clear to what extent this was done by improving efficiency or by cutting output. There is also evidence of slow approvals of new large scale investments and expansions. Legally, a municipality must approve electricity provision to new investments, although it may delay these by putting them in a 'queue'. In a context of constrained supply, any electricity provided to a new investment will have to take away from an existing user.

The challenge to government is to ensure that there is an enabling environment for new sources of electricity generation so that economic and employment growth are not constrained. The enabling environment has not yet been created where IPPs and own-generators can step into the breach and solve the short-term problem. IPPs are thwarted by a number of impediments which are holding them back from developing wind farms, small, clean coal generation capacity, and co-generation plants.

The HSRC/WSP model of a 'higher road' for renewables would include early wind farm developments of 400MW per annum, and urgent incentivisation of co-generation plants which will provide some relief in respect of the short term generation capacity shortfall. If coupled with solar concentrated plants in future years, this will allow a deferment of the commencement of efforts to build Kusile and expensive nuclear solutions, albeit only by a year or two.

A central policy question asks why the process of procuring energy and efforts to promote energy efficiency have proceeded so slowly. It does appear that the economy and employment will be dramatically constrained at least until 2016, unless more meaningful steps are taken. The steps to be taken are known, so the problems may lie in the process of decision making. While not the subject of this study, a number of concerns can be proposed based on extensive interaction with different stakeholders. The first challenge for rapid and meaningful action seems to lie in the complex and dispersed decision making structures in government, with the Department of Energy setting policy, Nersa regulating, the Department of Public Enterpises as the shareholder, and dti or Treasury having some responsibility for energy efficiency incentives and Eskom financing. The second set of issues relate to the role Eskom plays. It is currently a crucial source of information for decision making, and yet is also a monopoly provider. It is meant to expand the base of energy generation, but at the same time sign on external providers and encourage energy efficiency. It may be conflicted in this role, since it is an investor and provider, but also is meant to be responsible for drawing in competing generators and promote energy saving. Third, Eskom has stated a concern in being able to sign long term power purchasing agreements in the context of three year pricing determinations by Nersa. In turn, independent suppliers are not incentivised to enter the market without long term certainty that the power will be purchased, since currently Eskom is a monopsony as well as a monopoly. There are plans to move power procurement out of Eskom and into an Independent Systems Marketing Operator (ISMO). This is informally being done for REFIT purchases from the DoE but with oversight of DoE and Treasury. It is intended that the

[9] Comment by Mr K. Morgan of BHP Billiton, HSRC focus group, 3 November 2010.

ISMO would procure and sign up the independent producers. A long term approach to pricing, giving an approach for a minimum of ten years is nevertheless required to offer certainty.

Co-generation and renewable energy generation

Co-generation and renewable energy could provide significant electricity generation, in a relatively short time, according to feedback received by the Energy Intensive Users' Group during our focus group workshops (see Appendix 2). Some 7 000MW of co-generation potential is reported to be available, but much of this potential is inaccessible because it is more expensive than the current rates charged for Eskom electricity.[10]

The cost of the 'higher road' for renewables need not be a higher price of electricity for consumers, but an additional R37 billion of borrowings for Eskom (7.1% of turnover in 2025), and some extra R108 billion in net cash proceeds for IPPs in the same financial year.

The target as per the REFIT programme and the Renewable Energy Strategy is 10 000GWh for the MYPD2 period. This allocation will be quickly exhausted by present applications or expressions of interest for wind generation reported as totalling some 8 000MW of installed capacity.

The Final National Climate Change Response Policy will ultimately determine the proportion of renewable energy which is to be absorbed by the national economy by the time each reporting milestone is reached. This will need to be aligned with the IRP2010 when the documents are finalised, and built into the forthcoming MYPD3 planning. Presently the IRP2010 provides for some 15.8% of electrical energy to be generated from renewable sources.

The REFIT pricing for the MYPD2 period provides no guarantees of increases or adjustment to reflect long run marginal cost for those technologies beyond the end of March 2014. If it assumed that no inflationary or price adjustment is awarded by NERSA, the effect will be for renewable energies such as wind to become cheaper than fossil fuel-based generation toward the end of the review period.

Barriers to energy efficiency, co-generation and own generation

In relation to IPP contributions, there was a view that it has proved impossible to make business case for non-Eskom generation, without certainty of a place for non-Eskom generators as part of the overall generation mix. It had been understood that 400–500MW of non-Eskom generation had been allocated in the MYPD2, but Eskom's intentions remain unclear and it is therefore difficult for IPPs to take the risk of bringing on new capacity.

There are many possibilities for co-generation investments but progress is slow and investment is constrained. A mandate is needed for Eskom, government and industry to work together and find ways around the regulatory constraints. For example, on co-generation there is a range of issues that need to be resolved, such as power purchase agreements, fair charges for wheeling, grid code requirements, and a fair price which incentivises co-generation. All the challenges are related to policy or regulatory constraints. These concerns are being taken up by NEDLAC because the mandate and terms of reference must be accepted by the Council as a first step.

[10] Personal communication with Dr L Lotter, Executive Director, Chemical Allied Industries Association, about the need for COFIT pricing certainty.

Other challenges include:

- Eskom needs to gear up and retool in order install new connections.
- National Treasury and tax incentives must be available to co-generation operations.
- The technical specifications are not readily available and it is important to have a simplified grid code connection document; this is being worked on at present by a NERSA group.
- The price curve and certainty thereof will have a strong influence on new generators since if there is certainty then investment decisions can be made. However, NERSA does not have the power to guarantee any Eskom price beyond the MYPD2 period. Government therefore needs to empower NERSA to take a portion of the energy basket and guarantee a forward price.
- It is a challenge to make investment decisions on new ventures in the absence of any long-term idea of energy supply, and this also makes it difficult to plan for growth. This applies to most companies people as regards normal investment decisions. However, if the bureaucratic process was able to give certainty, then investments would be made.

In our industry focuse groups, there was a view expressed that there is a deep distrust among IPPs of Eskom, NERSA, and the DoE. There have been efforts made in the past to improve energy supply which have seen little success, and Eskom is viewed as being unreliable. There is also some cynicism regarding the future for renewables, where there is no acceptable power purchasing agreement in place, or any indication of how power will be allocated between generators, all contributing to a negative business climate for IPPs. There was also concern for the complex decision making framework in government.

There has also been an attempt by large international companies to invest in co-generation but they have lost money trying to do so. Although the environment is improving, this experience has dissuaded some companies from investing.

There is an additional challenge for electricity supply in the framework that sees municipalities transmitting electricity. NERSA has conducted an audit on maintenance and technical standards which indicates a huge backlog of work required on the distribution network. Eskom appears to have R30 billion to spend on maintenance, but municipalities have frequently run out of money and do not do maintenance as the benefit in the public perception is not tangible. A report is being prepared on municipal maintenance of electricity distribution systems. Weak maintenance could pose a very serious threat to reliable electricity, even if the supply is available.

5.2.2 Electricity supply to 2025

Going forward, future demand for electricity will partly depend on what is decided in respect of the energy mix. The Integrated Resource Plan (DoE 2010a) issued in November 2010 proposes possible energy futures. It puts forward many possible scenarios and explores the impacts of higher renewable energy generation, carbon taxes, and the costs to the economy.

In the Integrated Resource Plan 2010 scenario labelled 'Balanced Revised', the projection of demand is shown as growing from a base of 266 000GWh in the 2010/11 Eskom financial year to 400 000GWh projected for 2024/25. The expected growth in Gross Domestic Product over the same period is assumed to be 4.2% pa, and the electricity growth over this period, 2.8%.

The expansion of the Southern African region generating capacity over the period up to end March 2025 is planned to be effected mainly by the following programmes:

- The current coal-based phase to add 9 650MW before coal generation is reduced by some 6 043MW in a phase out of older stations scheduled to commence in 2020/21.
- Wind generation of 9 500MW.
- Solar generation of 800MW.
- Gas fired generation of 2 916MW.
- Co-generation of 1 540MW.
- Imported hydro generation of 3 349MW.
- Nuclear generation of 6 400MW.

The urgency of decisions required from government and NERSA to ensure the achievement of needed capacity and generation cannot be overstated. These are outlined in the IRP2010. The Balanced Revised Scenario assumes that: decisions are taken in respect of the expansion of the renewable energy budget by NERSA; a nuclear solution for base-load energy generation is accepted; international agreements are signed for regional supply; and that IPPs are introduced more rapidly. The time horizon for nuclear generation is typically about sixteen years (see EPRI 2010). While some progress has been made in preparing for this programme, the base-load generation decision required for the years from 2021 will be required by 2011, according to discussions with Eskom and with some industry participants in our focus groups.

Energy efficiency is meant to be a central contributor to solving energy shortages. However, there are alos other benefits. From an economic perspective, and in terms of the impact on poor households, a move toward greater levels of energy efficiency and a lower energy usage per unit measure of national output would be a contributor to generating a labour bias in the economy. Productivity and efficiency improvements can encourage growth and employment. South Africa's energy intensity biases the economy towards capital-intensive investments. Firms might improve their efficiency in response to the substantial price increases, or they might take advantage of the emerging support measures available to improve their technology or processes. However, if electricity consumption is reduced as a result of containment of output, expansions or new investments, this will have a negative knock-on effect on potential growth and job creation. There is evidence of both.

Electricity price increases have an effect of discouraging demand and incentivising energy efficiency initiatives. The IRP2010 reports an anticipated gradual reduction in energy intensity from a figure of 0.129kWh/R of gross value added to an expected 0.1kWh/R of value added by 2034. If the same reduction in energy intensity as indicated in the IRP2010 (see Table 18) is brought about, the net effect will be a reduction in energy intensity of 15% by 2025.

5.3 Energy efficiency

Data available from the Department of Energy shows that many industries were already improving their energy efficiency, even in the context of low prices, and prior to the energy crisis in 2008. This effort to reduce energy usage became more intense and was explicitly discussed from the period of the 2008 rolling blackouts in order to enable Eskom to stabilise the grid.

As to the cause of the drop in energy intensity, there is uncertainty. In section 4, we reviewed possible reasons indicated in the data over the period from 1992 to 2008 when energy intensity fell by 44% (see Table 7). The structure of industry slightly shifted towards more energy intensive sectors. However, we found that technical change was the main contributor to improvements in energy intensity, and there was a large fall in energy intensity per unit of machinery capital stock. However our discussions with small industry focus groups called some of the data into question. For example, the chemicals industry was an important contributor to overall improvements in energy efficiency. However, they noted that SASOL accounts for about 45% of chemical industry output and this company has experienced rising energy intensity. Much more investigation is needed into the data available, so that trends can be monitored more closely.

Below, we review more specific possible contributors to changing behaviour in electricity consumption. Eskom and the Department of Energy are relying heavily on the possible improvements in the efficiency of electricity use, as part of the overall IRP2010 and Medium Term Risk Mitigation Plan to 2017.

The reader is guided to Appendix 3 where contributors to energy efficiency are discussed. Energy efficiency will in the first instance be encouraged by the dramatic price increases implemented since 2008. But there are specific programmes to intensify energy efficiency and to promote rationing when required. Appendix 3 reviews the demand side management programme, demand market participation and energy conservation scheme. These programmes either incentivise efficiency or require rationing when electricity is not available. The DSM programme at Eskom went into demise for a period, and there was a view that the main seller of electricity was not well placed to promote long term containment of demand. However, the DSM function was not taken up by other government bodies and is now being revitalised within Eskom. There are a range of technologies that could be adopted. Some are reviewed in Altman et al (2008), and for the reader's reference some listed in Appendix 3 such as LED lights, energy efficient motors, fans and pumps, compressed air, hot water systems, those related to refrigeration, heating, ventilation and air conditioning, amongst others. Their application and potential to improve energy efficiency varies dramatically by industry. The costs incurred to implement most of these technologies can be recovered in anywhere from one to five years.

There are a range of investment incentives available that might encourage faster adoption of energy efficient technology and processes. A comprehensive list is offered for the reader's reference in Appendix 3. Some existed prior to the energy crisis, such as accelerated depreciation allowances and technology support programmes. Some new programmes have recently been introduced. Most notable is the 12I and 12L tax allowances which are specifically aimed at promoting energy efficient equipment or for proven energy savings in operations. The dti has introduced an Energy Efficient Stimulation Programme to cover up to 50% of the value of qualifying investment costs in energy efficient equipment. There are other private measures to support the adoption of energy management systems (EMS). Most notably firms spoke about support available from the Clinton Foundation. The extent of take up of incentives for energy efficiency investments is still apparently slow according to the industry focus groups: However, this might be expected in the context of pressures on firms associated with the downturn. In addition, even successful investment incentives can sometimes require three years or more before firms take them up meaningfully.

There is currently a coordinated effort by industry to save 5000 MW from the electricity grid. It is probable that if successful, the contribution will be made by a combination of energy efficiency measures as well as the introduction of own-power production where firms reduce their reliance on the grid.

5.3.1 Industry views on future energy efficiency

Three industry focus groups were held and revealed certain findings about the likely adoption of energy efficiency measures in the near future. Focus groups were held in order to gather industry views on the following:

- To gain industry insights into data on sector energy intensity trends, and whether this reflects their reality;
- To gain insights into company and industry plans in respect of energy usage; and

- To review potential impact of incentives and regulations on energy use.

The investment case for energy efficiency has to take its place amongst competing projects. While electricity used to be a relatively small expense for businesses, it is now proportionately a much higher cost and it is important to manage this resource optimally. However, energy efficiency must compete with other new plant expenditure for finance, as there are no additional funds flowing into companies simply because of the energy crisis. At a global level, a portion of capital expenditure goes to energy, but one cannot apply the same investment rules on a plant giving a rate of return of 150% or an energy project that gives 50%. There is a definite swing to energy projects but this is slow.

With DSM funding, it is possible to re-design a system, and then get a reasonable pay back over a period of time. Merely replacing a part of the system, e.g. the motors, may permit underlying inefficiencies to remain. Workable solutions with major impacts require redesigning systems.

Based on current tax allowances, and with rising energy prices, businesses will have an incentive to make use of the new tax incentives. Section 12I of the Income Tax Act is an energy efficiency improvement motivator for new and brownfields projects for all businesses, and Section 12L is a notional year-on-year improvement allowance available to manufacturers.

5.3.2 Opportunities and constraints in manufacturing

The major energy efficiency gains will in future be by the adoption of energy management systems, which would involve installing measurement, monitoring reporting and targeting systems, in accordance with ISO50001. The energy audit process is an integral part of this systematic approach.

Some short-term gains will have been achieved by way of switching to efficient lighting, and by using sensors and switches to prevent wastage. Further gains will require the re-design and re-engineering of processes in order to eliminate fundamental energy inefficiencies.

This would include installing energy efficient motors and variable speed drives for fans, pumps and conveyors. By using modern lighting (including high bay), compressed air and heat recovery and by replacing boilers with combined heat and power plants, further gains can be made. These technologies will require significant investment, but with financial support for energy audits, and incentives for capital cost spending, energy savings of approximately 20–30% are achievable.

The focus groups drew out a view that there is more energy efficiency improvement activity than is commonly assumed. For example, the motor industry has been developing energy efficiency mechanisms for some years now. However, on the actual production side, many of the fully automated processes are less energy efficient than when using a more labour intensive ones.

Pricing and security of supply remain critical issues. However, for most, security of supply is the first and most pressing issue. This is greatly influencing investment decisions, judging by the views expressed. Behavioural changes have had some influence in regard to efficiencies and more energy-efficient technologies.

Regarding cost of energy and reliability – there were two power failures in September and October in Merebank, Durban lasting an hour each, and these cost the Engen refinery approximately R100 million,[11] so the cost and supply of electricity is a huge variable expense. With the electricity price increases, there is a growing dependency on foreign shareholders to put money into cleaner fuels and environmental improvements, but they will not be keen to invest without a reliable energy supply.

There is no new power available to large power users, although as a small user it is still possible to gain connections. A new smelter can only get power in five years from the present time and this will be 75% interruptible. This is clearly poses a constraint on investment.

Sound businesses would also be thwarted because of the lack of electrical power supply in areas where the distribution network is inadequate. City Power (Johannesburg) was unable to accept applications from large users requiring a total of 300MW in a recent year.

There is a difference in the way large and small developments are handled. For example if a smelter is being built, Eskom will build a power-line to the smelter and assure supply, depending on the availability of capacity, but a small development will not be treated in the same way. This means that the existing power-line could become overloaded. These kinds of constraints are to be found at all levels of the distribution grid.

5.3.3 Opportunities and constraints in agriculture

Small-scale hydro-generation, pump storage, solar and wind-powered pumping can contribute to the energy efficiency of farms in the future. The potential of co-generation (producing electricity from burning methane which is produced in biological digestion plants) is large, using pig, poultry and cattle manure. It is envisaged that packaged plants will become available to serve this market.

Some quick but relatively small energy savings can be made in offices and residential accommodation on farms with efficient lighting (CFLs) and solar water heating.

The more expensive technologies could be supported by way of programmatic DSM and grant schemes, which could unlock energy savings and own-generation of 40% of present usage for mixed farming.

Participants in our focus group expressed concern that margins are thin in agriculture and this will constrain adaption. There is a specific incentive to ensure security of supply in activities that require cold storage.

5.3.4 Opportunities and constraints in mining

The major energy savings gains in mining are being achieved with the adoption of energy management systems, which involve installing measurement, monitoring, reporting and targeting systems, in accordance with ISO50001, and by making energy management a line responsibility. The energy audit process is an integral part of this systematic approach for identifying and prioritising energy-saving opportunities. About 400 MW had been saved in this way over the past three years.

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[11] Information supplied by Mr B Payne at an Industrial Sector focus group discussion.

A systems approach is needed to the analysis of the energy usage through the process flow to address the energy savings areas optimally. It is estimated that, even after initial gains, a further 20% reduction in energy usage will be achieved in future years, but only with significant investment.

The major gains in the mining industry to be had in the medium term are by way of compressed air (correct specifications, reduced pressures and with variable speed drives), refrigeration applications (ice slurry, hard ice), and from the many applications of motors (fans, pumps, conveyors), where the load is more accurately matched to the motor and drive.

Co-generation opportunities are possible where chemical reduction is taking place (in the presence of coal), and where partially combusted gases are released or flared.

The focus group participants noted that the energy conservation scheme will focus on the top 500 energy intensive users. It is meant to be a safety net should the main MTRM Plan measures not be adequate. It does appear that there is an expectation of substantial reliance by Eskom and DoE on the ECS programme. The focus group participants believed this would result in curtainled production.

Much can be gained, even in the short term, by the prevention of leaks and ex-filtration into worked-out stopes, and also by repairing leaks to the compressed air systems. Similarly, regular conveyor idler inspections are necessary. Maintenance management and staff training are at the heart of success in this area.

The mining sector could potentially create more than 200 000 jobs directly as expressed in the Government's Growth Path, and outlined in detail in the HSRC's mining employment scenarios. The largest opportunities, even within the constraints of environmental legislation, are in platinum group metals. This industry is difficult to mechanise, so it will remain labour-intensive for the foreseeable future.

Plans to develop platinum mines are on hold due to concerns about Eskom capacity. One-third of platinum production is refining and smelting, with electricity accounting for 15% of the value chain. The sector requires 1 000MW to grow, and this supply is not presently available. There are very high costs – for example, a pre-feasibility study could cost R300 million, and it may find there is ineadequate power for the project. Reliable energy supply is therefore crucial to the continued existence of this industry and others.

Although mining is constrained by a lack of electricity, there should also be ideas around new growth paths. The Chamber of Mines has conducted studies on unconstrained input supply. Electricity is one constraint, but transport, skills, liquid fuels, and, in some sectors, the water supply may also be critical constraints. Transport is a key challenge. At present 30 000 trucks travel from the Northern Cape to ports, and the intention is to upgrade rail links in the Northern Cape, but this cannot be done until an adequate electricity grid is in place. The constraints vary between the subsectors.

5.3.5 Opportunities and constraints in the commercial sector

Aside from 'harvesting low hanging fruit' in office lighting and in supermarkets, there are many opportunities for further energy efficiency gains in this sector. By addressing behavioural aspects of usage, much wastage can be eliminated in buildings, in the short term. HVAC application savings can be made by adjusting set points. These measures can save 10–30% of initial usage. These gains can be made more permanent by installing sensors on lighting switches, to allow for low occupancy or day-lighting, and by installing HVAC controllers, and building management systems. Modern chillers are inherently much more efficient than old technology, and coupled with more efficient lamps, luminaires and electronic ballasts, energy usage in buildings can be halved in the medium term.

There are challenges in promoting energy efficiency in the commercial and property sector.

- In property, the owners and managers are not the end users. About 40% of electricity usage lies outside of the control of owners and managers. There is control only over common services such as central air conditioning.
- There is a short-term horizon amongst property owners. Properties are increasingly owned by public companies who buy and sell to maintain yields. This reduces the incentive to implement energy efficient investments.
- It was believed that the tax allowances would not be the right incentive for property owners since the benefit would be realised upon sale. This would need to be clarified.
- The average commercial lease in SA is three years, as compared to 10 in the USA. This provides little incentive to firms to upgrade infrastructure.
- While the EIUG is well coordinated on energy questions, other sectors are much less so. For example, it was noted that SAPOA had only met once in the previous year to discuss energy issues. There is therefore less commitment to actions that would benefit the industry such as joint learning or joint submissions to Nersa or Government. For example, it was note that there are benchmarks and approaches in respect of lighting standards, or in the management of leases. On the latter, it was noted that rentals could be made on the "cost of occupancy" rather than rental cost. If based on occupancy, the cost of energy would be reflected, whereas if charged on rental, the electricity cost is accounted for separately. This approach would raise the attraction of locating in an energy efficient building.
- Unlike the EIUG, perhaps where there is greater prevalence of internal engineering capability, the commercial property sector finds the DSM programme complex and difficult to use. There was a common view that the BMS systems are being explained in a way that is opaque and that the benefits to the systems are unclear to them. It was felt that the engineers involved were selling technology and not management solutions with after-sale service. There was also concern that there was a sense that the Energy Services Companies (ESCO's) had vested interests as they were sometimes linked to a vendor. The participants in the commercial sector focus group (and not in the other groups) spoke extensively about the Clinton Foundation service providing independent support to identify approaches to energy efficiency. It was believed that this type of approach is needed in the DSM programme.

6 Conclusions

Electricity has historically been cheap in South Africa and, until recent times, plentiful. Industries that are energy-intensive such as smelters have been encouraged, and there has been little incentive for energy efficiency. Rolling blackouts in 2008 brought the true state of electricity supply to public attention, with serious implications for the economy arising just at the onset of the global economic crisis. Most seriously affected were firms supplied directly by Eskom, especially the smelters and the mines.

In 2008, the Human Sciences Research Council (HSRC) prepared independent recommendations on an appropriate price path for electricity charged by Eskom, keeping in mind the needs of both the economy and Eskom itself. The context was one of electricity shortages, mostly caused by underinvestment and poor management of coal stocks. It became clearer to the public and policy makers that some critical decisions were needed to overcome these challenges. This included decisions required by the National Energy Regulator of South Africa (NERSA) on the electricity price. The Presidency and the National Electricity Response Team (NERT) required support to form a view on an appropriate approach to raising the price to cover costs. This was regarded as an important contribution by an institute that does not have a vested interest in the outcome.

Since then circumstances have changed, especially with the global economic slowdown. In addition, new information is continuously coming to light in a context that has, until recently, been characterised by very limited knowledge-sharing. Further, it appears that South Africa's 'electricity crisis' will not go away soon. In 2008, when the electricity shortages came to light, there were deep concerns about the effect on potential economic growth. There was a respite as the pressure on electricity supply waned due to the global economic recession in 2009 and 2010. From a peak of 21 780GWh in July 2007, electricity consumption fell dramatically to a low point of 18 668GWh, but recovered to 21 316GWh by July 2010 (Stats SA 2009–2010).

There have been questions about the approach to rationing electricity and its price. The HSRC study in 2008 recommended that electricity not be rationed, but instead that the price should increase over time in a way that sets expectations and therefore encourages firms and households to improve efficiency. The policy approach has included the announcement and implementation of a known price path over three-year periods (although not always implemented as announced by municipalities), 'carrots' (incentives for improved efficiency), and 'sticks' (disincentives such as the Power Conservation Programme). Industry rationing is part of the policy mix, requiring a trade-off between existing operations, expansions and new investments.

It has taken some time to implement these policy elements, especially those related to sticks and carrots, and so this study in part aimed to explore the extent to which firms implemented efficiency improvements since the electricity crisis, and what their plans are going forward. We wanted to find out which policy elements have most impact on behaviour.

In terms of economic impact, improving energy efficiency could have a major impact on promoting productivity growth, even if there were no supply shortages. However, in the context of the shortages, the faster firms adapt and improve energy efficiency, the less the impact of shortages will be on price levels, output and employment. There is a real concern that rising electricity prices will encourage firms to instead shut down production or contain expansion, with associated downstream impacts on economic growth and employment. In addition, industry informants say they are currently rationed in a number of ways. The implications for employment outcomes should be assessed.

There are a range of recent policies that may impact on energy use and efficiency. These include the Multi-Year Price Determination (MYPD), reviewed annually by NERSA; the feed-in tariffs that would be paid by Eskom to co-generators and independent power producers (IPPs) (which are usually renewable energy sources); the introduction of measures to promote energy savings; the approach to rationing electricity when there are shortages; the extent to which firms generate their own energy; and, finally, future plans for the mix of electricity generation sources as proposed in the Department of Energy (DoE)'s draft Integrated Resource Plan (IRP2010). The National Economic Development and Labour Council (NEDLAC) recently completed a detailed document reviewing approaches to pricing for the poor (NEDLAC 2010).

The Integrated Resource Plan 2010 (DoE 2010a) was issued for comment in October 2010. Its aim is to 'determine long term electricity demand, and detail how this demand should be met in terms of generating capacity, type, timing and cost' (DoE 2010a, p. 1). Seventeen scenarios are compared and ranked based on their costs, impact on climate change mitigation, localisation and job creation potential, regional development impacts, diversity of energy sources and security of supply and energy efficiency. The document proposes a 'Revised Balanced Scenario' for energy mix. This would involve a mix of new generating capacity to be installed after the current coal 'build'. The additional generating capacity would be comprised mainly of renewables (33%) and nuclear power (25%), complemented by gas-fired generating facilities.

This report updated the HSRC 2008 research to take account of changed circumstances and improved knowledge to make it more accurate. The aim was to see how changed circumstances might influence Eskom's price and policy choices, and how the chosen price path might affect the economy, employment and incomes.

A critical component of this analysis was to explore the potential impact on poor households. In this, we reflect on the distributional impact of policy choices in respect of electricity. Often this is understood to mean the direct impact of rising electricity prices paid by the poor. Yet this is only one half of the challenge. The other half relates to employment creation, and price increases created indirectly where the price of goods normally bought by poor households rise disproportionately as firms pass on their electricity price increases.

The first part of the project focused on updating our work on the potential impact of the price path on the economy, employment and distribution of income. In this, we faced a critical challenge as we had deep concerns about the quality of energy data currently available.

The second part of the project updated our work on industrial responses. It is now three years since the initial load-shedding events of 2008, shortages are still felt, and further shortages are looming on the horizon. Government and Eskom have honed in on some policy offerings to encourage savings. Firms have now had time to respond, and more actors have factored in the inevitability of electricity price increases. We need to see how far companies have gone with respect to changes in their expectations and consider how this may have affected their plans for the future. Three industry focus groups were held to canvass experience and perceptions and to validate sector trends, especially in the mining, manufacturing and commercial sectors.

Finally, we updated our financial model to build a view to 2025 in order to consider the likely impact of electricity pricing on Eskom's sustainability going forward.

Some of the critical points which emerged in this report are summarised below.

- NERSA ruled in 2010 that the nominal electricity price should rise by about 25% per annum over the coming three years covered by MYPD2 (the second price determination).
- We modelled the impact of a once-off price increase of 35%, which was what Eskom asked for in November 2009. The impact on Gross Domestic Product (GDP) would be very small, approximately -0.1%. The producer price index would rise by 1.3% more than it would otherwise, and this would raise the cost of a representative basket of South African exports by 0.9%. At first glance, this result might seem surprising. But it must be remembered that electricity accounts for only 1.1% of all costs in services and manufacturing. Electricity contributes 2% or less to total costs in 72 out of 94 sectors in the economy. There are ten sectors where electricity accounts for about 4% of costs or more, such as chemicals, non-ferrous metals, general hardware, textiles, tyres, gold mining, and accommodation.

- We looked at the impact of a once-off 25% increase in the electricity price. In this case, the Consumer Price Index (CPI) for all households rises by 0.88%, with 0.53 % coming from direct effects and 0.35% from indirect effects. The impact is greater on poor households than on rich ones. This is driven almost entirely by the direct impact, which in turn is driven by the relative shares of total expenditure on electricity. Thus the richest households allocate 0.8% of their expenditure to electricity, so the 25% price rise raises their expenditure by 0.2%. By contrast, the poorest households spend 5.4% of expenditure on electricity, so the 25% increase raises their expenditure by 1.35%. Against this, the indirect effects are relatively uniform across household groups, contributing 0.40% to the CPI increase for the poorest and 0.32% to that for the richest.
- In its 2010 MYPD2 ruling, NERSA provided guidelines for acceptable tariff revision for municipalities. NERSA has surveyed municipal prices and this review process has shown that many municipalities are raising the electricity price well beyond this ruling. We drew a sample of 25 municipalities and found that their electricity tariffs for small firms rose by 39% to 90% over the period from October 2008 to November 2010. Based on Treasury and NERSA guidlelines, it would be expected that municipal electricity rates might have increased by 49% to 59% over this period. Twelve (12) of these municipalities raised their small business tariff by 60% to 90% over this period. In addition, the starting price is already considerably more than that charged directly by Eskom. Half of the municipalities reviewed charged more than 150% of the Eskom rate. For example, in November 2010, Eskom charged 49c per kWh to small businesses, whereas Cape Town, Johannesburg (City Power), and Ethekweni respectively charged 77c, 88c, and 84 c per kWh. Perhaps reflecting the character of its energy intensive business in Ekurhuleni, the rate was lower than many of the others at 63c per kWh. The municipalities rely quite heavily on cross-subsidies from electricity revenue. However, these increases may have the impact of slowing investment and employment growth, especially in weaker regions.
- In terms of pricing and services for the poorest households, there has been some debate about whether municipalities are applying guidelines in respect of free basic electricity or on pricing. We called a sample of 44 municipalities and found only 10 providing free basic electricity. We also scanned tariffs for low-income consumers in these same municipalities (with information provided by NERSA). The tariffs for those consuming less than 50kWh per month varied between 41c/kWh and 91c/kWh, but mostly fell into the range of about 60c to 75c. The tariffs for those consuming 51kWh to 150kWh/month ranged from 42c to 92c/kWh, although mostly they charged between 65c and 85c. NERSA began gathering information on municipal pricing in 2010, and should do the same for the provision of free basic electricity. This is long overdue and the regulator should be encouraged to sustain this survey.
- The WSP Energy Group Africa/ Human Sciences Research Council (WSP/HSRC) model of Eskom's financial status under different scenarios was further revised for this project, to update assumptions in a changing economic environment, to account for policy changes, and to extend it to 2025. The IRP2010 base assumptions are used, such as plant costs, operating costs, load factors, etc. The research team engaged with Eskom and an expert roundtable was held in October 2010 in respect of assumptions on the inputs to the model. In addition, the model now offers: an industry-wide financial model of Eskom and IPPs to show viability of different options/paths; a long-run margin cost comparison; extensive user input fields for scenario planning; and result outputs that are easy for many stakeholders to relate to. The test of the model was the closeness to the IRP2010 outcome on pricing, which we found to be strong.

  Two scenarios were produced, which compare the IRP2010 balanced scenario with the introduction of some 4 500MW of independent wind generation, and a pricing progression of five increases each of 25% from 2010 and subsequent years. The alternative scenario adds an extra 700MW of wind as early as can be achieved to alleviate short-term power shortages. We also assume there is an extra co-generation of 1 460MW via a COFIT [Co-generation Feed-In Tariff] programme based on pricing equal to the long-run marginal cost for new coal. Finally, we assume the earlier retirement of one coal unit.

  Eskom targets financial ratios appropriate for a public listed company, and it is worth asking if these are the appropriate ones for a state-owned monopoly with certainty of demand. Nevertheless, the focus of our results is on whether the proposed price increases would enable Eskom to achieve stated targets of profitability, interest cover and debt:equity ratios. Eskom is targeting an interest cover of 3.0 and debt:equity ratios below 200%.

The IRP2010 scenario has the real compound price of electricity rising by 265% between 2008 and 2019. The unit price increases to R1.20 by 2019. Interest-bearing debt peaks in 2014 at R275 billion and falls to R90 billion by 2020. This price increase would result in losses after tax and interest until 2012, whereafter net profit rises to R82 billion by 2020. Interest cover rises to 2.0 by 2013 and reaches 5.5 by 2018. The debt:equity ratio falls to below 200% by 2014, and to extremely low levels thereafter. It would appear that these price increases very quickly return Eskom to its required ratios within a very short space of time. A judgement is needed in respect of whether this pace of recovery warrants the very large annual price increases being introduced. It does certainly seem that the price should be reduced in real terms from 2016.

In the alternative scenario, interest-bearing debt peaks in 2014 at R270 billion, and falls to R215 billion by 2018. Profit after tax and interest is negative in 2012, but rises above R10 billion in every subsequent year, reaching R51 billion in 2018. Interest cover is above 2.0 in most years and reaches 3.0 by 2016. The debt:equity ratio falls below 200 by 2014, and to extremely low levels quite quickly.

- Economic and employment growth are likely to be hampered by electricity availability, at least until 2016. The Medium-Term Risk Mitigation (MTRM) Plan was issued to promote discussion in respect of options for electricity security to 2017. The Plan shows a potential shortfall that would mostly be filled by the feeding in of independent power producers and by co-generation. However, the IPPs and co-generators are being signed up too slowly to fill the gap timeously. Should the gap in electricity supply not be filled, as seems likely, rationing will be necessary. There is a trade-off between supplying existing businesses, business expansions, or new investments. Currently, the simplest route is to ration highly energy-intensive companies directly supplied by Eskom, generally the smelters and the mines. Government faces a legal challenge as it cannot legally deny a new investor access to electricity. However, our focus groups showed that, in practice, the municipalities are delaying approval for new connections to large new investments and expansions. The slow sign up of cogenerators and independent producers will lead to a heavy reliance on the Energy Conservation Scheme and associated rationing going forward. While energy efficiency may rise as a result, in this short period it is more likely that this rationing will lead to lower than potential output. This will most certainly dampen potential growth and employment at a time when it is sorely needed. This approach is most certainly not consistent with the aims of the Growth Plan, and will make it virtually impossible to achieve its targets. This is explained by the compound employment and output growth – if growth is constrained for 5 years.
- A central policy question asks why the process of procuring energy and efforts to promote energy efficiency have proceeded so slowly. It does appear that the economy and employment will be dramatically constrained at least until 2016, unless more meaningful steps are taken. The steps to be taken are known, so the problems may lie in the process of decision making. While not the subject of this study, a number of concerns can be proposed based on extensive interaction with different stakeholders. The first challenge for rapid and meaningful action seems to lie in the complex and dispersed decision making structures in government, with the Department of Energy setting policy, Nersa regulating, the Department of Public Enterpises as the shareholder, and dti or Treasury having some responsibility for energy efficiency incentives and Eskom financing. The second set of issues relate to the role Eskom plays. It is currently a crucial source of information for decision making, and yet is also a monopoly provider. It is meant to expand the base of energy generation, but at the same time sign on external providers and encourage energy efficiency. It may be conflicted in this role, since it is an investor and provider, but also is meant to be responsible for drawing in competing generators and promote energy saving. Third, Eskom has stated a concern in being able to sign long term power purchasing agreements in the context of three year pricing determinations by Nersa. In turn, independent suppliers are not incentivised to enter the market without long term certainty that the power will be purchased, since currently Eskom is a monopsony as well as a monopoly.

There are plans to move power procurement out of Eskom and into an Independent Systems Marketing Operator (ISMO). This is informally being done for REFIT purchases from the DoE but with oversight of DoE and Treasury. It is intended that the ISMO would procure and sign up the independent producers. A long term approach to pricing, giving an approach for a minimum of ten years is nevertheless required to offer certainty.

- Improving energy efficiency is one way to reduce pressure and ensure more energy is available. Certainly, the IRP2010 and the Risk Mitigation Plan rely heavily on improved energy efficiency. This would be beneficial as, in 2007, SA ranked 34th out of 128 countries in terms of energy to GDP ratios. This intensity arises as a result of the industrial composition, as well as energy inefficiency. The evidence points to firms having already introduced energy efficiency measures prior to the major price increases and the blackouts. We wanted to see whether firms are reacting more forcefully now that the challenges and opportunities are clearer. We held focus groups with three sectors (namely energy intensive users, mixed industries including agriculture, and property). While the energy intensive users are understandably well coordinated and clearly representing their interests, other sectors are aware of the issues but not nearly as well represented. Some common issues arise such as whether firms will cut back operations in response to price increases and rationing, or whether they will adopt more efficient processes and technology. The investment costs have to be weighed up against the challenges experienced in the economic downturn, especially in low margin industries such as agriculture. The property sector has a special challenge as owners and managers are not the end users, and an estimated 40% of electricity usage is controlled by the tenant. In SA, properties change hands regularly, and the lease periods also tend to be short by international standards: this reduces the incentive to invest in energy efficient measures. Municipal shortages are slowing down new and expanded investments: many municipalities find they are unable to supply large investments. The diffusion of knowledge on process and physical technologies for energy efficiency will be of benefit. The Energy Services Companies (ESCO's) are meant to assist in this regard, however some respondents believed they were too vested as they were sometimes linked to vendors.

- There are a number of policies that could impact on improving energy efficiency – some carrots and some sticks. In the first instance, the rising price will have an impact, potentially reducing consumption by 15% according to the IRP2010 (Table 18). A suite of tax and cash incentives have been introduced, but still have to be tested. The broad range of relevant incentives are reviewed in secton 10 of the report. In 2010, the dti announced the a tax allowance incentive (Section 12 i) aimed at supporting new and expanded investments in manufacturing. This can include an upgrade involving clearner production technology or improved energy efficiency. The value of this incentive could be as much as 35% to 55% of an investment. A new energy saving tax allowance investment incentive (Section 12 L) is still to be introduced, but it is said that it will be calculated on the basis of the amoung to energy saved. These incentives are to be welcomed, although they are being introduced at a slow pace. Incentives often require some time for diffusion, and this can take a number of years. Smaller manufacturing firms can already benefit from the dti's Enterprise Investment Programme, which can cover a substantial portion of the capital costs in a new or expanded investment. Of course, there are other programmes such as Eskom's Demand Side Management programme. Support will be needed for a wider range of industries, including property and accommodation. The dti will need to actively promote the effective use of these incentives, ideally in conjunction with technical support and knowledge diffusion in respect of new physical and process technologies. While a strong Rand works in favour of new technology adoption, the economic downturn mitigates against new investment and expansions.

- The National Treasury issued a discussion document in December 2010 proposing the introduction of a tax on CO2 emissions. It proposes that a tax of "R75 per ton of CO2, with an increase to about R200 per ton CO2 (at 2005 prices) would be both feasible and appropriate to achieve the desired behavioural changes and emissions-reduction targets" (National Treasury 2010). The document says that a carbon tax of R200 per ton CO2 would translate into an additional electricity price increase of 20c per kWh. If the tax started at R75 per ton, it might be presumed to translate into an additional electricity price increase of 7.5c per kWh. The burden of reducing emissions should naturally fall on the largest contributors to the problem, and Eskom certainly falls into this category. Eskom generates 47.6 % of SA's CO2 emissions. However, the context is one where the price of electricity is already being raised substantially, and a tax of 2c/kWh had already been introduced in July 2009. The price increases will in themselves encourage energy efficiency. An additional price increase, which is not aimed at solving the energy security challenge, will make SA's economic and employment growth objectives more distant. In this instance, it may be more sensible to guide the balance of energy investments, whether in coal, nuclear or renewables, going forward through the IRP process, rather than to raise the price.

- Data from the Department of Energy shows that many industries were already improving their energy efficiency, even in the context of low prices and prior to the energy crisis in 2008. This effort to reduce energy usage became more intense and explicitly discussed from the period of the 2008 rolling blackouts with the aim of enabling Eskom to stabilise the grid. There is uncertainty about the cause of the drop in energy intensity. In this report, possible reasons indicated in the data are considered. Below, we review more specific possible contributors to changing behaviour in electricity consumption. Eskom and the Department of Energy are relying heavily on the possible improvements in the efficiency of electricity use, as part of the overall IRP2010 and Risk Mitigation Plan to 2017. Voluntary reductions in energy usage continue to be implemented in 2010 by some industries prepared or able to cut back on production. The sacrifice of some industries is at the present time enabling the supply of other industries. Some firms say they are not in a position to implement expansion plans as result of a lack of availability of an electrical connection. Eskom expects that its Demand Side Management (DSM) programme will have brought about the reduction in demand by approximately 1 000MW between 2008 and the end of 2010. The adequacy of accelerated DSM savings to ameliorate a serious electricity supply shortage is explored, and the value of other generation measures proposed in the MTRM Plan are highlighted below.

- From an economic perspective, and in terms of the impact on poor households, a move toward greater levels of energy efficiency and a lower energy usage per unit measure of national output would be a contributor to generating a labour bias in the economy. Productivity and efficiency improvements can encourage growth and employment. South Africa's energy intensity biases the economy towards capital-intensive investments. Firms might improve their efficiency in response to the substantial price increases, or they might take advantage of the emerging support measures available to improve their technology or processes. However, as noted, if electricity consumption is reduced as a result of containment of output, expansions or new investments, this will have a negative knock-on effect on potential growth and job creation.

- Therefore, Eskom pricing is currently not the most critical issue affecting employment and incomes going forward. This is because a regularised price path has been determined that does not follow the original requests for large once-off leaps. The impact on GDP and employment for each increase is relatively small. Two critical issues stand out for attention: the first is the extent to which municipalities comply with NERSA rulings on price determinations. Second, is the security of power supply. These two factors could pose ***the most critical physical barriers to new investment, growth and employment.*** This is what should be receiving the lion's share of attention.

- Tracking energy intensity across the economy will be an essential part of monitoring of behaviour change. Yet the data gathered by the Department of Energy does not currently seem to reflect trends correctly. Our view on this emerged from a first scan of the figures, but also as a result of the interaction with firms. It is recommended that more reliable electricity consumption data be gathered.

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Appendices

8 Appendix 1: Some assumptions in the HSRC/WSP Model

Average Price per KWh

In our model, the average price is calculated as that paid by all customers, including exports and non-regulated customers. Therefore, the price may be reflected as lower than that communicated since it is believed that the non-regulated customers (that is Billiton) and exports are charged less per kWh.

Although the IRP 2010 suggests that prices would be set according to the regulatory rules after 2015/16, we have simply applied an amount according to inflation. Our aim was to see what sort of price might be needed to enable the achievement of certain financial ratios.

Some questions arise in respect of the presentation of price trends in the IRP 2010 document. It suggests a 25 % annual (nominal) price increase over five years (by 2015/16) and then a return to the rules. These rules would specify, amongst other things, the approach to pass through costs (such as primary energy or power purchases), and the regulatory asset base (including inflation)[12]. The pricing rules under the MYPD allows a rate of return of 8.17% on the regulatory asset base, plus pass through costs. The IRP 2010 document shows the price continuing to rise after the five year period to about R 1 per kWh by 2019, and falling slightly in real terms thereafter. It is not clear why the real regulated price should keep rising so quickly between 2016 and 2019 – from about 90c to R 1 per kWh. Nor is it clear why the real price should fall thereafter if based on the rules laid out by Nersa, as the asset base would have expanded.

The more important point here is that the regulatory rules would appear to over compensate Eskom going forward, as our lower trajectory seems to suffice in enabling Eskom to achieve acceptable financial ratios.

Prime energy costs

A forecast of the pricing of prime energy commodities is fraught with uncertainty, but the fundamentals of growing demand and constrained supply must point toward a long term upward pricing trend. The graphs in Figure 5 show the effect of an escalation rate of 4% above that of inflation on prime energy costs.

The IRP2010 does not venture into the speculative exercise of forecasting prime energy costs. The assumption of R200/MT (R15/GJ) for coal and gas at R74.4/GJ is made and this escalates at 6% along with all costs as a general inflationary assumption.

The HSRC/WSP model tests these assumptions and an alternative picture of slightly lower electricity pricing needs is indicated in the modelling, despite a higher rate of escalation of prime energy costs, with the resultant trends shown in Figure 11.

[12] The reader is informed that the HSRC/WSP model values assets using the Replacement Cost Method.

The Organisation for Economic Co-operation and Development, as reflected in Business Report (10 Nov 2010), forecasts that demand for oil-based fuel is expected to increase to 99 million barrels a day in 2035 from the present 84 million barrels per day, with a growth rate of 1.2% per annum. With exploration becoming increasingly expensive as it is increasingly deeper and more remote, reserves are expected to shrink. With the underlying demand growth, an upward movement in price is considered to be likely to move the price of crude oil to an average of US$135 per barrel in 2035.

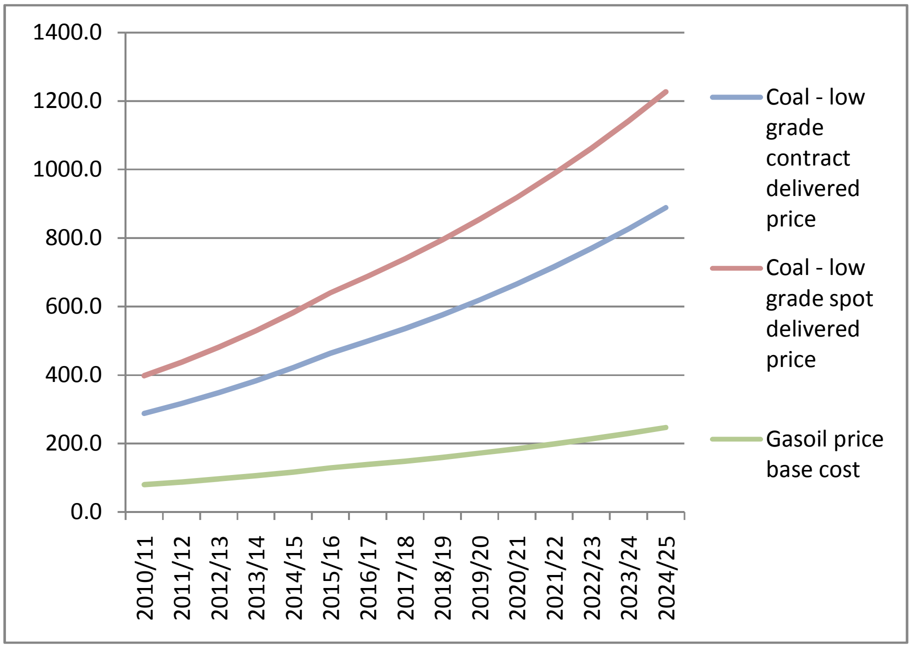

Figure 5: Illustrated costs of prime energy sources growing at 4% per annum

Source: WSP estimates, based on effect of an assumed 10% cost escalation.

Long-run marginal cost

The viability of the new generating equipment planned has to be ensured by adequate electricity pricing so as to afford operators a recovery of all costs over the life of the equipment. This is computed from the long-run margin cost or levelised cost. In the HSRC/WSP model, the long run marginal cost is a separate calculation making use of the cost estimates provided in IRP2010 and some independent assumptions which form the basis for indexing the Regulatory Asset Base or estimates of the RAB for a suitable depreciation and return on assets allowances. Prime energy costs which are extrapolations of current MYPD2-approved Eskom costs have been use in preference to those contained in the IPR2010 document.

The long run marginal cost calculation requires that the cost of plant and financing of the equipment and the depreciation of the value of the equipment is recovered over the life of the plant, as set out in Figure 6.

In an inflationary environment, it is also necessary that the replacement cost of the equipment is recovered in the depreciation in order to set aside funds for the eventual replacement of the equipment, and that the financing plan of the entity is such that these funds are available when the replacement investment is required, are not stripped out by a demanding dividend policy, and are not inadequately provided for as a result of underfunding or artificial price support, as was the case in South Africa up until recently.

Of note in the long run marginal cost trends is that the base-load generation – Coal, combined cycle gas turbine (CCGT), and Nuclear as proposed in the IRP2010 are narrowly grouped and tending towards R0.80/kWh and that this is coincident with the pricing considered necessary in the HSRC/WSP model of the IRP Revised Balanced Scenario.

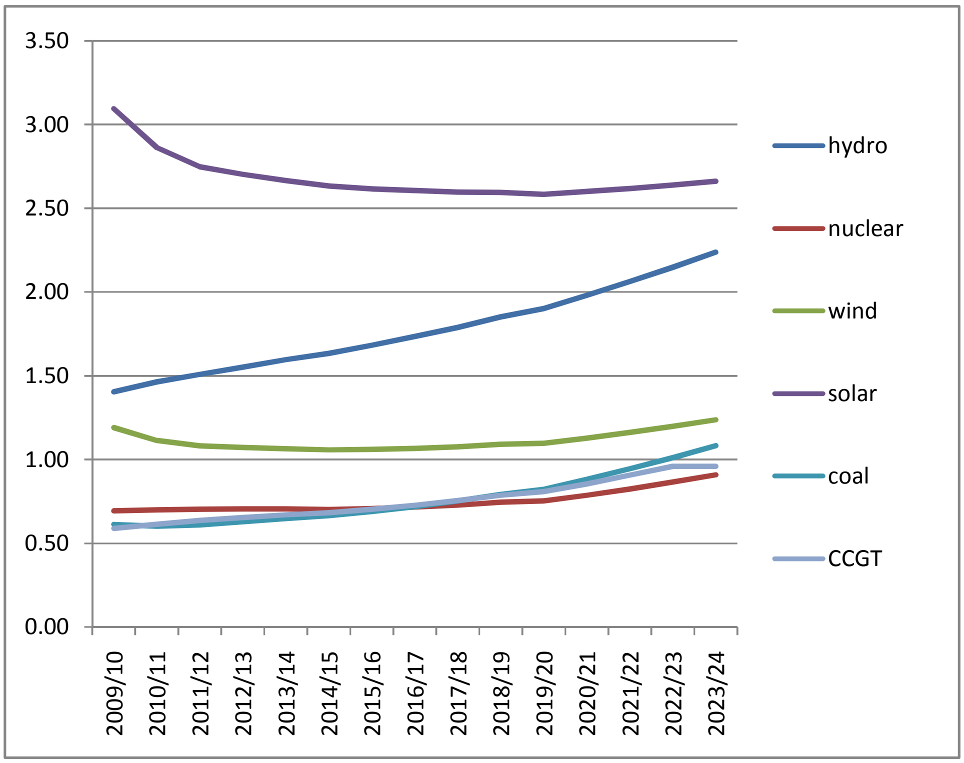

Figure 6: Long run marginal cost of various generating technologies per WSP estimate

9 Appendix 2: Candidate Renewable Energy Sources

9.1.1 Production expansion and projected reserve margin

Figure 7 presents WSP's estimates of pricing for renewable energy sources into the future. The electricity price with and without renewables is compared.

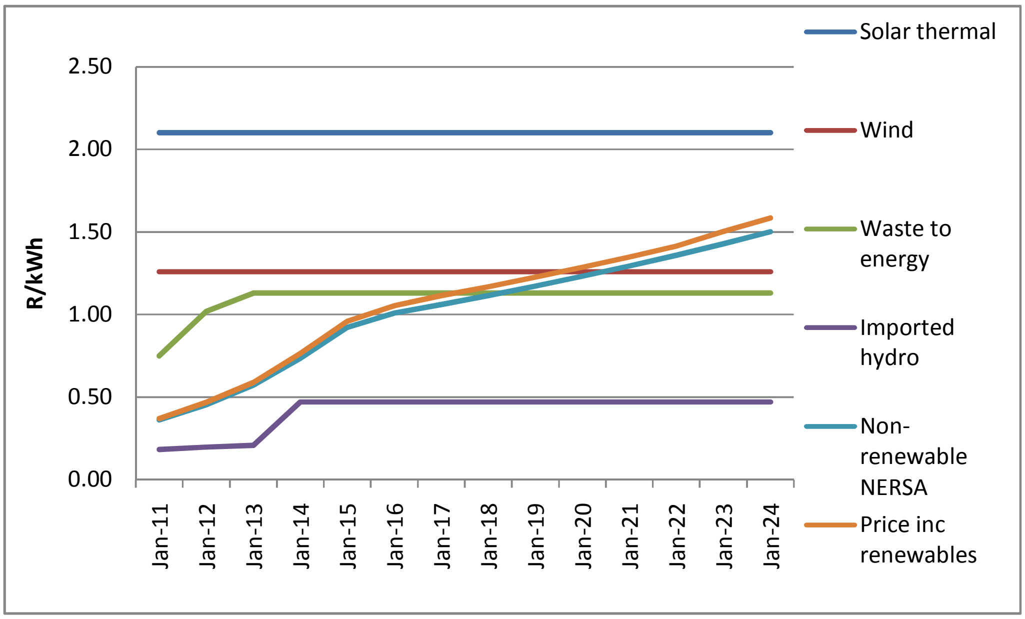

Figure 7: Relative pricing of renewable energy generation as per WSP estimates in nominal Rand terms

9.1.2 Candidate renewable energy sources

Candidate renewable energy sources were evaluated on the basis of the various industrial sectors being able to exploit them directly or invest in renewable energy projects. The investment potential of the industrial sectors are based on present trends where companies have already invested in renewable energy projects, either through power purchase commitments or shareholding or both, over and above purchasing electricity from Eskom.

A weighting scale, based on a subjective approach rather than an in-depth study, was used and should be seen as indicative rather than definitive. In the case of economic viability and technical maturity, a range was given for some energy sources and this is explained under the relevant headings below.

It should be noted, however, that the REFIT programme created expectations which appear beyond Government's current ability to deliver access to the programme. Some companies have realised this and have moved ahead with wind farm project development, with the objective of selling energy directly to other interested parties without the REFIT benefit. Table 10 evaluates, on a scale of 0 to 5, direct exploitation of renewable energy by the industrial sectors for their own benefit regardless of the REFIT.

Table 10: Exploitation of renewable energy by different sectors

RE resource/sector	Manufacturing	Agriculture	Mining	Commercial	Economic viability	Technical maturity
Wind large scale	1	4	2	1	4 to 5	5

RE resource/sector	Manufacturing	Agriculture	Mining	Commercial	Economic viability	Technical maturity
Wind small scale	1	5	1	2	3 to 5	5
Solar water heaters	1	3	2	2	5	5
Photovoltaic	1	5	1	2	2 to 5	5
Concentrated solar power	1	4	2	1	3	3
Solid waste	1	2	3	1	2 to 5	3 to 5
Sewage/animal waste	3	5	2	0	2 to 4	5
Biomass	3	2	2	0	3 to 4	3 to 5
Hydro large scale	0	0	0	0	3 to 4	5
Hydro small scale	3	3	2	0	3 to 5	5

Wind large scale

Large-scale wind (wind farms) would not normally be associated with industrial applications. However, electricity constraints currently experienced in South Africa, combined with future uncertainties caused a rethink from an industrial perspective with the result that some companies have already begun to invest in wind energy projects while others are planning to do so. Exxaro and Sasol are both examples of this. Added to this others have made an in-principle commitment to purchase energy from such IPPs.

The farming community is well placed to take advantage of the new heightened interest in wind farm development because most of the potential sites being on existing farm land. Some enterprising farmers have taken this further by initiating their own wind farm projects.

Whether technically possible or not, most participants in this sector expect that such projects will, to some extent, benefit them in terms of individual energy security.

The economic viability of wind energy is to a large extent determined by the REFIT. However this will be limited to the maximum capacity decided on by government. The wind IPPs which ignore REFIT to sell electricity directly to users will have a lower economic viability unless they can command the same tariffs.

Wind small scale

The economic viability of small scale wind as measured against Eskom tariffs is weak. However, some companies still make the gesture by installing micro wind turbines to supply what is often a small fraction of their energy needs.

On the other hand, it is for off-grid stand-alone applications such as in the agricultural sector where micro wind turbines comes into their own, as far as economic viability is concerned. The reason for this is the cost of a grid connection as compared to a stand-alone wind energy system. Wind turbines have been used for water pumping for many years with approximately 270 000 in use in South Africa.

Solar water heating (SWH)

The economic viability of SWH was marginal with limited penetration until the solar water heater programme was introduced by the government under the management of Eskom. This resulted in a significant growth in the SWH industry because the eventual target is to install one million units. However, this will mainly be in the domestic sector. SWH systems are finding stiff competition from heat pumps, especially in the mining and commercial sectors.

PV (Photovoltaics)

The same conditions apply to PV as are described under small scale wind turbines. Although PV will be benefitting from the REFIT to a limited extent, apart from the agricultural sector, it is unlikely that any projects, other than token projects for publicity and marketing purposes, will materialise outside the

REFIT.

Concentrated solar power (CSP)

CSP can be grouped with large scale wind in this assessment in that the farming community is a natural participant by default. However, the economic viability and stage of technical maturity will limit CSP exploitation outside the REFIT, except among large companies such as Exxaro and Sasol.

Solid waste

All the industrial sectors produce solid waste, but few companies produce enough to make the exploitation of waste for energy purposes economically viable. The mining industry has the most potential in that the disposal is becoming a problem and on site conversion of waste to energy could be feasible. Studies have also shown that companies in the commercial sector which ownlarge retail property portfolios have an interest in converting the solid waste produced at such centres into energy.

Sewage/ animal waste

For obvious reasons, the agricultural sector has the most potential for exploiting this resource for the production of energy. Although there is limited potential in the mining sector, exploitation at this stage is seen to be a contribution to a problem where waste is of a nuisance value rather than having real economic benefit, because of limitations in scale. If municipalities are categorised as manufacturing/ industrial, the processing of sewage using biogas digesters, by municipalities, may form a significant component in this category. The economic viability would to a large extent be determined by the scale of the plant combined with sophistication levels.

Biomass

In regards to the exploitation of biomass, the sugar industry has a long-standing track record in that bagasse has, for many years, been used to produce thermal energy for process applications while at the same time generating electricity. Another industry with an obvious potential as well as a track record is the pulp and paper sub-sector. Although some sawmills generated electricity using wood waste in the past, this practice was discontinued. However, an interest is developing in using wood waste for producing electricity with studies having been initiated by SACOL.[13] Added to this, moves are afoot in certain mines to use wood and wood waste for the generation of energy, and it is envisaged that trees will be planted with the specific objective of generating electricity.

Hydro large scale

Large scale hydro power stations are typically beyond the scope or capacity of all but the largest of power companies such as Eskom. By the same token South Africa being a water-poor country, further large scale hydro power developments are unlikely. The IRP2010 document makes mention of consideration being given to further large scale hydro plants being established in Mozambique and Zambia.

Hydro small scale

Some potential still exists for small scale hydro, with further exploitation in the agricultural sector. However, this will generally be with very small generating plants. Another potential area is water utilities and the pulp and paper industry, which are extremely dependent on a stable and constant water supply for production. It is therefore not uncommon for the pulp and paper industry to locate plant next to rivers or build their own dams. This provides opportunities for run off-of-river or dam-based hydro

[13] www.gnesd.org/Downloadables/RETs/ERC%20RETs%20final%20version.pdf.

plant. In-line turbines have reached such a high level of sophistication that a complete turbine and generator unit can be installed into a pipeline with relative ease.

Technology costs

The possible future costs of various generating options are anticipated Figure 8. Some points are worth noting in relation to renewable energy. There is a view that solar generation technologies may become significantly cheaper in the not-too distant future. There also appears to be a view, partly underpinned by IRP2010, that that wind generation might be able to make a sizeable contribution to the national energy requirement, and in a short time. However, the wind generation potential in the near term might be undermined by the size of the Kusile generating capacity, effectively blocking out opportunities for a larger wind investment. This needs confirmation. Also noteworthy is the possibility of further hydro generation elsewhere in Africa.

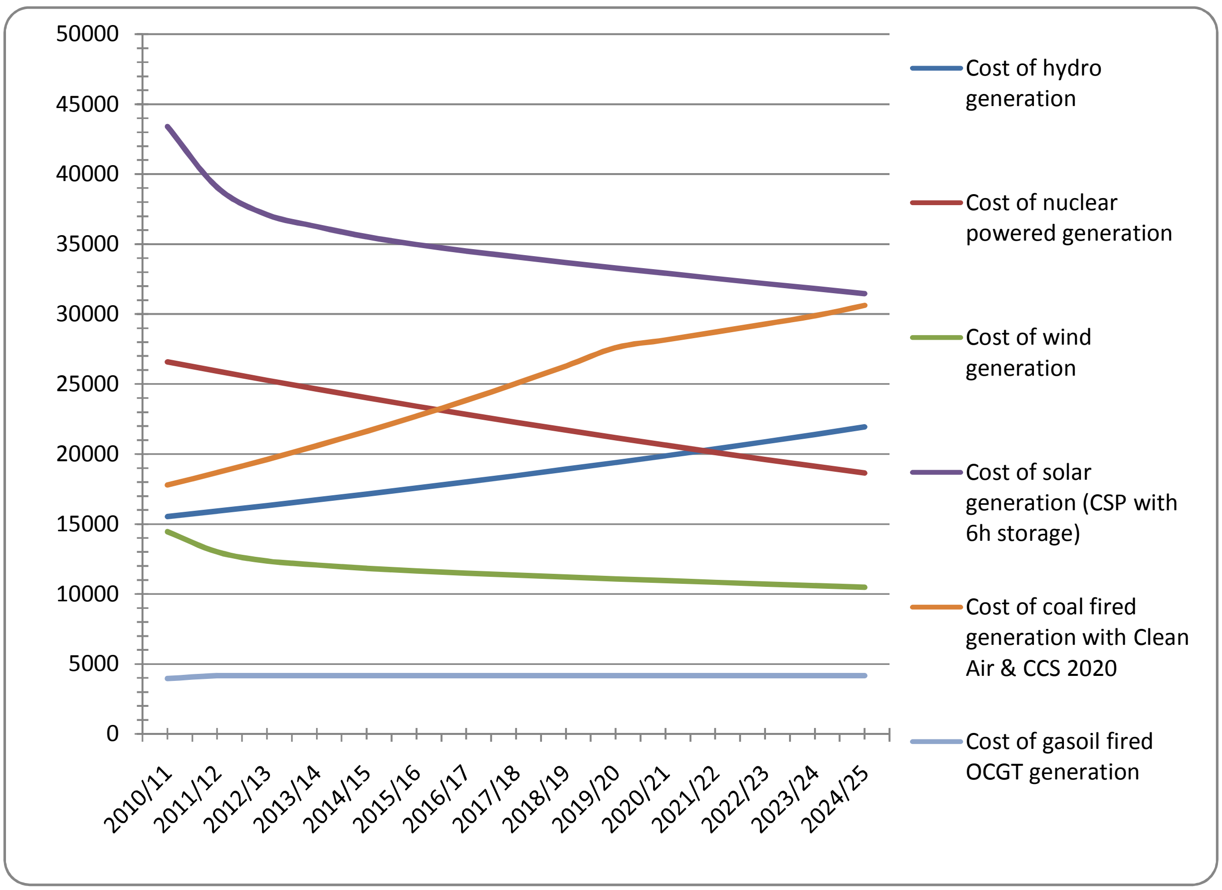

Figure 8: Possible dollar cost trends for electricity generating equipment per WSP estimate

Source: Extropolation of learning growth trends by WSP

10 Appendix 3: Energy Efficiency and Standards

Electricity price increases have an effect of discouraging demand and incentivising energy efficiency initiatives. The IRP2010 reports an anticipated gradual reduction in energy intensity from a figure of 0.129kWh/R of gross value added to an expected 0.1kWh/R of value added by 2034. If the same reduction in energy intensity as indicated in the IRP2010 (see Table 18) is brought about, the net effect will be a reduction in energy intensity of 15% by 2025.

Models of elasticity of electricity demand to price have been explored by Eskom and others at various times and the IRP2010 reports the results of a Council for Scientific and Industrial Research (CSIR) demand forecast based on such research. It is noticeable that the range of views expressed in the IRP2010 is significantly higher than that of the CSIR, and that the peak demand forecast for 2025 in the 'Revised Balanced Scenario' is 60 150MW by the 'moderate maximum demand' forecast.

10.1 Major developments and influences on energy efficiency

Proposed Carbon Tax

The National Treasury issued a discussion document in December 2010 proposing the introduction of a tax on CO2 emissions. It proposes that a tax of "R75 per ton of CO2, with an increase to about R200 per ton CO2 (at 2005 prices) would be both feasible and appropriate to achieve the desired behavioural changes and emissions-reduction targets" (National Treasury 2010). The document says that a carbon tax of R200 per ton CO2 would translate into an additional electricity price increase of 20c per kWh. If the tax started at R75 per ton, it might be presumed to translate into an additional electricity price increase of 7.5c per kWh. The burden of reducing emissions should naturally fall on the largest contributors to the problem, and Eskom certainly falls into this category. Eskom generates 47.6 % of SA's CO2 emissions. However, the context is one where the price of electricity is already being raised substantially, and a tax of 2c/kWh had already been introduced in July 2009.

In 2009/10, the average price paid to Eskom for electricity was about 28c per kWh (including all customers). In 2010 Rand, this is expected to rise to at least 77c per kWh by 2015/6. In 2010 Rand, the proposed carbon tax would add between about 10c to 26c/kWh to this price. So, in addition to the proposed price increases of about 175 % over 2009/10 to 2015/16, the tax would raise this by a further 36 to 93 %.

The price increases will in themselves encourage energy efficiency. An additional price increase, which is not aimed at solving the energy security challenge, will make SA's economic and employment growth objectives more distant. In this instance, it may be more sensible to guide the balance of energy investments, whether in coal, nuclear or renewables, going forward through the IRP process, rather than to raise the price.

Demand-side management

Eskom expects that its Demand Side Management programme will have brought about the reduction in demand by approximately 1 000MW during the period from 2008 to the end of 2010. In a longer term view, The IRP2010 presents a base assumption that 3 420MW will be saved by 2017 as a result of the DSM programme. An accelerated DSM option which might save a total of 4 954MW over a period of eight years is an alternative programme which would require some R8.0 billion of additional funding. This would indicate that there is a view that there is still scope for the improvement of energy efficiency in some sectors of the economy.

South Africa's energy intensity is estimated to be about twice the global average. Some business sectors, including mining, which have been proactively involved in reducing energy usage for some years, have the potential to fundamentally change their ways of operating such as to further reduce energy usage, but at considerable expense. Such investments will take place, but only when the investment opportunity makes financial sense.

The DSM programme as developed up to end March 2008 was saving over 400MW per annum, and this was set to rise to 800MW with an accelerated programme. The NERSA price determination of 2008 did not provide for further funding of the programme. The demise of the Eskom DSM programme created a vacuum in the area of support for energy efficiency projects, setting back efforts to reduce energy usage. The MYPD2 application called for R6.2 billion for DSM to the three-year period between 2010/11 and 2012/13 and projects are now supported to the extent of a R5 300 per kW maximum, versus a R3 500 maximum in the prior MYPD1 period.

Businesses can be encouraged to adopt the imminent new ISO50001 Energy Management Standard, to institute energy monitoring and targeting, and employ energy audits, in order to uncover the potential of DSM projects within their operations. Presently such programmes are voluntary and have not experienced major uptake outside of the Energy Intensive Users' Group (EIUG), the efforts by UNIDO [the United Nations Industrial Development Organization] to stimulate these activities notwithstanding, according to feedback received in our industry focus group meeting with manufacturers.

Demand Market Participation

A component of the Medium Term Risk Mitigation Plan is the Demand Market Participation (DMP) where customers will be paid a pre-arranged fee in exchange for reducing their demand in response to a request by the system operator. This is especially meant to help at peak times. Eskom is banking on access to 2 000 MW of interruptible supply and 570 MW of DMP capacity. The MTRM strategy proposes that realistically Eskom might be able to cut peak consumption by 980 MW four times a week.

Energy Conservation Scheme: A contingency plan for reducing excessive energy usage

A National Standard (NRS 048) was developed to serve as the protocol that will be applied in the event of forced load-shedding. The primary aim of the Contingency Plan is to avoid forced load-shedding.

The process of consultation between government and business has resulted in a compromise arrangement – the Energy Conservation Scheme (ECS) which includes a number of core components:

- The technical specifications are not readily available and it is important to have a simplified grid code connection document.
- A "Normalised Reference Consumption" per customer must be agreed with the supply authority. This would aim to eliminate any unfair burden based on an exceptionally low baseline. The baseline will be adjusted, if caused by artificial circumstances, or significant savings implemented prior to the baseline reference dates. Eskom would need to gear up and retool in order instal new connections.
- Equitable and realistic savings targets relevant to particular industries would be determined, as well as the ability of the particular industry to make energy savings reasonably economically, thereby helping to close the energy gap.
- The rules for the ECS are to be refined and agreed, with enabling legislation (in terms of the Electricity Regulation Act) amendments and gazetted regulations. This process is currently underway.
- The circumstances for exemptions, allocation management, excess charges payable, and what will happen to the revenue raised from excess charges payable, etc. are to be finalised.
- An allocation management system, which allows for inter-company re-allocation and bilateral trading between energy users should be put in place.
- All preparations must be completed to enable the scheme to be activated at short notice should

the energy shortages be anticipated or experienced.

The Energy Conservation Scheme discussed shortly after the 2008 shortages by a NERT team proposed progressive penalties for consumption exceeding 90% of the energy usage in a reference period. The proposals were considered to be somewhat draconian, albeit that they were based on the cost of peak generation. The proposed penalties seemed unnecessary severe in the light of the subsequent drop in electrical demand during the economically depressed period of late 2008 and 2009.

The proposed MTRMP conservation scheme could be implemented in a phased manner with large power users (i.e. those consuming more than 25GWh per annum) in less than 12 months. The scheme requires users to reduce their consumption to a level below an individually-agreed allocation (Energy Cap). The penalties have still to be agreed at NEDLAC.

Users who consume less than 25GWh per annum should be incorporated into the scheme over a period estimated to be three years, via the municipalities. This discriminates unfairly against large users. The effect of the ESC's application to businesses which have already achieved the required or agreed energy usage reductions is also inherently unfair, and may not be legally implementable, without enabling legislation.

Achieving environmental goals

IRP2010 has proposed various scenarios of generation capability, electrical demand and CO_2 emission production, each of which has an impact on the environment and cost to the economy.

The business-as-usual approach is to consider unbridled (mainly) coal technology, being the cheapest form of generation, as the base case. In reality, this not an option, due to financing constraints, but presents as the reference case against which various other scenarios can be examined for the cost of any un-served energy, capital expenditure and running costs, comparative CO_2 emission levels, and water usage.

The IRP2010 Revised Balanced Scenario balances the relative merit of the planned introduction of the various generation technologies and suggests a course which will achieve a renewable energy level of some 15% by 2025, and 19% reduction of CO_2 emissions by this date.

However, this would not achieve the overall 34% emission reduction for 2025 which President Zuma committed South Africa to at the Copenhagen Conference of Parties meeting (COP15) in 2009.

The failure of the Conference of Parties meeting in Copenhagen to reach a binding international agreement on global carbon emissions reductions, with the inclusion of China, India and the USA; and to extend the Kyoto Protocol, was viewed by many commentators as disappointing. However, the South African position has been firmed up with challenging commitments.

This global reality will mean that countries such as South Africa will be under pressure to exact penalties for excessive carbon emissions, and some may impose emission caps. Increasingly, global businesses are therefore planning their activities to build in the expectation of a carbon tax of the order of €20–€30/Mt on coal or non-renewable energy sources, or alternatively R0.25–R0.40/kW. A carbon tax of R150/MT of CO_2 is modelled in the IRP2010 with the expected consequence of higher prices. There is an interesting dilemma. If South Africa continues to export coal to India and China, enabling those countries to maintain relatively cheap energy generation costs, while it takes on more expensive but cleaner energy solutions, South African industrial production could be further displaced.

The Long Term Mitigation Scenarios (LTMS) proposal of the Department of Environmental Affairs (DEA 2007) is accepted government policy, may be moderated after consultations, and may become national policy for incorporation into all national institutional planning. If the CO_2 emission targets of 2050 are to be reached, the present R0.02/kWh will need to be steadily increased in an orderly fashion, thereby according decision-makers ample time to adjust their planning, and this funding should then be used to fund investments in clean electricity generation. This was a view that was expressed in our industry focus group workshops.

The viability of alternative paths which have higher levels of renewable energy component and greater investment on Demand Side Management programme is explored in Section 6 of this paper.

10.2 Review of main technologies for enabling energy efficiency

10.2.1 Candidate energy efficiency technologies

Altman et al (2008) laid out possible candidate technologies for energy efficiency in different industries. We expand on this below, where candidate energy efficiency technologies are evaluated on the basis of their energy savings potential within specific industrial sectors. Table 11 shows a ranking from zero to five of the potential impact of different technologies in different sectors. The ranking given was based on a subjective approach rather than an in-depth study and should be seen as indicative rather than definitive. Some industrial sectors involve activity types that have a higher potential for energy savings, and so interventions in some technologies would have a greater impact. The reader is also encouraged to read Altman et al. (2008).

Table 11: Ranking of candidate energy efficiency technologies by sector

Technology/Sector	Manufacturing	Agriculture	Mining	Commercial
Lighting	3	2	3	5
Motors	4	2	4	1
Fans and pumps	2	2	5	1
Compressed air	3	1	3	0
Boiler plant	3	0	0	0
Hot water systems	2	5	1	1
Refrigeration	2	5	0	5
Heating, ventilation and air conditioning	2	1	5	5
Processes and process control	5	3	5	0
Waste heat recovery	5	1	5	3
Water use	5	5	5	5

Lighting

Depending on the industrial sector, short and long term gains can be achieved by way of switching to efficient lighting, and by using sensors and switches to prevent wastage. New developments in terms of product range and a larger uptake of LED (light emitting diode) lighting are likely to continue to drive LED costs downward. Although there is already a positive cost benefit with regard to the use of LED light fittings, the reduced capital outlay combined with the reduced life cycle costs will see an increased uptake of LED lights. As a result of the significant savings which LED lights offer, some industrial sectors can benefit massively from this. Generally there will be a pay-back of between 1 and 3 years for most lighting interventions, given current energy cost escalation rates.

Energy efficient motors

Although it is estimated that 75% of energy consumption by industry occurs via electric motors, the gains with regard to switching to energy efficient motors will be slow and have a limited impact, although some sectors have a more significant potential than others. The reason for this is that the percentage savings are limited to 2% to 8% with the result that the cost benefit impact, per motor, will be low resulting in long payback periods. The trend is therefore that motors are only replaced with energy efficient ones when they fail.

However, there are sub-sectors where a switch to energy efficient motors can be motivated on a cost-benefit basis. Pump and blower motors can account for 80 to 90% of the energy costs in water supply and wastewater treatment facilities. Water pumping and ventilation form a large component of the total energy costs in the mining industry.

Another industrial subsector worth mentioning with regard to the use of energy efficient motors is the food and beverage processing industry. The average bottling plant, for example, can boast a large number of motors driving conveyor belts and associated equipment.

Generally there will be a pay-back of between 3 and 10 years for motor upgrade projects, given current energy cost escalation rates.

Fans and pumps

Although the replacement of an inefficient fan or pump with a more efficient one can result in energy savings, most of the losses incurred by fans and pumps are not as result of the component itself. Fans and pumps from part of an overall system which has to be well-designed and if the fan or pump does not match the system flow and pressure characteristics, then significant energy losses can be incurred. Energy savings in this instance should show a very good cost:benefit ratio in that modifications often do not entail more than a motor drive, a damper/ baffle or throttle, respectively, depending on whether it is a fan or a pump. Generally there will be a pay-back of between 1 and 3 years for fan upgrade projects, given current energy cost escalation rates.

Compressed air

Compressed air as an 'energy source' to drive hand held tools, operate clamps, valves control systems etc. is commonplace in most manufacturing and mining operations. Other than interventions with regard to the motor or compressor, gains can be achieved at low cost by simply fixing leaks. Generally there will be a pay-back of between 1 and 3 years for various levels of compressed air upgrade projects, given current energy cost escalation rates.

Boiler plant

Direct energy saving is more a function of good housekeeping and maintenance and the potential for electrical energy savings is limited. Where there is a need for steam, there usually is a combined heat and power potential. Producing thermal energy for steam, e.g. in the sugar or bottling industry, provides an opportunity to generate electricity. The sugar industry, because of the availability of bagasse as a fuel has for many years seen to its steam needs while generating electricity at the same time.

Generally there will be a pay-back of between 3 and 5 years for boiler plant upgrade projects, given current energy cost escalation rates.

Hot water systems

Hot water can be required for sanitary applications, e.g. hotels, hostels and hospitals or in the food and beverage industry for washing. Solar hot water systems and heat pumps have shown that energy savings of 60% and above are achievable. Generally there will be a pay-back of between 1 and 10 years for hot water system upgrade projects, depending largely on the volume of water usage, and given current energy cost escalation rates.

Refrigeration

Energy savings achievable with regard to refrigeration may be focused in two areas, namely efficient compressor systems and cooling losses. Major savings can be achieved, especially in the commercial and agricultural sector, where there are continuous movements in and out of cold storage facilities. This is by means of effective design, installation and sealing of openings.

Generally there will be a pay-back of between 1 and 3 years for refrigeration equipment efficiency upgrade projects, and reduction of cooling losses, given current energy cost escalation rates.

Heating, ventilation and air-conditioning (HVAC)

Some of the inefficiencies in HVAC systems can be addressed directly. However, overheating and under-cooling are two areas where most of the losses are often incurred. This may be a combination of poor design, which does not allow even distribution of warm or cool air, or lack of proper control. In addition, the building envelope may be poorly designed in respect of limiting climatic impacts from outside the building.

Generally there will be a pay-back of between 1 and 5 years for HVAC equipment efficiency upgrade projects, and reduction of cooling or heating losses, given current energy cost escalation rates.

Processes and process control

Processes and process control can include a wide range of systems and technologies such as ovens, kilns, furnaces, or mixers. Each of these have their own energy savings potential. However, it has been found that the potential is higher in any system where thermal energy is produced or expended. Generally there will be a pay-back of between 1 and 3 years for system equipment efficiency upgrade projects, and reduction of energy losses, given current energy cost escalation rates.

Waste heat recovery

Waste heat recovery is an intervention which can be implemented in a number of areas. Examples of these are absorption coolers used to recover waste heat from chiller plant, heat energy from flared waste gas and waste heat from furnaces, steam plant and industrial processes. Generally there will be a pay-back of between 1 and 3 years for waste heat recovery projects, and reduction of cooling losses and heating losses, given current energy cost escalation rates.

Water use

Although the use of water is often not seen in connection with energy savings, water savings can play a significant role in terms or the overall energy consumption. Water has to be purified and pumped to the point of use, using electric motors. At the point of use a large portion of this water is heated before being used. It has been found that using a low flow shower head in preference to a normal shower head can reduce flow rate by as much as 85%. Such a reduction would result in a commensurate reduction in energy used to heat the water.

10.3 Information availability and standards

There has been some progress with developing energy efficiency standards in 2010, and a number projects have been finalised or are nearing completion.

SANS 10-400XA – Sustainability in building (DSS – Draft South African Standard)

This standard introduces sustainable development to all aspects of the construction sector. Existing buildings will not be regulated in terms of these regulations, but market forces will gradually operate to bring a larger stock of buildings to a higher standard of energy efficiency. Within this standard all new buildings will be required to have at least 50% of all hot water needs served by non-resistance heating technologies.

SANS 204 – Energy efficiency in building (DSS)

This standard is referred to by SANS 10-400XA, but is a comprehensive non-binding standard of energy efficiency for all new buildings. It forms the base-line for all green buildings wishing to attain the 'four star' status.

SATS 50010 – Measurement & verification (Published)

This standard is a guide for measurement and verification professionals who are providing assurance on energy savings for projects.

SANAS 17020: 1998 – General criteria for the operation of various types of bodies performing inspections

This standard governs the accreditation of aspirant measurement and verification entities, as per the application of TR-81-01; SANAS guidance on the application of SANS17020: 1998 in the assessment of inspection bodies application of SATS 50010: 2010.

ISO50001 – Energy management (DSS)

The standard for energy management is soon to be available to formalise the process of managing energy in businesses and organisations. The publicising of this standard and its wide-scale adoption, as has been the case with the ISO9000 and ISO14000 series, could bring about quantum leaps in improved energy efficiency. United Nations Industrial Development Organization projects with this purpose are being conducted in South Africa through the Department of Trade and Industry.

10.4 Review of energy efficiency incentives

The Risk Mitigation Plan and IRP2010 depend substantially on energy saving and efficiency gains, especially in industry. Certainly demand reduction is inexpensive compared to having to build new generating equipment.

The rapid increases in electricity prices should in themselves have an impact on energy efficiency. The recent NERSA-approved MYPD2 included 'stepped tariffs' or 'inclined block tariffs' through which different rates apply, based on a consumer's level of consumption. This incentivises domestic consumers to conserve energy to avoid high tariffs.

However, the impact on firms may be different. They may introduce energy efficiency measures, or they may avoid electricity costs by cutting production or containing future investments. It is critical for South Africa's growth and employment objectives that companies emphasise energy efficiency. In a context of a downturn especially, industrial incentives ('the carrot') are available to encourage a more rapid adaptation.

The views distilled from the focus group discussions and those of leading energy consultants is that energy efficiency is not seen as a core business activity of any sector, except those where energy is one of the top four input costs, or when this cost exceeds 20% of input costs.

The value of incentives will have to tip the financial return calculation into a range which is acceptable to companies, but is often not within the same range of return on investment which firms are able to achieve from their core investments and activities.

The list of incentives available to various industries in support of energy efficiency is impressive. However, participants in the focus group discussions expressed some concerns about the potential uptake of the allowances, keeping in mind that many of the incentives have only recently been introduced. There is evidence to show that it can take three years before a newly introduced incentive ramps up to scale. Therefore the incentives are unlikely to have a mahor impact in the medium term, but with support, might do so in the longer term.

One question was whether the available incentives make a significant difference to the financial justification for greater levels of investment in energy efficiency covering the high transaction cost and high level of management effort necessary to exact the benefits. As the cost of energy (and electricity) increases, the interest in the incentives and the concomitant effort by business to access those benefits can be expected to increase.

However, some of the targeted incentives are still new, and it will take time to see which are effective. The main industrial incentives that can be used to finance energy efficiency programmes are outlined below.

10.4.1 Existing incentives and tax concessions promoting energy efficiency

Tax-based incentives

The accelerated write-off of the cost of capital expenditure has been retained. The proportion of write-off in each of three years is 50/30/20. A 150% deduction of research and development operating expenditure and an accelerated capital write-off are also allowed.

Two new tax incentives are either now available or soon to be enacted:

- Section 12I has been passed, and regulations published to provide for an extra 35% or 55% of the value of an investment in energy-efficient equipment for manufacturing businesses, available as an additional allowance over and above the usual Section 12 wear and tear allowances.
- Section 12L has been passed (but not the supporting regulations at the time of writing) which will

make a deduction available to all businesses to the extent that they save energy, expressed in kWh, and as evaluated by an accredited official.

In the commercial sector, landlords may not deduct the capital cost of any building improvements (or energy efficiency improvements) against rental income, except when in in terms of an improvement in a lease, in which case the cost of any improvement is amortised over the duration of the lease. The costs of running central air-conditioning plants are generally distributed among tenants, and are therefore fully recovered by landlords. However it is **currently** not in the **monetary** interests of a landlord to upgrade a building for improved energy efficiency, or even to maintain the efficiency of such air-conditioning plant. This inherent barrier to the improvement of rented buildings, it is submitted, can only be corrected with an appropriately structured specific tax-based incentive.

Incentive grants

The results of a survey of incentive grants available for energy efficiency improvement to South African businesses is set out in Table 12.

Demand-side management

The DSM fund is managed by Eskom and the cost of the programme is recoverable through the electricity tariff. The programme was intended to be driven by energy service companies, some of which are vendors of energy efficient equipment or devices. Expenditure in the year ending March 2010 was approximately R800 million,[14] for which some 372MW was saved.

Eskom solar water heater subsidy

Eskom has increased the solar water heating subsidy by up to 120% so that it can cover about 25% of the R20 000 to R25 000 cost of installing a new SWH geyser, or over a third of the cost of converting an existing electric geyser.

This subsidy is resourced by the DSM fund and electricity tariffs. The programme is gaining momentum according to industry contacts, [15] and the industry has achieved over 100 000 equivalent m^2 of installed heating in 2010.

Eskom DSM has recently added a commercial SWH Standard Offer, so this programme would appear to hold great promise for incentivising energy usage reduction. The Department of Trade and Industry's Industrial Policy Action Plan (IPAP2) will support continued funding to this programme.

Energy Efficient Motors Programme (EEMP)

This programme supports the cost of replacing older electric motors with new, energy-efficient motors, but the amounts payable are small compared to the cost of installing new motors. While its counterpart in the UK is reported to be highly successful, the uptake in South Africa is reported to be very low.

Renewable Energy Project Support Office (REPSO)

This programme is funded by the Department of Energy, and may be of interest to investors in wind or hydro technologies.

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[14] MYPD2 revised application by Eskom

[15] Personal communications with Henning Holm (Omnibus Engineering) and Dylan Tudor-Jones (Solar Heat Exchangers).

Technology and Human Resources for Industry Programme (THRIP)

THRIP is a partnership programme which facilitates business- and government-shared funding of innovative research in South Africa. This programme is administered by the National Research Foundation (NRF). It has been used to fund energy-related research through in partnerships between universities and organised industry.

Energy Efficiency Stimulation Programme (EESP)

The Department of Trade and Industry has initiated and is intending to implement an incentive designed to stimulate investment in energy efficiency, in line with the government's National Energy Efficiency Strategy (DME 2008). The primary objective of the EESP is to stimulate investment in improved energy efficiency initiatives. The incentive programme aims to enhance energy efficiency (EE) in manufacturing, mining and commercial enterprises of all sizes. The programme provides investment support to both local- and foreign-owned entities, by offering an investment grant of up to 50% of the value of qualifying investment costs in energy efficient equipment.

UNIDO support for energy audits and training

UNIDO has provided support funding to aid South Africa's capacity to conduct energy audits. This assistance is currently available via the National Cleaner Production Centre of the DTI. UNIDO is also planning to assist by funding training in energy efficiency.

10.4.2 Incentive schemes in other jurisdictions

Australia

Australia has introduced legislation which requires the mandatory disclosure of energy usage in buildings, which is known as NABERS (National Australian Built Environment Rating System). This means that all businesses will by law need to report on their energy consumption.

The new national Commercial Building Disclosure programme is now in effect, meaning that most sellers or lessors of office space of 2 000m^2 or more are required to obtain and disclose an up-to-date energy efficiency rating in terms of NABERS.

During the first year of the programme, a valid NABERS energy base or whole building rating must be disclosed. However, from 1 November 2011, a full Building Energy Efficiency Certificate, or BEEC – which includes a NABERS Energy star rating, an assessment of tenancy lighting and general energy efficiency guidance – will be required.

The intention initially is that owners of inefficient buildings will be 'punished by tenants' as they will either not be able to let their space or they will have to discount their rentals.

The advocacy of a National Efficiency Scheme by the Australian Energy Efficiency Council would seem to point to somewhat un-coordinated incentives being provided at state rather than Commonwealth government level.

United Kingdom and Europe

The grid-feeder law in Europe has given rise to a huge self-generation industry, particularly in Germany. The European Energy Directives have driven a major improvement in the level of energy usage, particularly in buildings, and the Energy Efficient Motor Replacement programme in the UK is a successful model that South Africa could follow.

United States

The USA also has many innovative energy efficiency programmes, both tax-based and grant-based, at federal, state and utility level. Coupled with the steep increases in energy cost since the initial energy price shocks of the early 1970s, these measures have reportedly had a significant positive effect on reducing energy usage. However much potential exists to further reduce energy consumption,[16] and there is potential to reduce residential prime energy usage by 33%, industrial energy usage by 32% and commercial energy usage by 35%. The mechanisms for achieving these goals by 2020 are in an advanced stage of development.

However, there is no Federal Building Energy Efficiency code in the USA., and there is no promotion of voluntary energy-efficient building codes in order to reduce energy bills.

[16] Unlocking Energy Efficiency in the US Economy, McKinsey Global Energy & Materials, 2009.

Table 12: Incentives available to South African businesses

Programme	Broad programme	Administrating institution	Primary promotion function	Secondary promotion function(s)	Sectoral focus	Purpose	Key access criteria	Benefit(s)
Section 12 I tax allowance		SARS	Manufacturing investment	Growth, employment, energy efficiency	Manufacturing	Promote investment, employment creation and energy efficiency in new and expanded investments	Manufacturing firms Size of investment (above R200m on new investment and R30m on expansion) This can include an upgrade involving clearner production technology or improved energy efficiency	The value of this incentive could be as much as 35% to 55% of an investment. Maximum allowance is R550m to R900m on new investments and R350m to R550m on expansions
Section 12 L tax allowance Not yet introduced by first quarter 2011		SARS	Energy saving		All industry and commerce			Tax deduction based on demonstrated energy saving, as determined by accredited official
Renewable energy market transformation programme (REMT)	Renewable energy investments	DoE & DBSA	Renewable energy	Employment, energy security	Energy	To assist investors to overcome some of the obstacles and barriers preventing growth in the renewable energy sector To remove the barriers and reduce the implementation costs of renewable energy technologies, To promote on-grid electricity for renewable energy sources To assist the DoE to reach its target of 10 000GWh of electricity to be generated from renewable sources by 2013	Renewable energy technology (RET) manufacturers, suppliers & Installers	Some $8,3-million in funding has been made available for the programme from government ($2,3-million), and global financial institutions, namely the World Bank, through its Global Environment Facility ($6-million). Note however, that REMT would not actually finance investments, but would rather assist with feasibility studies
Energy Efficiency Stimulation programme (EESP)		DTI			All industry & commerce	To stimulate investment in energy efficiency in line with the National Energy Efficiency Strategy		Grants of between R100 000 and R30 million available (Ave. R5 million)

Programme	Broad programme	Administrating institution	Primary promotion function	Secondary promotion function(s)	Sectoral focus	Purpose	Key access criteria	Benefit(s)
Renewable Energy Programme Support Office (REPSO)		DoE			Renewable energy generators	Support of R250 per kW available for renewable energy projects	Investors in wind and hydro technologies, for projects of size from a minimum of 1MW for projects up to R100 milion	Potential value of R100 million to beneficiary (for 2 potential projects at a total cost of R200 million)
Energy audits		DTI & UNIDO			All industry & commerce	Funds to conduct energy audits and provide training in energy efficiency		R25 000 per audit (for 1000 potential projects at a total cost of R25 million
Capital allowance – EE improvement of rented commercial & industrial buildings (EECIA)		SARS			Landlords for commercial & industrial buildings	Energy efficiency improvements written off over the period of a lease		
Demand side management (DSM)		Eskom				To support investment in energy-saving devices	Programme driven by energy service companies	Cost of programme recoverable in electricity tariff Support ceiling is currently R5 300/kW
Eskom solar water heaters (SWH)		Eskom				To support the uptake of SWHs instead of conventional electric resistive heaters		The programme offers a rebate to consumers who have installed solar water heating equipment to replace a conventional resistive heating powered hot water geyser. The rebate is worth R6 000 for a high performance SWH which might havea purchase price of between R20 000 and R24 000
Energy Efficient Motors Programme (EEMP)						Supports the cost of replacing older motors for new efficient motors		
Enterprise Investment Programme (EIP)		DTI					A 50% hurdle of historical fixed (not depreciated) capital	

Programme	Broad programme	Administrating institution	Primary promotion function	Secondary promotion function(s)	Sectoral focus	Purpose	Key access criteria	Benefit(s)
Partnership in Industrial Innovation (PII)		DTI	R&D			Support South African-based product or process development that represents a significant technological advance and provides a commercial advantage over existing products	Private sector enterprises Will not support government-funded institutions, although they can be used as consultants or subcontractors by applicants Enterprise must have the managerial, financial and manufacturing ability to carry out the proposal	Financial contribution up to maximum of 50% of qualifying costs(pre-competitive development activity) Repayment on successful implementation of the project; can also be made in the form of a levy on sales generated from the project
Support Programme for Industrial Innovation (SPII)	–	IDC	R&D	–	–	Support South African-based product or process development that represents a significant technological advance and provides a commercial advantage over existing products	Available to all private sector enterprises Enterprise must have the managerial, financial and manufacturing ability to carry out the proposal	Matching Scheme: Matching grant of 50% of direct cost up to R1,5 million Feasibility Scheme: Matching grant of 50% of consultant costs for small or micro enterprises up to R30 000
Cleaner Production Scheme		IDC				Promote investment in cleaner technologies	Provides finance for acquisition of fixed assets to control/ abate pollution, protect environment, safeguard exports (at normal interest rates)	
Technology Industry Finance		IDC				Development and expansion of technology-intensive businesses in information technology, telecoms, electronic and electrical industries	New tech ventures with proven technology.	Minimum financing of R1 million (loans, equity or quasi-equity)

Programme	Broad programme	Administrating institution	Primary promotion function	Secondary promotion function(s)	Sectoral focus	Purpose	Key access criteria	Benefit(s)
Reduced electricity rates		Eskom or local municipality				To facilitate investment	'Special deals' are available with Eskom for specific large customers on a negotiated basis. Or some local authorities offer lower electricity rates as incentives to certain sectors or locations	
Critical Infrastructure Programme		Municipalities/ DTI				Facilitates investment in critical infrastructure	Available to private businesses or municipalities	Financial support (10–30%) of costs of required infrastructure such as roads, electricity cables, etc for projects >R15 million only
THRIP	Research & development incentives	IDC/ NRF	Innovation research & development			A partnership programme that challenges companies to match government funding		
THRIP	–	NRF/DTI	R&D	Competitiveness	–	To enhance competitiveness of industry through encouraging long-term strategic partnerships between industry, research and educational institutions and government and the development of appropriately skilled people To improve the competitiveness of South African industry, by supporting research and technology development activities and enhancing the quality and quantity of suitably skilled people	Research groups in natural sciences, engineering and technology within educational institutions can collaborate with private sector companies/ consortia Projects must involve the training of students	50% matching grant to industry's contribution 100% matching grant to industry's contribution if at least half of the participating students are black or female R150 000 grant to the firm for each student involved and trained through the programme

Programme	**Broad programme**	**Administrating institution**	**Primary promotion function**	**Secondary promotion function(s)**	**Sectoral focus**	**Purpose**	**Key access criteria**	**Benefit(s)**
Innovation Fund	–	Department of Arts, Culture, Science and Technology	R&D	–	–	Large scale research with a significant R&D component to address research to overcome problems affecting socio-economic development or that affect South Africa's ability to compete in products and services	Projects must be large-scale science, engineering and technology (SET) innovation programmes The fund can be accessed via competitive bidding by statutory research and technology institutions, higher education bodies, the business and industrial community and non-governmental bodies. Preference given to consortia	Grants of a minimum of R1 million and maximum of R5 million per year up to a maximum of 3 years. There are 3 broad areas covered: Information Technology; Biotechnology; and Value-adding in natural resources and materials and manufacturing
The Innovation Fund (IF)	Research & Development Incentives	IDC				Promotes the protection of and commercialisation of innovations from South Africa		
Development Bank of Southern Africa		DBSA				Subsidised loans to facilitate infrastructure (water and sanitation, solid waste management, transport, energy, telecommunications, health, education, eco-tourism)	Provides financial and/or technical services to leverage private sector infrastructure provision that would not otherwise be realised through commercial banks	Finance: Long-term (20–25 years) finance in the following forms: Loan finance Equity investments Guarantees Refinancing commitments Technical assistance: Assistance in finance structuring, negotiation and with respect to the tender process
DBSA public finance		DBSA			Government buildings	Funding of improvements to energy efficiency	Public sector (specifically government departments)	

Programme	Broad programme	Administrating institution	Primary promotion function	Secondary promotion function(s)	Sectoral focus	Purpose	Key access criteria	Benefit(s)
Clothing and Textile Competitiveness Improvement Programme (CTCIP)	Clothing & Textiles Competitiveness Programme (CTCP)	DTI/ IDC	To create a group of globally competitive clothing and textile companies, thus ensuring a sustainable environment that will retain and grow employment levels.	To obtain higher levels of world-class manufacturing	Clothing & textile companies	The purpose of the CTCIP is to build capacity among manufacturers and in other areas of the apparel value chain in South Africa, to enable them to effectively supply their customers. These role-players include major retailers, government and a number of niche markets, both local and international. The Programme aims to grow South African-based clothing and textile manufacturers to enable them to be globally competitive. Such competitiveness encompasses issues of cost, quality, flexibility, reliability, adaptability and the capability to innovate. The intervention will include activities relating to people, equipment, materials and processes	Large companies and SMMEs	The incentive programme provides investment support to both locally and foreign-owned entities by offering a cost-sharing grant incentive of 75% of project cost for cluster projects and 65% of project cost for company -level projects. These incentives will not cover costs pertaining to machinery, equipment, commercial vehicles, land or buildings in an existing clothing and textile production facility Grants made under the programme will be made exclusive of value added tax (VAT). In all cases, the incentive payment is subject to the approved project/s achieving the stipulated performance requirements

11 Appendix 4: Modelling the impact of electricity pricing on employment and poverty

The ongoing challenges to sustainably supply electricity in South Africa has raised questions about the impact on the poor of shortages and appropriate official responses to them. Most of the public dialogue concerns the potential *direct* impact of price increases on poor households. However, there should be equal or greater concern about the more complex *indirect* consequences, since poor households contain workers and consumers. The energy price hikes and supply breaks have an impact on production, employment and incomes.

In this part of the report, we ask what impact the rapid price increases might have on poor households.

There are two perspectives that are important for assessing the consequences of electricity price increases:

- First, they should be contrasted with the consequences of alternatives. Electricity price increases have been motivated in order to facilitate the expansion of capacity. In principle, the alternatives would include:
  - Continued shortages;
  - Importing electricity rather than building new local capacity; and
  - Financing domestic capacity expansion in some different way, such as borrowing.

  The consequences of price increases need to be compared with the consequences of these alternatives.

- Secondly, they have to be situated in the broader context of energy in general. South Africa adopted an Energy Efficiency Strategy in 2008 and has subsequently set policy targets and introduced a number of measures to reduce energy consumption. Concerns with electricity, which is only one carrier of energy, need to be located within this broader energy framework. Users can respond to electricity shortages and to price increases by switching to other carriers. However, this option will be constrained if there are simultaneous policies to reduce use of other energy carriers. Even if switching does take place, there will be consequences for other energy targets. Treating electricity in isolation clearly leaves out a crucial part of the story.

We explore electricity price increases from both these perspectives, organised into two main parts. Part I looks at various electricity price scenarios, while Part II brings in the broader energy context. In most of the analysis, we take an economy-wide perspective. We take a scenarios approach, using an economy-wide model to isolate the effects of different policies and energy paths. While this does not permit us to forecast, it does help us understand the ways in which effects work and the channels through which the poor are affected.

11.1 Appendix 4a: Electricity price scenarios

We begin our analysis with an estimate of the impact of an electricity price increase on households in different income groups. This helps us understand the importance of considering the indirect as well as the direct effects of the price increases. We follow this with a consideration of issues that need to be taken into account in a more dynamic setting, where we evaluate effects that might take place over time.

11.1.1 *Impact analysis*

For the impact analysis we use a Supply-Use Table for 2008, derived from the 2008 Quantec Social Accounting Matrix (SAM) (Quantec 2010). We use a standard Leontief-type price model to examine the cost push effects of a rise in the price of electricity on all users of electricity, assuming that price increases are passed on 100%. The approach also assumes the price increases do not cause adjustment in the use of goods. From this perspective, the estimates should be interpreted as the *maximum* increase that would result once the effects have worked their way fully through the economy. Insofar as users do reduce their use, the impact on their cost of living would be reduced.[17] However, we have also not included a wage response to the increase, which would make the impact higher.

To convert the increases in the prices of different commodities into a price index, we use the consumption patterns of different household groups as depicted in the Social Accounting Matrix. These give expenditure weights that differ from those in the Consumer Price Index, since the SAM is more aggregated.

Table 14 gives some estimates of the impacts of a 25% increase in electricity.[18] Since we are interested in the energy context, we have also included the effects of similar increases in the price of coal and of coke and petroleum products. The table gives both the direct and the indirect effects. The former is driven by the share of electricity in the overall expenditure of the household. The latter arises from the increase in costs of production in activities that use electricity. We assume that these cost increases are passed on, and cause further cost increases. Our estimates are the final effects after all these rounds of price increases have worked through the system.

For electricity, the patterns are much as expected. The CPI for all households rises by 0.88%, with 0.53 percentage points (pp) coming from direct effects and 0.35% pp from indirect effects. The impact is greater on poor households than on rich ones. This is driven almost entirely by the direct impact, which in turn is driven by the shares of expenditure on electricity in total expenditure. Thus the richest households allocate 0.8% of their expenditure to electricity, so the 25% price rise raises their expenditure by 0.2%. On the other hand, the poorest households spend 5.4% of expenditure on electricity so that the 25% increase raises their expenditure by 1.35%. Against this, the indirect effects are relatively uniform across household groups, contributing 0.40% to the CPI increase for the poorest and 0.32% to that for the richest.

While the absolute size of the indirect impact is relatively uniform, the relative impact increases in significance as households become richer. The impact operating through the goods they buy contributes relatively more to the rise in their cost of living than does the impact operating through the electricity they use.

Table 14 shows these impacts are reversed for petroleum. Richer households find their cost of living rising more than poor, indirect effects are much more significant than direct ones. Coal price increases have almost no direct effects, but feed through indirectly so that poor households see their cost of living rising more than twice the percentage increase for rich.

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[17] More sophisticated analysis would take into account these adjustments and try to measure the welfare impact of both the increase in price and the consequent reduction in consumption.

[18] The 25% reflects the electricity price increases granted to Eskom recently by NERSA. However, since the model is linear, the effects are scalable: 50% increase would have twice the impact; 12.5%, half.

One can take this analysis of indirect effects further by looking at what the major drivers of indirect effects are for each group. We can use the disaggregated indirect effects to calculate the price rise of each component. By weighting this by the share of that component in the expenditure of household groups we can trace the path through which indirect effects operate.

For electricity, 48% of the indirect impact on the poor comes through its impact on food, whereas for the rich, 56% of the impact is channelled through services. Similarly, more than half the indirect effect of the petroleum price increase on the poor (total indirect effect 1.08%) works through the impact on food prices. This impact is in fact greater than the direct impact. For rich households, the indirect effects work primarily through the impact on services.

These results of impact analysis are useful for getting an initial idea of who is likely to feel the price increases most keenly. They of course are based on a number of key assumptions, which we have given above. In addition, they make the assumption that people pay for the electricity they use.

As mentioned above, the analysis is static in that it does not allow for changes in the productive capacity of the economy through investment. It is also a linear model: it assumes goods are used in fixed proportions to each other, in both consumption and production. This is a reasonable assumption for relatively small price changes, when we would not expect behavioural adjustments to be very large. However, the method does not allow us to examine properly a sequence of price increases, such as has been implemented in South Africa under the MYPD2. Because of the linearity, the impact of three successive increases of 25% each is the same as the impact of a single increase of 75%. Nonetheless, the analysis does help us to begin to think about this. The cumulative impact of a sequence of increases will only differ from the impact of a single increase if at each point in the sequence there is a change in behaviour or in the structure of the economy. In other words, the various actors in the economy respond to the first 25% increase in such a way that the economy on which the second 25% increase is imposed is different. Clearly this requires much more information about behaviour. We return to this in the modelling section of the paper.

Most importantly, it is not possible for this type of analysis to show anything other than a negative effect. No compensating consequences of price increases are taken into account, only the cost-increasing ones. To look at these, we need a more flexible approach to the economy-wide impacts, which can take into account changes in the output-employment nexus. This we turn to in the next section.

11.1.2 Dynamic analysis

As noted in the previous paragraph, the static impact analysis focuses attention solely on the price increasing consequences of a rise in the electricity tariff. However, there are other consequences to NERSA granting – or not granting – a price increase. For example, as we have already noted, the price increases are motivated partly on the basis that they are needed to avoid continuing electricity shortages. If this is true – an assumption that needs to be investigated – then it can be argued that the price rise creates jobs (or at least avoids the loss of jobs) for the poor, there will be a trade-off: the welfare-reducing effects working through the rise in the cost of living would be countered by the welfare-raising effects working through more jobs and income earning opportunities. The net impact on welfare would be ambiguous theoretically and could only be resolved empirically. In general, it is not obvious that price increases will have bigger negative effects on firms (and therefore employment, incomes and poverty) than would continuing shortages.

However, while this may be true in general, it may not be of direct relevance to thinking about the impacts specifically on the poor. If excluding the poor from a price increase has little impact on revenue, doing so would be unlikely to significantly alter Eskom's ability to expand capacity. It seems implausible that a price increase to the poor would then make or break Eskom's credit rating.

Are the poor important for revenue? A rough calculation reveals the broad parameters. In the 2008 SAM that is our primary database, the electricity sector earns about 60% of its total income from sale to other industries and 40% from sales to households, 7.3% of which is from sales to the poorest 40% of households. The impact of a price rise on revenue depends on the elasticity of demand in the standard way. If the elasticity is zero, the revenue increases by the same percentage as the price rise; if it is 1, there will be no increase in revenue and if it is greater than 1, *reducing* the price would raise more revenue. At the extreme then, when the poor do not reduce their consumption of electricity (elasticity = 0), raising the price to the poorest 40% by 25% would raise (7.3% x 25% =) 1.8% more revenue than no price increase. This could be raised by increasing the price rise to 26.9% for all the non-excluded (i.e. not poor) groups.

This suggests that it would be wrong to argue that the negative consequences of raising electricity prices to the poor, which impact on them as direct and indirect consumers of electricity, will be offset by some positive effects flowing from expanded electricity supply, which impacts on them as employees in activities that use electricity. In other words, it is wrong to suggest that the poor should accept higher electricity prices because they will otherwise face fewer jobs. This does ***not*** mean that the shortages – and measures to deal with them – have no consequences for the poor. Lack of electricity can clearly constrain growth of production and employment. Against this, investment in supply capacity may draw resources away from other sectors of the economy where jobs and growth are being created. From this perspective, the context in which we should view the price increase is not continuing shortages but rather the impact of alternative ways of raising the required resources. Would the poor be better off if the electricity build programme was funded, for example, by public sector borrowing or if the additional electricity required was imported?

It is important to make a clear distinction between the financial mechanism that raises the finances needed to pay for the investment, and the real process that makes sure the real resources needed for the investment are available. In this review, we are concerned with the latter. We can set out the broad framework easily from a national income perspective. Investment comes from national savings. If savings cannot be raised (and this may not be the case), then total investment is fixed. This would imply that investment in any one sector is necessarily at the expense of investment in other sectors.

Electricity capacity constraint versus electricity investment crowding-out

The apparent suddenness with which electricity shortages manifested themselves in 2008 created an understandable sense of urgency in tackling the problem. However, it also meant that attention was directed primarily to increasing capacity 'at all costs'. Little was said about the potential costs of over-investment in capacity, despite the previous history of excess capacity which led Eskom to promote the use of electricity through low prices and tying itself into long-term contracts to supply cheap electricity. The assumption was that constraints on financing investment would mean that capacity expansion would, for the foreseeable future, be constrained below a desirable level. However, as far as we are aware, little has been said about optimal rates of growth. The Integrated Resource Plan (DoE 2010a) has been drawn up using an essentially engineering approach to optimisation: forecast economic growth rates, derive from this a path for energy demand, then use an optimising program to determine the least cost mix of energy, given costs of capacity expansion in each type, issues related to emissions, etc. This focuses on the engineering and business tradeoffs, but does not capture all of the economy-wide ones.

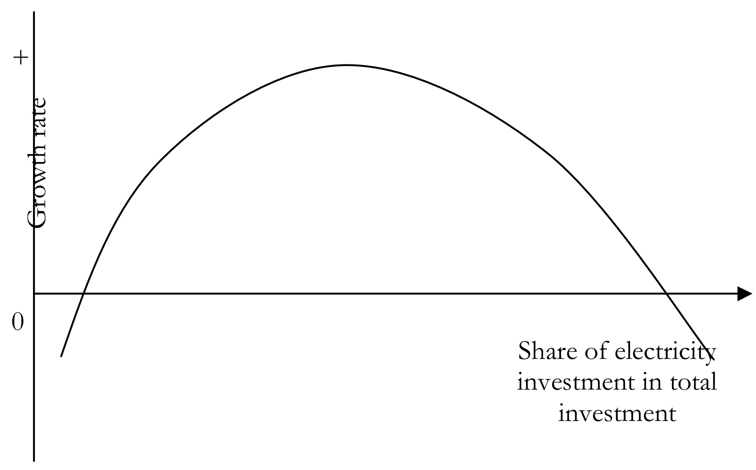
These potential tradeoffs are complex. One way of thinking about them is as follows. Growth does not come from the electricity sector itself (although the build programme does inject demand into the economy). Rather electricity capacity facilitates or constrains growth driven by other sectors. From this point of view, we can conceptualise a minimum rate of capacity expansion. Even if electricity capacity did not expand, there would be some growth possible at least in the short run, since the availability of electricity would be shifted towards users willing to pay more for it because their returns and growth rates warrant it.[19] But this would be a highly constrained growth rate and the constraint would become more and more binding over time. The composition of growth would also become more and more skewed towards the sectors that are least constrained by the shortages. It is not clear that other concerns such as job-creation or poverty alleviation would be addressed: there is no particular reason why those sectors most willing to pay for electricity would also be those that stimulate the fastest employment growth.

As electricity supply capacity expands through investment, these constraints would be relaxed, and the growth rate should rise. We can conceive of a situation arising in which there is no constraint on growth from the side of electricity provision: the economy grows as fast as it is able, given the other growth drivers in the economy. It would be tempting to take this as an optimal growth path for electricity. However, growth is not only inhibited by an electricity supply constraint. Expanding capacity in energy competes for investment resources with other sectors that drive growth. As we invest more in expanding electricity capacity, so we crowd out investment in other sectors.

This crowding out could have many immediate causes: the nature of financing, competition for capital goods, and exchange rate impacts. Fundamentally, however, it arises because of the old-fashioned Keynesian notion that the resources for additional investment have to come from additional savings. National savings come from the private sector, the public sector and from abroad. Each of these faces constraints, particularly in the short to medium term, and thus the investment resources that can be mobilised over any period are limited.

Figure 9: An electricity-growth Laffer curve

A simple thought experiment tells us that growth will be constrained by both an extremely low level of investment in electricity *and* an extremely high one. There is what economists might call a Laffer-curve relating electricity investment and economic growth (see Figure 9). It is probably



[19] There has to be some mechanism that permits this type of reallocation. The administered prices of the South African system, with the consequent rationing under shortages, may work against this optimal allocation.

more correct to normalise electricity investment as a share of total investment. Since we know that there must be both low and high shares of investment in electricity that cause the economic growth rate to be zero, we know there must be a turning point at which investment in electricity is 'optimal' in that it permits the highest growth rate.

As with all Laffer curves, the problem is not that it is conceptually wrong, but rather that we need to know where the turning point is for it to be useful. Determining this empirically is difficult particularly in an economy-wide model with a large number of sectors. These add flexibility to the responses and increase the number of permutations that have to be considered. What we can do is to try to determine the broad turning area and what determines its upper and lower bounds.

To do this, we need to understand how any investment is allocated across the different sectors of the economy. In our model we assume that investment in electricity is determined exogenously: it follows the path planned by those who make these decisions. The amount of electricity investment is deducted from the pool of available investment resources, leaving a residual available for investment in other sectors of the economy. We assume that the sectoral allocation of this residual is the result of the mix of two forces. First, there is inertia, so that much investment goes into sectors according to their existing size or capital stock. If this was the sole force operating, the structure of capital in the economy would remain constant: every sector would expand its capital stock at the same rate. However, investment also responds to differences in rates of return in sectors, with those sectors with higher rates of return attracting relatively more investment than those with lower rates. The evolution of the structure of capital is thus the result of a combination of these forces.

We assume that the residual investment, after investment in electricity, is allocated in this way.

As an experiment, we ran a number of simulations that started by holding electricity capital constant. The economy grows endogenously as savings from one year is invested, increasing capacity in the next. We then increased electricity investment, increasing competition with other sectors for investment resources. We had calibrated the model around an assumed growth rate of electricity capital of 3.3% per year (see Appendix 1d). It turns out that moving the growth of electricity capital stock substantially away from this rate in either direction reduces the GDP growth rate. In other words, both lower *and* higher investment in electricity reduced the GDP growth rate.

This result needs careful interpretation because it appears to be model-dependent. If we make the reference path of the economy grow much faster, say by increasing foreign savings or increasing the growth of skilled labour supplies, then the turning point at which electricity capacity ceases to constrain the economy but electricity investment crowds out other sectors becomes higher as well. Putting it differently, the optimal rate of growth of electricity investment depends on the underlying growth in the economy. Causality runs from the GDP growth rate to the required electricity investment rate.

This may seem to be a spurious result, an artefact of the model. However, there are two important practical implications. Firstly, it raises some questions about the apparent methodology underlying the scenarios in IRP2010. They appear to be based on an assumed GDP growth rate of 4.6%. The growth of electricity capacity flows from this assumption. While this is entirely acceptable, it does mean that the discussion of the IRP2010 should interrogate the assumed GDP growth rate closely.

Secondly, and related to the first point, this result points to the sensitivity of the appropriate rate of investment in electricity to the GDP growth rate. South Africa has seen this in practical terms in the past decade and a half: the 2008 electricity crisis arose in part because the economy grew faster than forecast and thus the electricity capacity constraint kicked in. But we now see that this can work the other way: locking the economy into a high rate of investment in electricity could worsen any future downturn, as the crowding out impact would come into play.

Electricity price increases and growth

There is the possibility of a price scenario that is parallel to the capacity/ investment narrative in the previous section. Raising the price of electricity obviously affects the profitability of sectors using it. In the short run, this may affect output and employment. In the long run it will affect the sectoral pattern of investment since this depends in part on the profitability of sectors.

We modelled this as explained in Appendix 1d. The assumption concerned what 'Eskom' does with the additional income from the price increase. This is crucial in determining the result. If 'Eskom' saves it, then it adds to national savings and indirectly increases investment. This is a reasonable representation of the scenario in which the investment in electricity is financed at least in part by the price increase. It eases the investment crowding-out constraint discussed above, so that the given level of electricity investment is consistent with higher investment in other sectors. This results in higher GDP and employment growth for any given level of electricity investment.

If some of the additional revenue is distributed to others, in the form of either dividends or higher wages and salaries to 'Eskom' employees, this effect will be dissipated. Recipients may save some of the additional income, permitting higher investment. However, less will be saved than when the additional revenue is retained by 'Eskom'.

The timing of electricity investment

Building electricity supply capacity can take two years for wind or solar, four years for a coal-fired power station and six years for a nuclear one (see the IRP2010 documentation). There will thus be a period before any capacity constraint on growth is relieved by the commissioning of new supplies in which the crowding-out effects of building operate. This raises the question of whether the timing of build programmes matter.

We explored various time profiles of build programmes. The effects over the whole period were negligible. It makes little difference to long run GDP growth whether investment is spread out over a number of years or concentrated in a few. The sectoral composition of the economy is affected, since there are impacts on relative profitability. However, even these effects are small.

We should note, however, that we do not really have the information to model this process well. We do not have good information about how firms respond to shortages in the short run. We know that output levels are affected. These effects are captured by the model. But we do not know what happens once the shortages are reversed. In the model, the effects are reversed: firms revert to the levels of production and employment there would have been without the shortages. In the real world it may be that output is permanently reduced by, for example, seriously affected firms relocating outside South Africa. We are unable to capture these effects.

11.2 Appendix 4b: Energy scenarios

11.2.1 Background

This report is not intended as a guide to energy use in South Africa. Nonetheless it is useful to be clear about some aspects of energy, so that we know what we are talking about. More extensive guides can be found in Stats SA 2009a, and in DoE, various dates. A good non-technical discussion of energy in general can be found in OECD et al. 2005.

We distinguish between the energy sector and the energy-using sectors. Within the former we make a further distinction between those activities that produce energy from primary sources (Coal, Crude Oil, Gas, Nuclear, Hydro, Geothermal & Solar, and Renewables & Waste) and those that transform energy from one form into another – primarily Electricity and Petroleum Products. Our main concern in this paper is with the provision of energy to final users.

Table 15 provides some recent data on final use (consumption) of energy in South Africa. The underlying data shows the Kilotonnes of Oil Equivalent (KoE) from each source, allowing comparison across energy types.

Panel A shows that Petroleum Products are the most important source across all uses, followed by Electricity and Coal [Row 7]. However, this pattern varies considerably amongst users. Electricity is the most important source for Industry and Mining, followed by Coal, whereas residential use is dominated by Renewables and Wastes, followed by Electricity and Coal.

Panel B shows the pattern of final consumption by user. The Total column shows Industry (including Mining) is the biggest user of energy, followed by Transport[20] and Residential Users. Again these patterns differ amongst the different sources.

Panel C shows total final energy use by user and source, so that one can judge the significance of the particular source and use. Thus, although Industry and Mining accounts for 99% of use of Gas (Panel B), gas supplies only 3.0% of energy (Panel A), so that use of gas by industry accounts for only 3.0% of total final energy use (Panel C).

One can use the descriptive figures in Table 15 as the basis for quick insights into where the broad impact of energy policy is likely to be. For example, a rise in the electricity price affects about 27% of final energy use (Panel A, Row 7). But it affects 52% of the energy used by Commerce and Public Services and only 2% of Transport's energy use. So while a 10% rise in the price of electricity will, other things equal, push up overall energy costs directly by 2.7%, it will push up Commerce's energy costs by 5.2%. On the other hand, there is almost a one to one relationship between a rise in the price of petroleum products and the Transport Sector's energy costs.

Rather than rely on this static description, we would like to have some information about how energy use has evolved in South Africa. Unfortunately, the International Energy Agency data (IEA 2008) used in Table 15 is not readily available for past years. We therefore use the energy balance data published by the Department of Energy (DoE, various dates). Although these are similar to the IEA data, they are not exactly comparable.[21]

We use this time series of energy uses for two purposes. First, it is of interest how (and why) the inputs of different energy carriers into final energy consumption have changed. The final consumption of a particular source of energy might change because overall energy consumption changes or because the contribution of the particular source has changed.

We call the first effect the energy demand effect. It reflects the impact of the change in the economy's level of demand for energy, which could be because output is growing or because more energy-intensive processes are being used. The second effect we call the energy composition effect. It reflects influences that cause a shift in the type of energy used. Broadly speaking there is a change in energy technology that could be caused by changing relative prices or by exogenously-driven technology change.

[20] One has to be careful interpreting sectors in the energy accounts since they are not identical to those in the Standard Industrial Classification. In particular 'Transport' is not the transport sector, but transport use by all sectors, including residential.

[21] DoE uses Terajoules whereas IEA uses Kilotonnes of Oil Equivalent. Unfortunately converting at the standard conversion factor does not generate the same figures where the series overlap. The two sets also do not have the same industrial breakdown. Finally, the most recent DoE data available is for 2006.

Appendix 1a shows how we can decompose overall changes in energy demand into these two effects, while Table 16 shows the results of such a decomposition applied to South African data between 1992 and 2006. Over that period, total energy used in final uses in South Africa rose by 773 533Tj, a 44.7% increase. This change was composed predominantly of rises in electricity (18.6 percentage points) and petroleum (16.7%), with both gas and coal contributing just under 5% each. If there had been no change in the composition of energy supplies, the use of coal would have risen more than the use of electricity (Col [3] – 14.8%vs. 11.8%). However, the shift away from coal (-12.1%) towards electricity (6.8%) completely reversed this. Petroleum demand grew almost solely because of the energy demand effect. Although it supplied more energy in 2006 than in 1992, this was primarily because of an expansion in demand for energy. On the other hand, a 'technical shift' towards using electricity accounted for slightly more than a third of its expansion in consumption.

While this decomposition does not show causality, it does suggest that factors affecting energy choices shifted in favour of electricity over the period and away from coal. We cannot provide a rigorous analysis of the causes, but casual evidence does suggest that changes in relative prices play an important role. Figure 10 provides evidence that the cost of energy from all sources rose relative to the costs of energy from electricity over the period. By 2006, a joule of energy from coal cost 20% more relative to the cost of a joule from electricity compared to 1992. The relative cost of energy from other sources mostly doubled between 1992 and 2006. One would expect these relative price shifts to lead to a shift towards the use of electricity. Even if activities were dependent on fixed inputs of a particular energy source per unit of output and there was no technical change, one would expect an increase in output of activities using electricity relative to those using gas, so that the average use of a sector (which comprises a number of disparate activities) would shift.

Of course one would also expect such price changes over this period of time also to lead to technical changes that would enhance the shift.

11.2.2 Households as consumers of energy

There are several sources of data on energy use by households available. The Department of Energy's energy balances (DoE, various dates) provide data on direct energy use, both in the form of natural units (tonnes, cubic metres, GwH etc) and also converted to Terajoules (DoE, various dates). These physical data would be ideal for much of what we are interested in. Unfortunately, they are not available in the disaggregated form we need in order to focus on the poor. We therefore have to supplement them with expenditure data, showing the amount spent on various energy products. There are a number of sources for such data. We use the 2005/2006 Income and Expenditure Survey (Stats SA 2008).

According to the Department of Energy, residential use of energy accounted for approximately 20% of all energy use in South Africa in 2006.[22] Electricity accounted for 27% of this use, with renewables (36%), coal (29%) and petroleum (7%) accounting for the balance. Policies to reduce South Africa's carbon footprint will have to take this into account. On the one hand, leaving households out of any mitigation and adaptation strategies will omit a large user. On the other, including them may have negative consequences for household poverty, especially if prices are the main instrument for reducing consumption.

[22] Note this is residential use, not household use. It measures use of energy in residences. Households also use energy outside the residence – notably in cars – but this is accounted for elsewhere in the energy accounts.

The data above refer to all residential users, not simply the poor. Since such physical data are not disaggregated according to household income. As NEDLAC (2010) demonstrates, numerous definitions of who is poor are used in South Africa. Although a precise definition and associated measure is important for policy implementation, it is beyond the scope of this paper to develop one. Constrained by the data we use, we will consider the bottom four deciles of the household distribution to be poor. This puts 40% of households with 52% of the population below the poverty line. In the modelling we will look across the whole income distribution.

Households use different forms of energy, although on average electricity dominates. The General Household Survey (Stats SA 2009b) shows that although 82% of households in South Africa used electricity, 26% used paraffin and wood for cooking. These proportions of households are roughly confirmed by the 2008 National Income Dynamics Survey, which found that 52% used electricity and 25% wood as their main source of energy for cooking.[23]

Table 17 shows direct energy consumption by the residential sector.[24] The supplies from different energy carriers have been converted into Terajoules for comparison. There are problems with the data and comparability over the years.

It is likely that a smaller proportion of poorer households use electricity than rich, and that they use other forms of energy more.

The main point is that it is not simply electricity that affects the poor. As electricity prices rise, we are likely to find them substituting away from it. However, the prices of other energy sources are also rising, driven in part by carbon taxes and other mitigating policies related to climate change. Will this simply reduce the level of energy consumption? Will they maintain energy consumption at the expense of other purchases?

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[23] This differs from the Energy Account data because of the distinction between residential and household measures explained in footnote 22.

[24] See comments on data in Appendix 1b for a discussion of accuracy.

11.3 Appendix 4c: Decomposing energy consumption

It is of interest how (and why) the inputs of different energy carriers into final energy demand have changed. One way to think of this is whether a particular energy source has changed because the overall demand for energy in the economy has changed or because the composition of energy demand has changed. The share of a sector's energy use in total energy use can be defined as

$$s_i \equiv \frac{E_i}{E}$$

where s_i is the share of source *i* (*i* = coal, petroleum, gas and electricity) in total Tj supplied, E_i is the total Tj supplied to final consumption by source *i* and *E* is total Tj supplied.

This can be rewritten as

$$E_i \equiv s_i \cdot E$$

Changes in E_i can then be decomposed in the standard way to give

$$\Delta E_i \equiv s_i \cdot \Delta E + E \cdot \Delta s_i + \Delta s_i \cdot \Delta E$$

The first term on the right is the change in supply of source *i* that would have occurred if total energy demand had risen the way it did, but the shares of each source had remained constant. We call it the 'energy demand effect'. The second term is the change that would have occurred total energy demand had remained constant, but the composition of supply had changed the way it did. We call this the 'composition effect'.

The *energy demand effect* reflects the impact of changes in the economy's demand for energy. This could be because output is growing or because more energy intensive processes are being used. The *energy composition effect* reflects influences that cause a shift in the type of energy used. Broadly speaking, this reflects a change in energy technology that could be caused by changing relative prices or by exogenously driven technology change.

11.4 Appendix 4d: Data problems

There are a number of problems associated with data on energy use in South Africa. Essentially there are two types of available – physical and value data. The physical data provide information on actual energy used measured either in natural units (eg tonnes of coal, GwH of electricity, litres of petroleum) or in common energy equivalents (typically terajoules or tonnes of oil equivalents). Value data show the value of energy either produced or used.

Most of the physical data is derived directly or indirectly from tables compiled by or on behalf of the Department of Energy, formerly the Department of Minerals and Energy (Department of Energy, various dates). These cover the years 1992–2006[25] and follow the methodology set out by the International Energy Agency. These data have recently been compiled by Statistics SA (Stats SA 2009a). The International Energy Agency provides similar data (IEA 2008). Although its data comes up to 2008, it is assumed that the data is derived from information provided by the DoE.

Value data are available primarily from Statistics South Africa. Stats SA provides some physical data, such as electricity generated and available for distribution (Stats SA 2009–2010 [monthly]). Household expenditure on energy is available in the Income and Expenditure Survey (Stats SA 2008). Expenditure by industrial users is available from the supply use tables, the latest of which is for 2005 (Stats SA 2010). There are also similar data from other surveys such as the National Income Dynamics Survey (NIDS 2010). These data have been used by Quantec in compiling the Social Accounting Matrix (Quantec 2010).

Both types of data are useful. The physical data are crucial for understanding energy and emissions. However, for energy demand issues it is important to be able to make comparisons with demands for other goods and services and this requires some common measure such as values.

Unfortunately there are a number of limitations to the DoE data. In particular:

- There are a number of gaps in the historical data: for example, several sectors show petroleum being used in some years but not others.
- Some of the year-on-year changes seem implausibly large: for example, petroleum supplies Commerce and Public Services with 151Tj in 2000 and 32 823Tj in 2001.
- The residential use data requires investigation. Table 16 shows that renewable energy is the main energy source, with exactly the same use in every year (190 400 Tj). This seems implausible. There is no record of gas usage. The use of coal rises by an average of 44% annually from 2000 to 2006, as compared to about 6% annually for electricity.
- It is not clear how accurate the data are. The focus group discussions organised by as part of this project raised queries suggested that the data did not resonate with their intuitions about trends in their sectors. These could simply be misperceptions, but there is a *prime facie* case for interrogating the data further.

While the value data suffer from the normal drawbacks of survey data, for energy purposes a particular problem is created by the fact that prices of energy products, particularly electricity, differ according to users. It is therefore very difficult to retrieve the quantity data from the value data. There are some price data available, but deriving consistent price, quantity and value series is beyond the scope of this project.

[25] For some reason the DoE website currently displays links to 1992–2005, whereas it previously displayed 2006.

Finally, there are problems using the physical and the value data for consistent comparisons. In particular, the 'sectors' in which the energy accounts are not consistent with sectors as commonly defined by economists using the Standard Industrial Classification. For example, 'Transport Sector' in the Energy Accounts refers to all uses of energy for transport, whereas in the SIC it refers to business offering transport services. Thus the energy accounts include use of energy for transport by households; in the value accounts this would be classified as part of household expenditure.[26]

Given the importance of these data for energy policy formulation, particularly their role in international climate negotiations, it would seem worthwhile investing in producing good, systematic and consistent data.

The data should be publicly available. The growing importance of energy policy in international climate change agreements require that there is more awareness amongst decision makers of what the data mean. Public discussion should lead to an improvement in accuracy as the primary data providers realise the importance of reporting accurately.

[26] These differences should not be interpreted as meaning one method is wrong. Rather they collect the data for different purposes for which their particular classification is most suited. However, it would make the task of researchers easier if they were more readily comparable.

11.5 Appendix 4e: Industry mapping

We present energy intensities in the report. To do this, we draw together Department of Energy data on electricity consumption, with Stats SA data (assembled by Quantec) on capital investment and output. The model we constructed was also designed to align economic data with available energy data. Below we show how sector definitions in each data set were aligned.

Table 13: Alignment of sectors across datasets

Department of Energy	Quantec South African Standardized Industry Database (SASID)
Agriculture	Agriculture, forestry and fishing [1]
Mining and Quarrying	Coal mining [21]
Mining and Quarrying	Gold and uranium ore mining [23]
Mining and Quarrying	Other mining [22/24/25/29]
Food and Tobacco	Food [301-304]
Food and Tobacco	Beverages [305]
Food and Tobacco	Tobacco [306]
Textile and Leather	Textiles [311-312]
Textile and Leather	Wearing apparel [313-315]
Textile and Leather	Leather and leather products [316]
Textile and Leather	Footwear [317]
Wood and Wood Products	Wood and wood products [321-322]
Paper Pulp and Print	Paper and paper products [323]
Paper Pulp and Print	Printing, publishing and recorded media [324-326]
Chemical and Petrochemical	Coke and refined petroleum products [331-333]
Chemical and Petrochemical	Basic chemicals [334]
Chemical and Petrochemical	Other chemicals and man-made fibers [335-336]
Chemical and Petrochemical	Rubber products [337]
Chemical and Petrochemical	Plastic products [338]
Non-Metallic Minerals	Glass and glass products [341]
Non-Metallic Minerals	Non-metallic minerals [342]
Iron and Steel	Basic iron and steel [351]
Non-Ferrous Metals	Basic non-ferrous metals [352]
Iron and Steel	Metal products excluding machinery [353-355]
Machinery	Machinery and equipment [356-359]
Machinery	Electrical machinery and apparatus [361-366]
Machinery	Television, radio and communication equipment [371-373]
Machinery	Professional and scientific equipment [374-376]
Transport Equipment	Motor vehicles, parts and accessories [381-383]
Transport Equipment	Other transport equipment [384-387]
Non-specified (Industry)	Furniture [391]
Non-specified (Industry)	Other manufacturing [392-393]
Electricity	Electricity, gas and steam [41]
Electricity	Water supply [42]
Construction	Building construction [51]
Construction	Civil engineering and other construction [52-53]
Commerce and Public Services	Wholesale and retail trade [61-63]
Commerce and Public Services	Catering and accommodation services [64]
Transport Sector	Transport and storage [71-74]
Transport Sector	Communication [75]
Commerce and Public Services	Finance and insurance [81-82]

Department of Energy	Quantec South African Standardized Industry Database (SASID)
Commerce and Public Services	Business services [83-88]
Non-specified (Other)	Medical, dental and veterinary services [93]
Non-specified (Other)	Excluding medical, dental and veterinary services [94-96]
Non-specified (Other)	Other producers [98]
Non-specified (Other)	General government services [99]

11.6 Appendix 4f: The Model

For the modelling in this study we have adapted the dynamic IFPRI Standard Model that has been widely used in South Africa and elsewhere. The standard set-up is described by Thurlow (Thurlow, 2005). The model is a recursive dynamic model in which each year is solved separately, with no forward-looking behaviour connecting them.[27] In between years various growth drivers are up-dated so that the capacity of the economy grows.

The central feature is that capital stock is up-dated endogenously. This works as follows. Total investment is determined as an outcome of a particular year. It is then allocated to sectors based on a mix of relative sectoral profitability and existing shares in economy-wide capital. If the allocation was based solely on profitability, investment would be directed entirely at one or two highly profitable sectors. While profitability does play an important role in determining the pattern of investment in the real world, in practice we do not find it as lopsided as this. Much investment consists of expansion of existing firms in activities in which they already operate, even though there are more profitable opportunities elsewhere. We could say there is inertia in the real world. We capture this by assuming that investment is also determined by the existing share of a sector's capital in the national capital. If profitability played no role, sectoral capital stocks would expand uniformly across all sectors and the structure of the economy (with respect to capital) would not change. We control the relative importance of these to influences through a parameter, which in this application we have set so that the inertia is relatively high and the structure of the economy does not change dramatically.

Along with this endogenous updating of capacity, we can update labour supplies and productivity exogenously. In standard runs of the model we assume that high skilled is in limited supply that grows at 1% per year and is fully employed. Both semi- and low skilled labour are assumed to be in plentiful supply and maybe also be unemployed. We assume that their real average wage rates grow by 3.8% pa and 2.2% pa respectively. Total factor productivity grows by 0.4% per year.We assume that investment is driven by savings, that foreign savings grow by 2.6% per year. Government spending is exogenously determined, and grows by 0.85% per year.

These assumptions, coupled with electricity capital growing at 3.3% pa (the average rate implied in the Integrated Resource Plan's Revised Balanced Scenario) result in a GDP growth rate of 4.5% pa, roughly the rate assumed by IRP2010.

This provides us with a benchmark against which we can judge the impact of alternative assumptions.

To apply the model to energy issues, we first adapted the 2008 Social Accounting Matrix supplied by Quantec (Quantec, 2010). We separated 'electricity capital' from other capital and introduced a vector of demands for capital inputs into electricity investment. The data for constructing this vector were derived from a number of sources, primarily the report by the Electricity Power Research Institute (EPRI, 2010).

We also modified the SAM to make the sector reflect the sectoral structure of the available Energy Balances (see Appendix 4e).

[27] A different tradition adopts inter-temporal optimisation, assuming that agents determine their behaviour today based in large measure on what they expect to happen in the future. There is some relevance of energy issues. Where investments undertaken today make take more than six years to come to fruition. Clearly investors think about what they expect conditions then to be. However, we think a more myopic approach is more relevant to South Africa.

In the standard runs of the model the electricity price is market determined. One adaptation we made was to impose fixed price increases. These are in the form of a 'tax' on electricity, the proceeds of which accrue to "Eskom" in the first instance.

12 Appendix 5: Summary tables

Table 14: Impact of 25% increase in three energy prices on CPI for different households (%)

	Electricity, gas & steam				Coke & refined petroleum products				Coal mining			
	Share	Direct	Indirect	Total	Share	Direct	Indirect	Total	Share	Direct	Indirect	Total
Poorest 10% of households	5.4	1.35	0.40	1.75	1.5	0.38	1.08	1.46	0.0	0.01	0.47	0.48
2nd Decile	4.6	1.14	0.39	1.53	1.3	0.32	1.09	1.41	0.0	0.01	0.42	0.43
3rd Decile	3.6	0.90	0.38	1.28	1.2	0.30	1.12	1.42	0.0	0.01	0.37	0.37
4th Decile	3.0	0.74	0.38	1.13	1.2	0.30	1.13	1.43	0.0	0.01	0.33	0.34
Poor Households	3.8	0.96	0.39	1.34	1.3	0.32	1.11	1.43	0.0	0.01	0.38	0.39
5th Decile	2.6	0.66	0.38	1.04	1.4	0.36	1.14	1.50	0.0	0.01	0.31	0.32
6th Decile	2.4	0.61	0.38	0.99	1.9	0.47	1.13	1.60	0.0	0.01	0.30	0.31
7th Decile	2.2	0.55	0.37	0.92	2.8	0.70	1.11	1.81	0.0	0.00	0.29	0.30
8th Decile	2.2	0.55	0.37	0.92	4.0	1.00	1.07	2.07	0.0	0.00	0.30	0.30
9th Decile	2.2	0.56	0.35	0.91	5.7	1.41	0.98	2.39	0.0	0.00	0.30	0.31
90th—95th percentile	2.1	0.52	0.34	0.86	5.7	1.42	0.91	2.32	0.0	0.00	0.29	0.30
95th—96.25th percentile	1.7	0.42	0.33	0.75	7.1	1.78	0.87	2.65	0.0	0.00	0.27	0.28
96.25th—97.5th percentile	1.6	0.40	0.33	0.73	6.6	1.66	0.88	2.54	0.0	0.00	0.27	0.27
97.5th—98.75th percentile	1.4	0.35	0.33	0.68	6.3	1.57	0.86	2.43	0.0	0.00	0.25	0.26
Richest 1.25%	0.8	0.20	0.32	0.52	5.5	1.38	0.83	2.21	0.0	0.00	0.22	0.22
Rich Households	1.9	0.48	0.35	0.83	4.9	1.22	0.97	2.19	0.0	0.00	0.28	0.29
All	2.1	0.53	0.35	0.88	4.5	1.13	0.98	2.12	0.0	0.00	0.29	0.30

Source: Own calculations using (Quantec 2010)

Note: 'Share' shows direct expenditure on the item as a percentage of total consumption expenditure by the household group

Table 15: Total final consumption by source and sector, South Africa, 2008

		Coal	Petroleum Products	Gas	Renewables and Waste	Electricity	Total
	PANEL A: Composition of Energy Use within Sectors						
1	Agriculture/ Forestry	1.1%	69.0%	0.0%	0.0%	30.0%	100.0%
2	Industry (including Mining)	33.9%	4.2%	8.6%	8.0%	45.3%	100.0%
3	Transport	0.0%	98.0%	0.0%	0.0%	2.0%	100.0%
4	Commercial and Public Services	36.8%	10.7%	0.4%	0.0%	52.0%	100.0%
5	Non-specified and Non-Energy Use	42.6%	42.7%	0.0%	1.6%	13.1%	100.0%
6	Residential	21.8%	5.0%	0.0%	51.9%	21.2%	100.0%
7	Total	22.2%	31.6%	3.0%	16.1%	27.1%	100.0%
	PANEL B: Composition of Use of Energy Sources by Sector						
8	Agriculture / Forestry	0.1%	5.8%	0.0%	0.0%	2.9%	2.7%
9	Industry	53.1%	4.7%	99.0%	17.3%	58.4%	34.9%
10	Transport	0.0%	76.4%	0.0%	0.0%	1.8%	24.7%
11	Commercial and Public Services	12.5%	2.6%	1.0%	0.0%	14.5%	7.5%
12	Non-specified and Non-Energy Use	9.2%	6.5%	0.0%	0.5%	2.3%	4.8%
13	Residential	25.0%	4.1%	0.0%	82.2%	20.0%	25.5%
14	Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
	PANEL C: Use of Total Energy by Sector and Source						
15	Agriculture/ Forestry	0.0%	1.8%	0.0%	0.0%	0.8%	2.7%
16	Industry	11.8%	1.5%	3.0%	2.8%	15.8%	34.9%
17	Transport	0.0%	24.2%	0.0%	0.0%	0.5%	24.7%
18	Commercial and Public Services	2.8%	0.8%	0.0%	0.0%	3.9%	7.5%
19	Non-specified and Non-Energy Use	2.1%	2.1%	0.0%	0.1%	0.6%	4.8%
20	Residential	5.6%	1.3%	0.0%	13.2%	5.4%	25.5%
21	Total	22.2%	31.6%	3.0%	16.1%	27.1%	100.0%

Source: calculated from International Energy Agency nternational Energy Agency. 2008. Energy Balances for South Africa.

Table 16: Changes in energy final consumption, 1992–2006

	Levels (Tj)		**Percentages**		
	Energy Demand Effect	**Energy composition effect**	**Energy Demand Effect**	**Energy composition effect**	**Total Change**
	[1]	[2]	[3]	[4]	[5]
Electricity	203,486	117,818	11.8%	6.8%	18.6%
Petroleum	269,339	20,394	15.6%	1,2%	16.7%
Gas	10,518	71,631	0.6%	4,1%	4.7%
Coal	290,190	(209,843)	14,8%	-12.1%	4.6%
Total	773,533	-			44.7%

Source: Authors' calculations from Department of Energy. various dates. Energy Balances. Department of Energy. [Online]

Table 17: Residential energy use

	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Terajoules (Tj)														
Coal	55350	56700	58050	59400	60750	50483	41932	41604	67083	89564	103027	121581	135343	152604
Petroleum	29470	30800	33625	30682	28709	27033	30506	25214	37779	35909	39637	43278	39420	38867
Gas	0	518	466	470	512	0	0	0	0	0	0	0	0	0
Renewables	0	0	0	0	0	190400	190400	190400	190400	190400	190400	190400	190400	190400
Electricity	97045	96467	101218	106385	106533	108587	106240	103248	124641	109507	122669	130432	133093	142815
Total	181865	184484	193359	196938	196504	376504	369078	360467	419903	425379	455733	485692	498256	524686
Percentage shares														
Coal	30.43	30.73	30.02	30.16	30.92	13.41	11.36	11.54	15.98	21.06	22.61	25.03	27.16	29.08
Petroleum	16.20	16.69	17.39	15.58	14.61	7.18	8.27	6.99	9.00	8.44	8.70	8.91	7.91	7.41
Gas	0.00	0.28	0.24	0.24	0.26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Renewables	0.00	0.00	0.00	0.00	0.00	50.57	51.59	52.82	45.34	44.76	41.78	39.20	38.21	36.29
Electricity	53.36	52.29	52.35	54.02	54.21	28.84	28.79	28.64	29.68	25.74	26.92	26.85	26.71	27.22
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Source: DoE, various dates

Table 18: Energy targets in South Africa's energy efficiency strategy (2008)

Sector	Measure targeted		
	Reduction in Final Energy Demand	**Improvement in Energy Intensity**	**Parasitic electrical usage**
Total	12%		
Industry and Mining	15%		
Iron and Steel		1% p.a.	
Chemical and Petrochemical		1% p.a.	
Mining sector	10% (using adjustable base)		
Paper, Pulp and Printing		2% p.a.	
Cement		2% p.a.	
Power generation			15%
Commercial and Public Buildings	20%		
Transport	9%		
Residential	10%		

Source: Constructed from DME 2008, pages 20–26.

Table 19: Energy/ consumption elasticities

Source of demand	'Elasticity'
Bottom income decile	0.006
2nd decile	0.009
3rd decile	0.013
4th decile	0.018
5th decile	0.023
6th decile	0.031
7th decile	0.043
8th decile	0.060
9th decile	0.085
Top percentile	0.198
All households	4.853
Government	0.804
Investment	1.373
Exports	2.895

Note on calculation

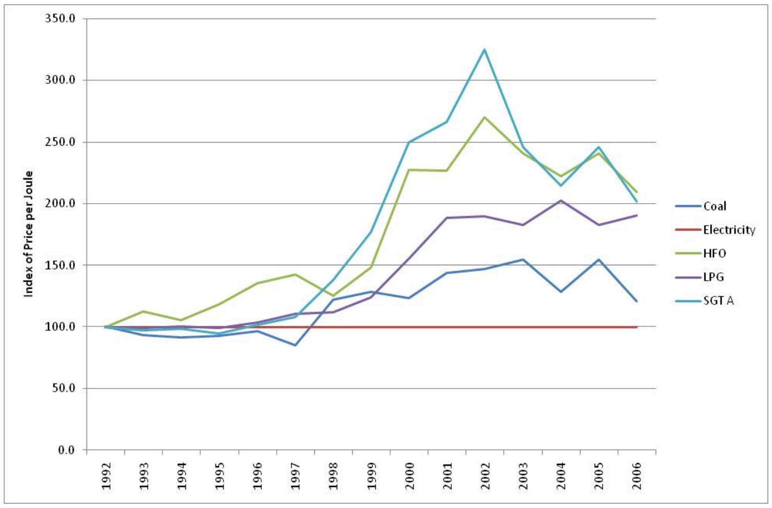
These 'consumption' elasticities show the percentage change in direct and indirect energy demand, measured in terajoules, which will result from a 1% change in the total demand by the relevant source.

Thus, for example, if the 4th decile household raises its demand for all goods by 1%, there will be a 0.018% rise in the Tj demanded in the economy.

The calculations are based on the 2008 Social Accounting Matrix. The procedure involved estimating the normal output multipliers and then applying energy input data.

In a linear model the elasticities are all equal to unity. If we raised all the demands in this table by 1% simultaneously, the demand for Tj would rise by 1%. The differences in the 'elasticities' here arise because of differences in levels and patterns of demand and because of the different energy inputs into the production of each sector.

Figure 10: Indices of relative energy prices in business use



Source: calculated from (Department of Energy, 2010) Table 9.2
Motes: HFO = Heavy Furnace Oil, LPG = Liquid Petroleum Gas, SGT A = Sasol Gas Tariff A

13 Appendix 6: Industry focus groups

It was initially planned that a small industry survey would be implemented to identify attitudes to energy saving, utilising a mailed questionnaire, with telephonic follow-up. Industry representatives made us aware of the risks with this approach, in a context of historically very poor response rates. Instead, we were advised to implement industry focus groups organised into mining, manufacturing, and commercial sectors. After some agriculture representives in an initial workshop informed us of the difficulty and cost associated with an agriculture industry focus group, we decided not to convene such a meeting. Three workshops were held with people identified with the assistance of various industry representative bodies such as Business Unity South Africa (BUSA), The South African Property Owners' Association (SAPOA), the Chemicals Industry Association and the Chamber of Mines, amongst others. BUSA kindly offered the use of its offices for these workshops. Participants are listed below. We kept word-for-word record of these meetings, and a reflection on what was learned is provided throughout the report.

03 Nov 2010 – Mining and Smelters

Miriam	Altman	HSRC
Andries	van der Linde	WSP Group
Howard	Harris	WSP Group
Chris	van Heeswijk	Gold Fields
Christian	Teffo	Chamber of Mines SA
Dave	Fleming	WSP Group
Dick	Kruger	Chamber of Mines SA
Kevin	Morgan	BHP Billiton
Mike	Rossouw	Xstrata Alloys
Ntsiki	Mbono	BHP Billiton
Roger	Baxter	Chamber of Mines SA
Shaun	Nel	BHP Billiton
Thomas	Garner	Exxaro Resources
Tommie	Hurter	Xstrata

04 Nov 2010 – Mixed Industry

Miriam	Altman	HSRC
Howard	Harris	WSP Group
Andries	van der Linde	WSP Energy
Piet	van Staden	Sasol

Lindie	Stroebel	Agri Business Chamber
Bert	Koster	Rand Water
Francois	van der Bank	ArcelorMittal SA
Johann	Kriek	ABSA
Andre	Rosslee	ABSA
John	Posthumus	Prana Energy
Dawie	Maree	Agri SA

29 Nov 2010 – Commercial Sector

Miriam	Altman	HSRC
Howard	Harris	WSP Group
Essop	Basha	Growthpoint
Gareth	Rowlands	Old Mutual Group Property Investments
Neal	Markham	Barloworld Power
Siyabonga	Mbanjwa	Crowie Holdings
Susjan	Wentzel	Park Dev Asset Management Group
Johann	Kriek	ABSA
Greg	Nichollas	WSP Group (informant, not part of research team)

Prior to these industry focus groups, the HSRC hosted a roundtable with industry stakeholders in October to get feedback on the project approach. These included the following participants:

Roger	Baxter	Chamber of Mines SA
Howard	Harris	WSP Group
Miriam	Altman	HSRC and National Planning Commission
Yogesh	Narsing	Presidency: National Planning Commission
Laurraine	Lotter	BUSA
Avril	Halstead	Chief Director Sectoral Oversight: National Treasury
Witness	Simbanegayi	Director NT ; National Treasury
Andries	Van der Linde	WSP Group
Neva	Makgetla	DDG: Dept of Economic Development
Saliem	Fakir	WWF-SA
Barry	Bredenkamp	NEEA / SANEDI
Rob	Davies	HSRC

14 Appendix 7: Terms of Reference

14.1 Background

In 2008, the HSRC prepared independent recommendations on an appropriate price path for electricity charged by Eskom, keeping in mind the needs of both the economy and Eskom itself. This was regarded as an important contribution by an institute that does not have a vested interest in the outcome. Since then circumstances have changed, especially with the global economic slowdown. In addition, new information is continuously coming to light in a context of very limited knowledge sharing until recently. Further, it appears that South Africa's 'electricity crisis' will not go away soon. This project will update the work done in 2008 based on changed circumstances and knowledge to make it more up-to-date and accurate. The aim is to see how changed circumstances might influence the price Eskom would need to charge and how any price path might affect the economy, employment and incomes.

A critical component of this analysis is to explore the potential impact on poor households. In this, we will reflect on the meaning of 'poor households' and the distributional impact of policy choices in respect of electricity. Often this is understood to mean the direct impact of rising electricity prices paid by the poor. Our preliminary modelling shows that this is one half of the challenge. The other half relates to employment creation, and price increases created indirectly where the price of goods normally bought by poor households rise disproportionately as firms pass on their electricity price increases.

14.2 Project Objective

This project will develop and make available:

- An improved independent view on Eskom's financial options
- An improved economy-wide model to assess the social and economic impacts of electricity pricing

14.3 Project Outline

There are five aspects to this project:

- Developing the existing financial model to explore the implications of different price paths for Eskom. This entails:
    a. Determining what conditions have changed that might influence the price;
    b. Deepening the financial model and improving its accuracy;
    c. Building scenarios under different assumptions in respect of economic conditions, and different funding and investment options.
- Economy-wide modelling to assess the impact of the price path on the economy, employment and the level and distribution of income. This will entail:

   a. Strengthening the existing economy-wide model so that it is more sensitive to the specificities of the energy sector and its links to the rest of the economy. For example, when the price of electricity goes up, larger users may find alternative sources of supply, different users may be charged different prices, etc.;
   b. Using the model to explore further the implications of price rises for the poor, particularly through their impact on employment and incomes;
   c. Updating the social accounting matrix upon which the model is based to take account of changes in the economy;
   d. Building scenarios under different pricing and behavioural assumptions.
- Update the HSRC report on the potential response of the main economic sectors to price increases. This will review both short term and potential longer term responses. A revision to this is needed, as we prepared the last report at the time of the first rolling blackouts in 2008. Firms have now had time to respond, and more actors have factored in the inevitability of electricity price increases. We need to see how far companies have gone with respect to changes in expectations and plans for the future.
- Stakeholder interaction to draw in information and debate insights.
- Preparation of a report to review findings.

14.4 Deliverables

1. Updated and more accurate financial model, which will be usable by key stakeholders such as NERSA, National Treasury and others.
2. Updated and more accurate economy-wide model which is open access.
3. Up-to-date sector analysis.
4. Stakeholder engagement.
5. Project report