

IRP 2010 Energy Forecast Revision 2 Report

Report prepared for IRP 2010 Revision 2

By: Systems Operations and Planning

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EXECUTIVE SUMMARY

Forecasts are estimates of future demand. Similarly, GDP growth forecasts and all the other assumptions used in forecasting electricity sales growth are estimates based on information, trends and expectations at the time of doing the forecast.

As reflected in the track record of the System Operations and Planning Division (SO) model, forecasts produced since 1992 were fairly close to the actual sales achieved. The same methodology has been applied by the SO in producing the IRP 2010 revision 2 forecast. It can therefore be expected that the SO model should produce a reliable set of forecasts, all else remaining the same. The CSIR model, done independently but using the same assumptions, produced a forecast that fluctuates around the low SO forecast.

The figure below shows the proposed SO model forecast for the period up to 2035 using three different GDP assumptions: High – 5.51%, Moderate – 4.51% and low - 3.51%. These result in electricity growths of 3.65%, 2.84% and 1.85% respectively.

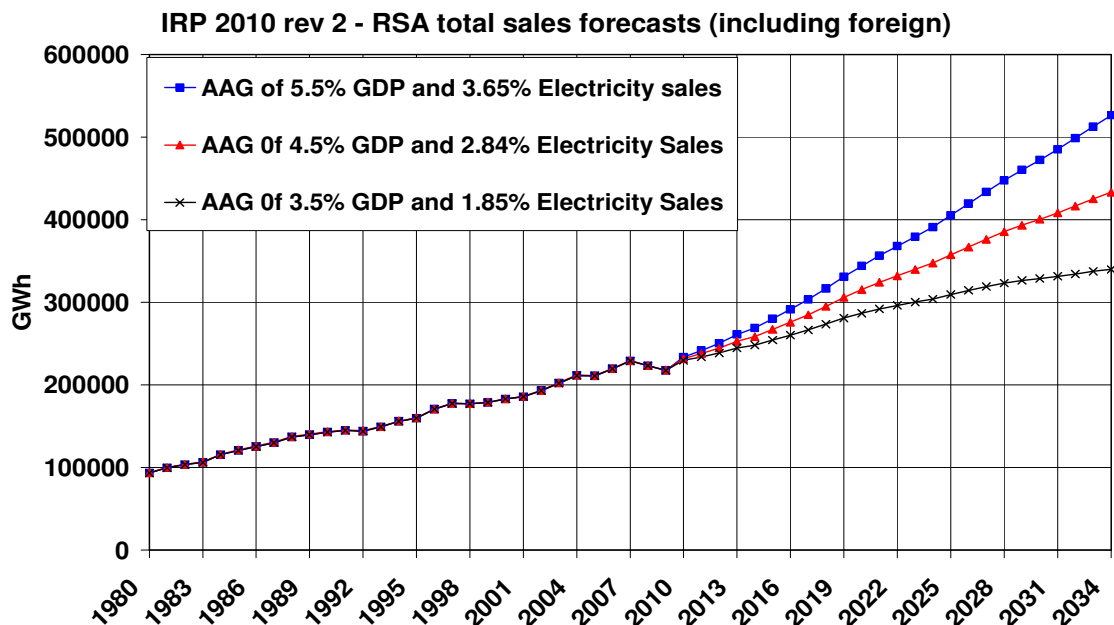


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1. Introduction

Objectives

The purpose of this document is to discuss the methodology for deriving the IRP 2010 Revision 2 forecast as well as the key assumptions underpinning the forecast. The document also discusses the results of the forecast in detail.

2. Scope

Although the IRP has a time horizon of 20 years, the load forecast covers the period 2010 to 2035.

The IRP 2010 Revision 2 load forecast covers the total requirement for electricity generation to meet the needs of South Africa, including the needs of neighbouring states and international customers, as contracted for in accordance with cross-border cooperation protocols.

The forecast includes the total energy requirements of all consumers, irrespective of the source of this generation (which may be a result self-generation or co-generation).

Demand Side Management initiatives that are planned (i.e., not yet realised) are excluded from the forecast, since these are included in the planning process to be treated similarly to supply-side options.

The long-term forecast for electrical energy is the key input from which the long-term *demand* forecast (i.e. the forecast for the annual demand profile) is derived. The long-term energy forecast and the long-term demand forecast determine the energy and capacity requirements, respectively, that must be met through the IRP for 2010. The demand forecast will be concluded once the energy forecast is approved.

3. Forecasting Methodologies used

The SO used an in-house developed methodology for the energy forecast, called the Sectoral Model. The SO Sectoral Model uses Eskom sales categories as the basis for developing the forecast, and is closely aligned to the Eskom MYPD sales forecast for the first 5 years. The model is a combination of statistical analysis, tracking of historical trends and applying expert knowledge. It is further expanded to include individual forecasts for all of the Eskom key customers. The other Eskom categories are done per customer service area and the model enables a geographical view per Eskom categories.

The CSIR was requested to provide an independent energy forecast. The CSIR use a statistical model which they developed. The model is basically a multiple regression model forecasting technique used to forecast the annual consumption within the individual electricity sectors by relating various conditions (or “drivers”) to the demand in each sector.

This report focuses on the methodology and results from SO model, as the CSIR model is discussed in a separate report.

The long term forecasts as produced by the SO model have been compared to actual results since 1994 and a high level of accuracy has been achieved, as can be seen in Figure 1.

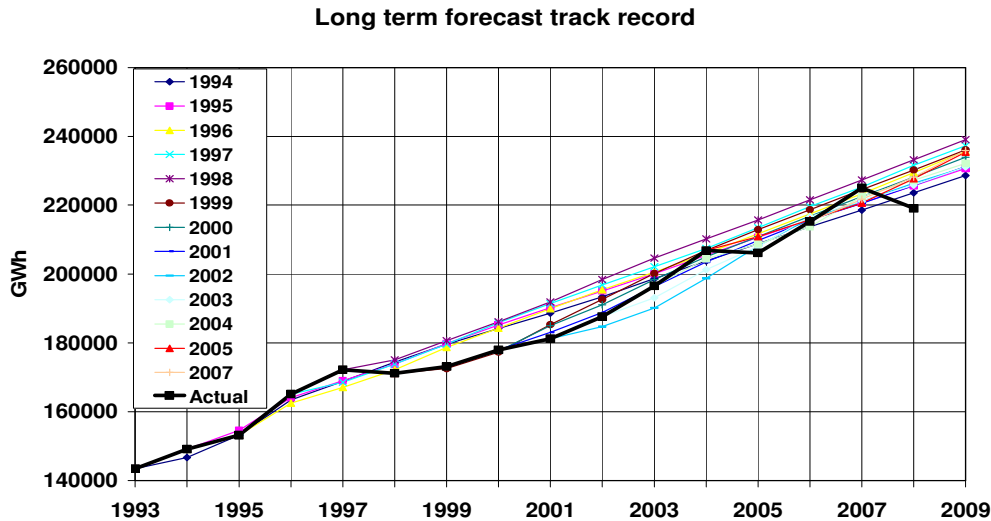


FIGURE 1: SO FORECAST TRACK RECORD (SOURCE: ESKOM)

The SO model focuses on individual forecasts for all of the Key Customers which accounts for almost 40% of the Eskom total sales. The remainder of the Eskom sales is forecasted per Eskom category and per Eskom Customer Service Area (including international sales). This forms the total Eskom forecast (including international sales). Own generation and losses are then forecasted and added to get the total RSA sent out forecast. This is the forecast that is used in the IRP planning process.

4. Parameters and assumptions

The Gross Domestic Product (GDP) reflects the sum total of all the economic activities that takes place in the country. A strong correlation exists between the GDP growth and the electricity sales growth and the electricity sales forecast is based to a large extent on this relationship. The two assumptions underlying this relationship are the forecasted GDP and the electricity intensity.

Some of the more important other factors considered in the System Operations IRP 2010 revision 2 electricity sales forecast are:

- Price Elasticity
- Electricity efficiency
- Universal Access to Energy
- Customer specific input parameters (history and projections)

- International sales
- Demand Side Management
- System Losses
- Load Profiles
- Temperature

Economic Assumptions

In Figure 2 the relationship between the GDP- and electricity sales growth rates can be seen clearly in the trend lines. As an economy develops the activities shift from the more energy intensive primary activities to the less energy intensive tertiary activities. Figure 2 reflects the same trend for South Africa.

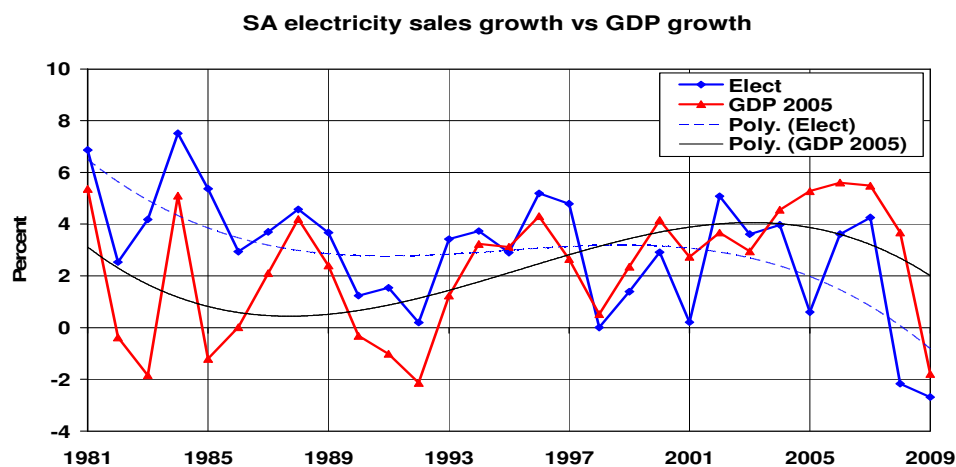


FIGURE 2. ELECTRICITY SALES VS GDP GROWTH RELATIONSHIP (SOURCE: ESKOM)

A set of three long term economic forecasts reflecting high-, moderate- and low growth has been developed over more than twenty years and is used as the main driver of the electricity sales forecasts. The growth rates of these forecasts have been adjusted over the years as historical economic growth and the structure of the SA economy have changed, and also as expectations for future growth have changed or improved.

During the 1980s central government planning department economic forecasts were used. More recently (from the late eighties to the mid nineties) a number of major internal and external scenario exercises were considered. Cognizance was also taken of: the Keys Normative economic model of the early 1990s and its economic growth target; the RDP economic forecasts; GEAR economic targets; and SA Reserve Bank economic scenarios around the middle of 2000. Economic forecasts from large financial institutions and AsgiSA targets have also been considered during recent years.

Numerous GDP forecasts from different economists are considered in the compiling of the GDP assumption for the SO model. International economies are monitored regularly. The economic forecasts are adjusted based on the changes in the SA economy and review of forecasts from a number of institutions including local banks, the IMF and the World Bank.

Although the three growth forecasts are influenced by the recent growth performance of the world and SA economies and expectations of future growth, the experience of previous forecasts provide a basis for the development of the current expectations for electricity demand.

The AsgiSA targeted growth of 6% GDP growth by about 2014 is currently used as a base for the **high GDP growth forecast**. This is a figure which was proposed by government as a target since 2005. The intention of this target was also to halve unemployment by about 2014. The model assumes an adjustment to the target date (delaying to 2016) to compensate for the impact of the global economic recession.

Although this could be seen as a rather optimistic target, it should be borne in mind that GDP growth rates of close to 6% had been achieved in the recent past and that other developing economies experience economic growth rates into the double digits. The newly created Planning Commission will, within the not too distant future, publish their strategic guidelines and long term plan (twenty years) for infrastructure and social development in the country. Once published this may inform later electricity forecasts.

While the growth is expected at 6% p.a. for a large portion of the forecast period, this is expected to gradually decline over time to 5,3% in 2035. Thus the average annual growth rate of the high GDP growth forecast over the period of 2010 to 2035 is 5.5%p.a.

The **moderate GDP growth forecast** is similar to the average historical GDP growth over the last few years. The latter is also seen as the potential growth if the AsgiSA targets are not achieved, and are also close to the potential growth of the SA economy as seen by the SA Reserve Bank. It is also in line with the forecasts by many institutions over the medium term. The average annual GDP growth of this forecast is approximately 4.5% between 2010 and 2035.

The low GDP growth forecast is about 1% lower, on an average annual basis, than the moderate GDP forecast. This is also in line with **low growth** scenarios which were part of the scenario exercise referred to above. During the past twenty years a narrow cone of +/- 1% growth was found very realistic and appropriate for long term planning and therefore the values assumed for the GDP growth rates are as per Table 1.

TABLE 1: GDP GROWTH RATE ASSUMPTIONS

GDP - growth rate assumptions							
Year	Moderate	High	Low	Year	Moderate	High	Low
2008	3.68	3.68	3.68	2022	4.90	5.90	3.90
2009	-1.70	-1.70	-1.70	2023	4.80	5.80	3.80
2010	2.50	3.50	1.50	2024	4.80	5.80	3.80
2011	3.70	4.70	2.70	2025	4.80	5.80	3.80
2012	4.00	5.00	3.00	2026	4.70	5.70	3.70
2013	4.00	5.00	3.00	2027	4.70	5.70	3.70
2014	4.00	5.00	3.00	2028	4.70	5.70	3.70
2015	4.50	5.50	3.50	2029	4.60	5.60	3.60
2016	5.00	6.00	4.00	2030	4.60	5.60	3.60
2017	5.00	6.00	4.00	2031	4.50	5.50	3.50
2018	5.00	6.00	4.00	2032	4.50	5.50	3.50
2019	5.00	6.00	4.00	2033	4.40	5.40	3.40
2020	5.00	6.00	4.00	2034	4.40	5.40	3.40
2021	4.90	5.90	3.90	2035	4.30	5.30	3.30

Electricity Intensity

Electricity intensity is the amount of electricity consumed for every one rand of GDP in real terms – see Figure 3 for the historical trend. When GDP grows faster than electricity consumption, electricity intensity decreases. If both grow at the same rate, electricity intensity stays constant. When the growth in electricity consumption is higher than that of GDP, electricity intensity increases. The latter was the case in the early years up to about the 1990s.

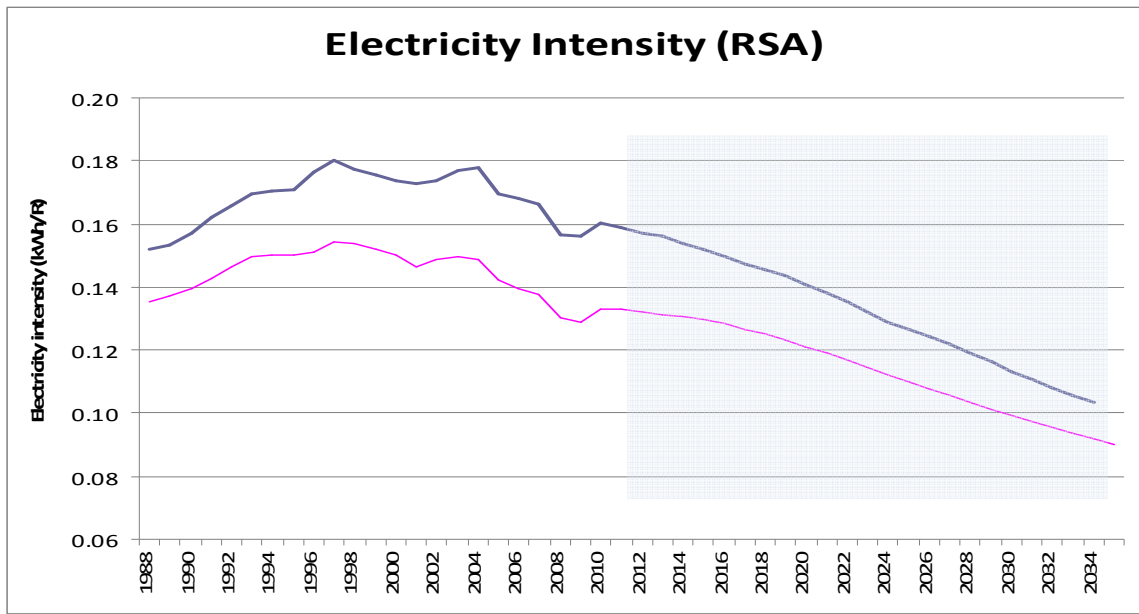


FIGURE 3. HISTORICAL TREND AND PROJECTION OF RSA ELECTRICITY INTENSITY (SOURCE: ESKOM)

The forecasted electricity consumption produced by the SO model is verified by comparing its growth to the assumed GDP growth and electricity intensity. It is done by using the electricity consumption-GDP growth margin which is the difference between the percentage electricity consumption growth and the percentage GDP growth.

Figure 4 shows the actual and projected “margin” based on the expected GDP and electricity intensity up to 2035. The polynomial curve is used to smooth the times series especially in the case of the historical values which tend to show large variations.

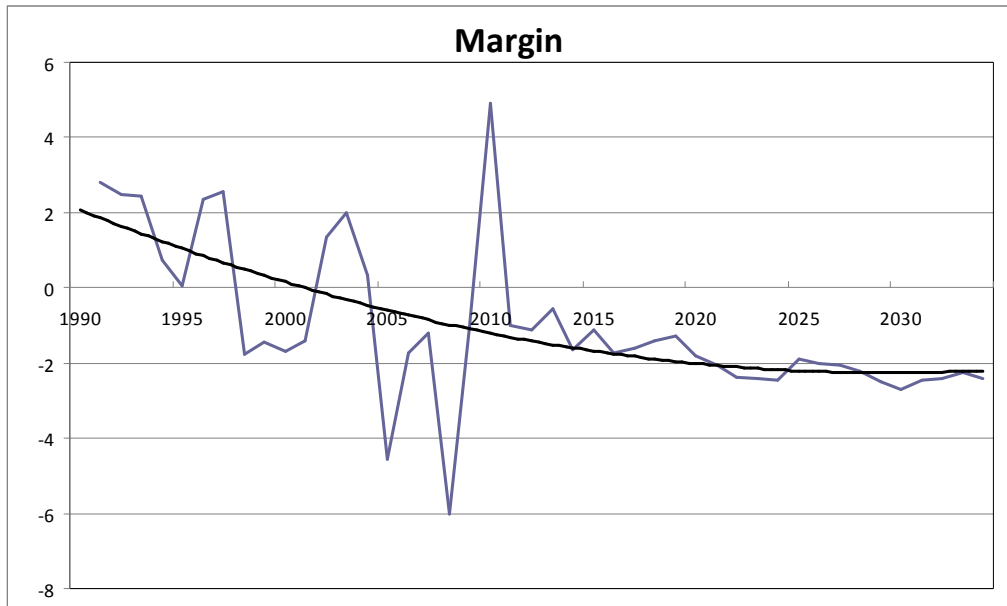


FIGURE 4. ELECTRICITY AND GDP GROWTH MARGIN (SOURCE: ESKOM)

Figure 4 indicates the clear trend from a positive to a negative margin over time. From 1980 to 1997 many high intensity electricity customers were added, such as aluminium and ferro-chrome smelters, resulting in electricity sales growth exceeding the growth in the GDP. Since the late 1990's the financial services and transport and communication sectors (amongst others) have contributed significantly to GDP growth (as indicated in the shift in sector share of GDP, illustrated in Figure 5). These sectors are characterised by low electricity intensity, resulting in GDP growth exceeding the growth in electricity sales. As a result the margin declined to current levels of a negative margin.

It is expected that the margin will continue to decrease over the forecast period.

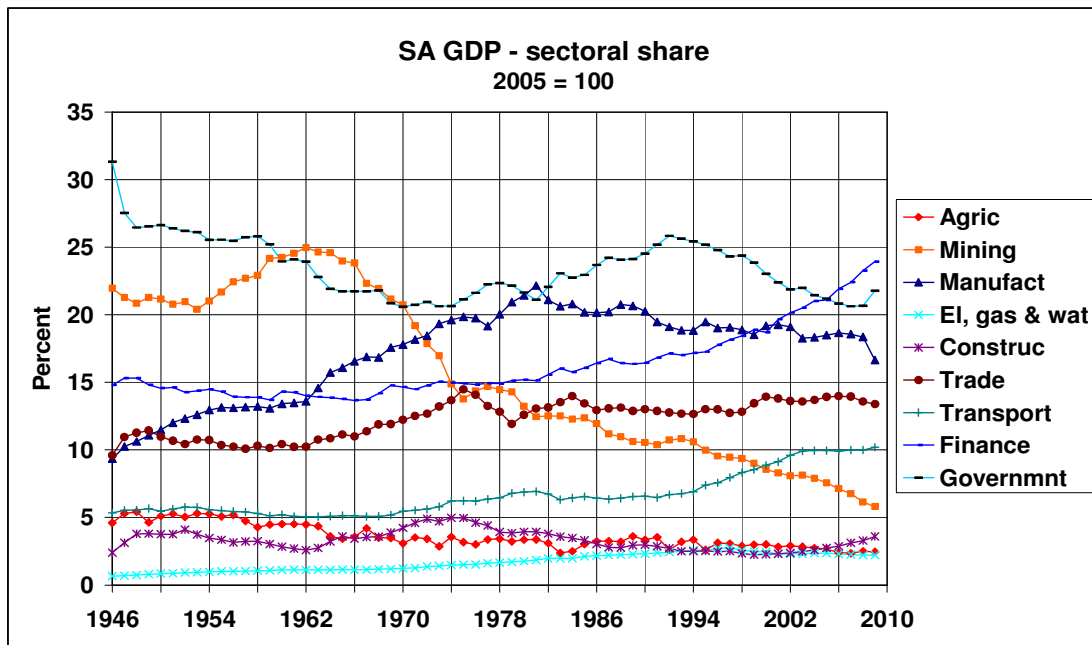


FIGURE 5. SOUTH AFRICAN GDP SECTORAL SHARE (SOURCE: STATS. SA)

Other assumptions

- Various customer and sector specific key input parameters are used.
- Universal electricity access is based on historical trends and expected GDP.
- International sales are based on the current Eskom contractual obligations.
- Future incentive-based Demand Side Management impact was not considered because these are dealt with as supply options in the IRP 2010 revision 2.
- Price elasticity is accounted for in the GDP and electricity intensity. Refer to annexure 2.
- System losses are based on the current transmission and distribution losses.
- Moderate weather patterns are assumed for the forecast, based on historical averages.

5. Forecast Results

Historic Sales Growth

From 1980 to 1994 actual annual economic growth (GDP) and Eskom electricity sales growth amounted to 1.09% and 3.41% respectively. From 1994 to 2009 the actual annual economic- and electricity sales growth amounted to 3.06% and 1.81% respectively.

The main reasons for the growth over this period are indicated in Figure 6. South Africa possesses substantial mineral reserves and had a surplus electricity generation capacity at prices that were amongst the lowest in the world from 1986 to 2006. The low electricity prices resulted in the establishment of energy intensive aluminium plants which contributed largely to the high growth in the electricity sales from 1988 to 1998. The electrification of low cost houses also started in the early 1990s and also contributed to the growth in electricity sales up to and beyond 1994.

The retraction of sanctions against South Africa following the change of Government in 1994 led to the consistent average annual economic growth experienced from 1994 to 2007. This was the main reason for the underlying growth in the Eskom Re-Distributor category (the municipalities) that contributed to the high annual average growth rates in sales in that sector. Huge expansions in the ferro-chrome sector also contributed to the sales growth. Although there was a decrease in the gold mining sector, the decline was more than offset by a strong demand for platinum. The prepaid sector growth also added to the sales growth.

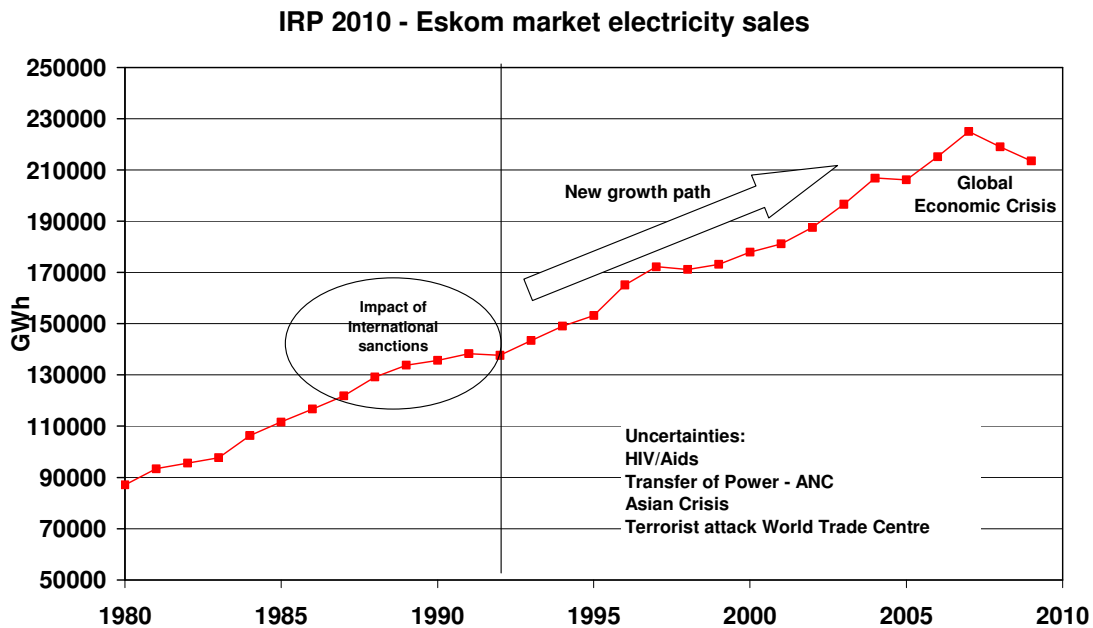


FIGURE 6. ESKOM MARKET ELECTRICITY SALES (SOURCE: ESKOM)

The energy crisis that started in 2007 constrained the growth in electricity sales but as a result of the global economic crisis in 2008 the demand for electricity was reduced, although the major portion of the reduction may prove to be of a temporary nature. As the global economy recovers, the demand for commodities has also increased and South African producers are increasing their production levels back to full capacity.

In addition, the need to expand the generation capacity also resulted in higher electricity price increases. These electricity price increases will influence consumer behaviour. The behaviour changes will lead to efforts to save on electricity usage and/or to use electricity more efficient.

Draft IRP 2010 revision 2 forecast

Figure 7 shows the forecast for RSA sent-out including the generation required to meet international sales. Eskom sales for the 2009 calendar year amounted to 211 TWh. The sales are expected to grow to an estimated 433.3 TWh by 2035, growing on average by 8.5TWh per year in the moderate forecast. This forecast has been influenced by expected higher electricity prices. For example, the average electricity prices for the next 3 years are expected to increase by +/- 25 percent per year. This will lead to energy efficiency improvements which will have an impact on the expected sales as reflected in the changing electricity intensity. The electricity intensity also reflects growth in less energy intensive economic sectors, over and above energy

efficiency improvements. The growth in electricity forecast is driven primarily by significant growth in the following areas:

- Electrification of low cost housing area in order to ensure that all of the population have access to electricity
- Growth in the Eskom Industrial category due to demand for resources specifically in the base metals like ferro-chrome, steel, ferro-manganese together with strong growth in the petroleum category
- The Mining category where global demand for the minerals like platinum and coal will remain strong.
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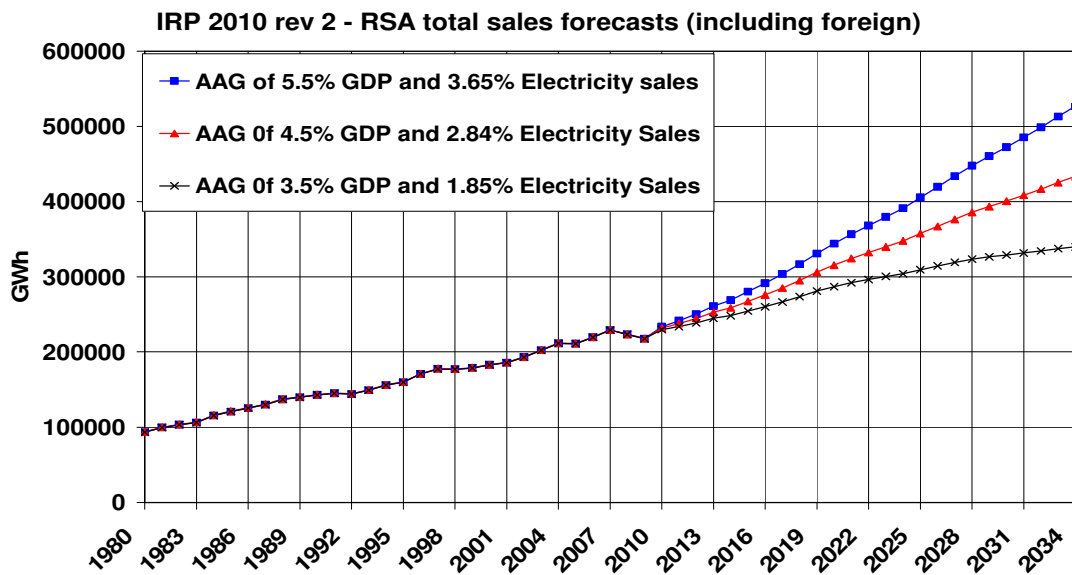


FIGURE 7. NATIONAL PLUS FOREIGN (RSA) SENTOUT FORECAST (SOURCE: ESKOM)

The electricity sales growth as reflected in Figure 7 is made up of sales to the different Eskom categories as per Figure 8.

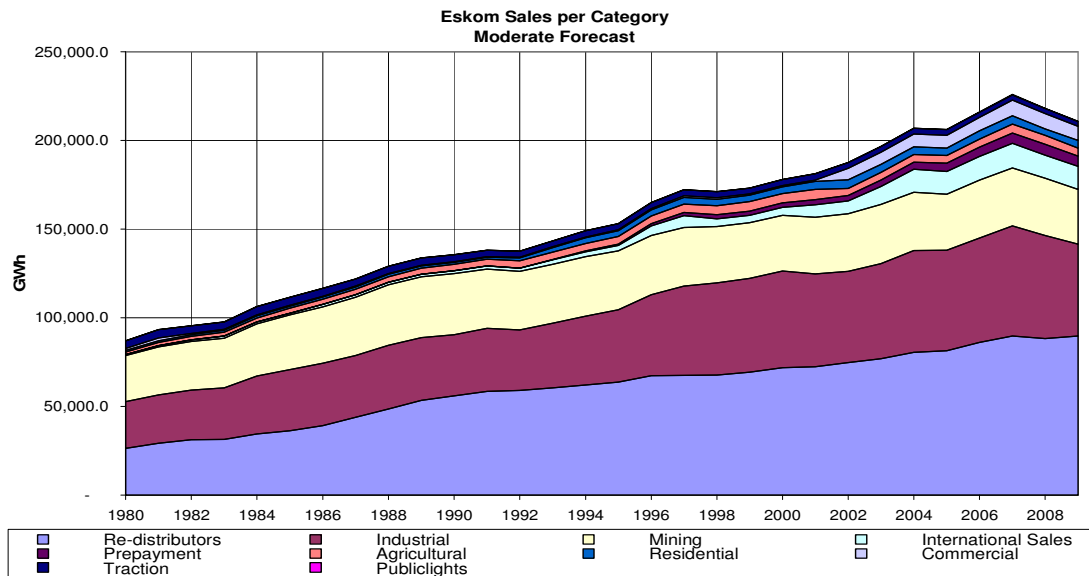


FIGURE 8. HISTORICAL Eskom SALES PER CATEGORY (SOURCE: Eskom)

The average annual electricity sales growth rate for the moderate forecast is 2.84% against an average annual growth rate of 4.51% for the GDP. The corresponding numbers for the high forecast are 3.65% and 5.51% and for the low forecast 1.85% and 3.51%. These forecasts do not take into account any specific planned incentive based DSM initiatives.

These forecasts take the impact of the high price increases in the medium term into account together with the resultant customer reactions as reflected by the declining electricity intensity and the derived margin. The global economic crisis in 2008 has resulted in decreased electricity sales which will only be regained once the global economy has recovered and it is estimated that the electricity sales will recover to the same level as before the economic crisis in the 2010 calendar year.

Figure 8 reflects the historical electricity consumption per Eskom sales category. Figure 9 shows the forecasted electricity consumption per Eskom category up to 2035. Most of the growth is from the Industrial-, Re-Distributors- (Municipalities), Prepaid- and Mining Eskom categories.

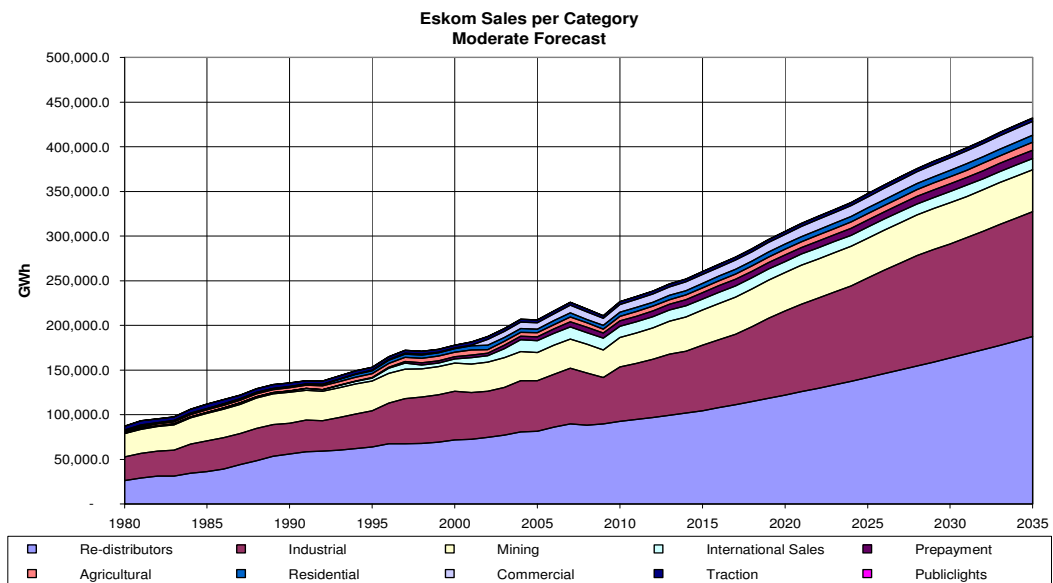


FIGURE 9. MODERATE SALES FORECAST BY ESKOM CATEGORIES (SOURCE: ESKOM)

Comparison of Results SO Forecast vs. CSIR

Figure 10 compare the SO electricity sent-out forecast with the forecast produced by the CSIR. The CSIR forecast does not include the expected international sales. For comparison purposes the international sales has been removed from the SO forecast (which includes international sales). The CSIR forecast is substantially lower than the SO forecast. The CSIR moderate forecast is almost the same as the SO low forecast, but slightly lower than the SO forecast up to 2029 and thereafter slightly higher.

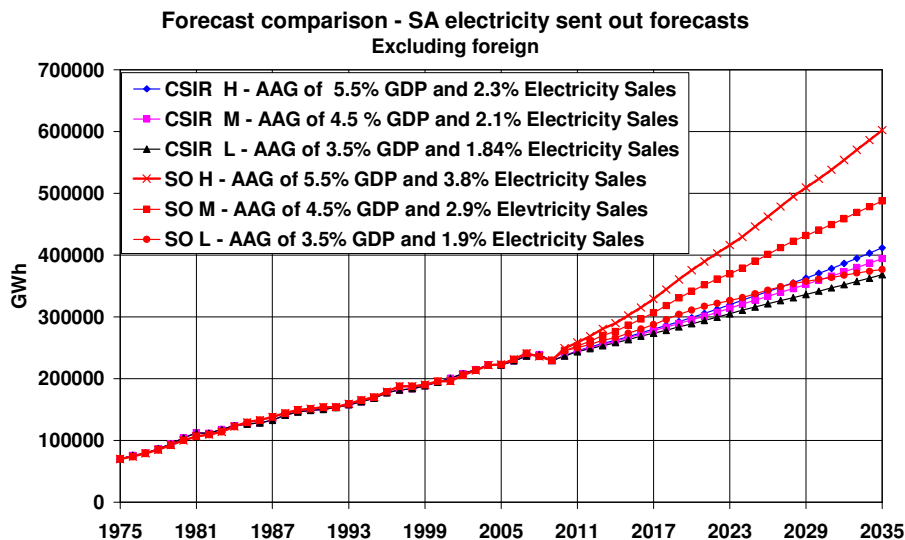
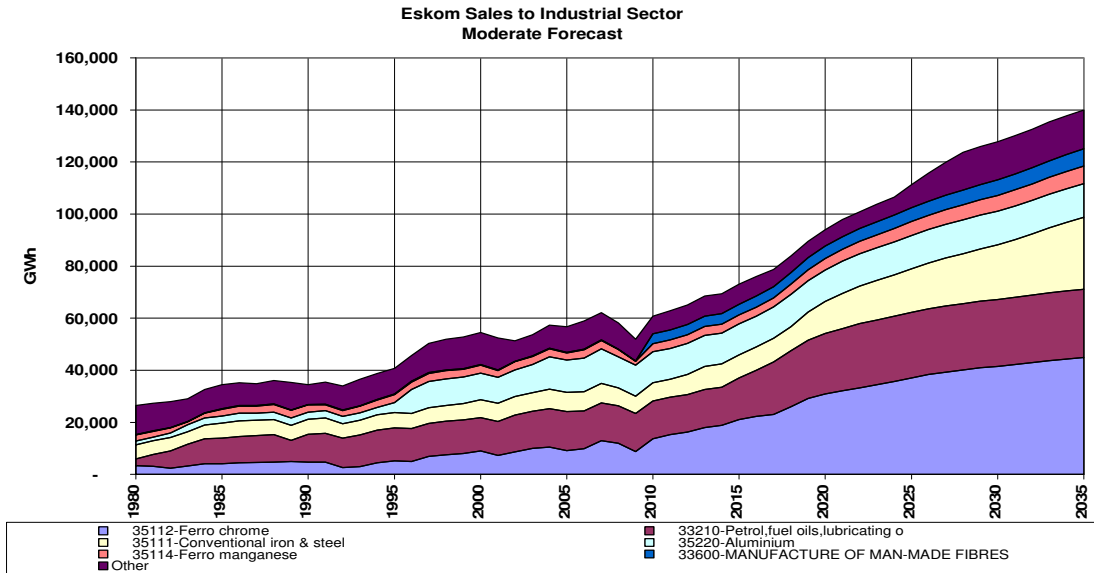


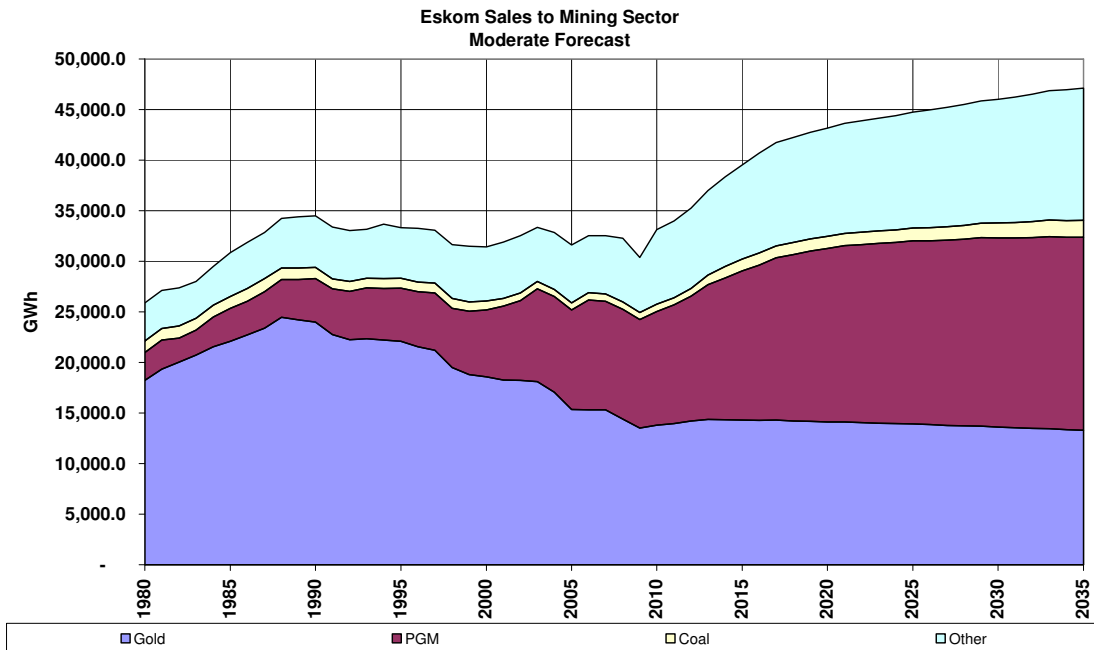
FIGURE 10. SO AND CSIR MODEL FORECAST COMPARISON – RSA ELECTRICITY SENT OUT EXCLUDING FOREIGN

ANNEXURE 1: DETAILED SECTOR FORECASTS

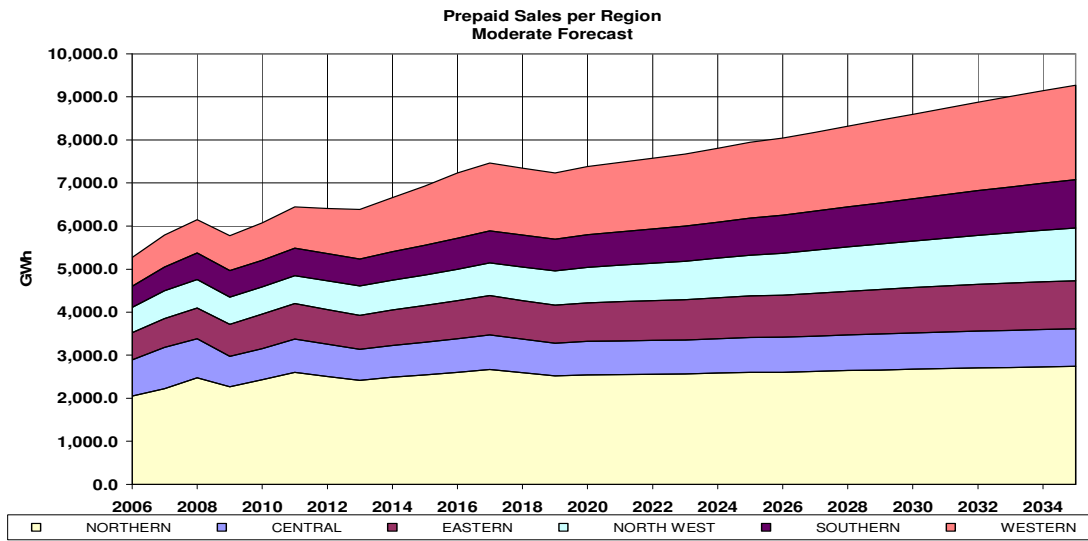
Graph 1



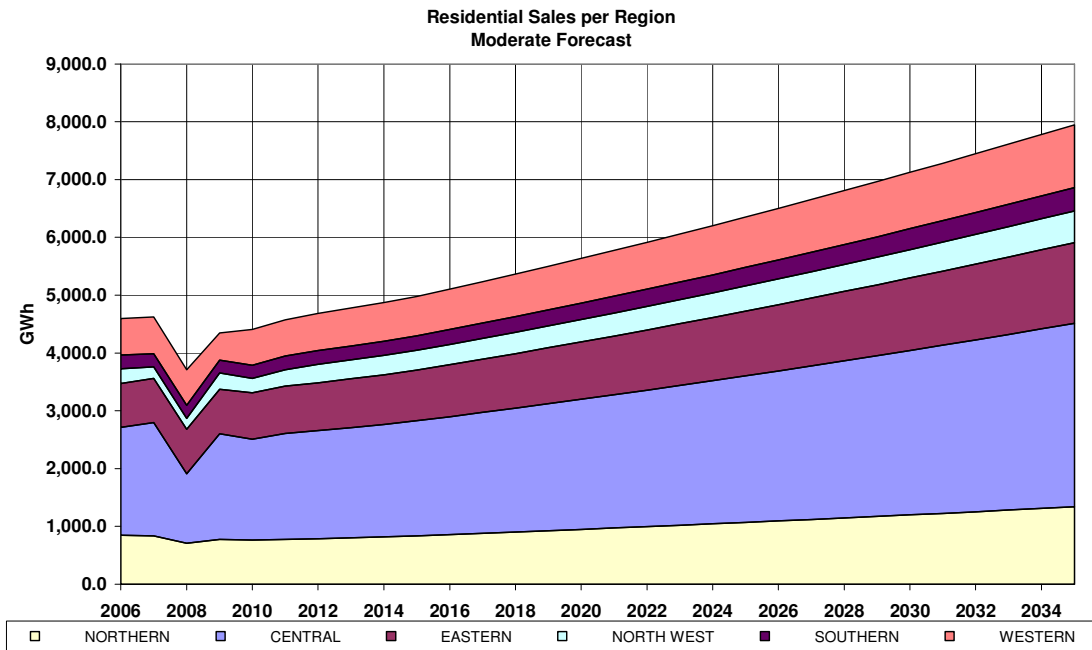
Graph 2



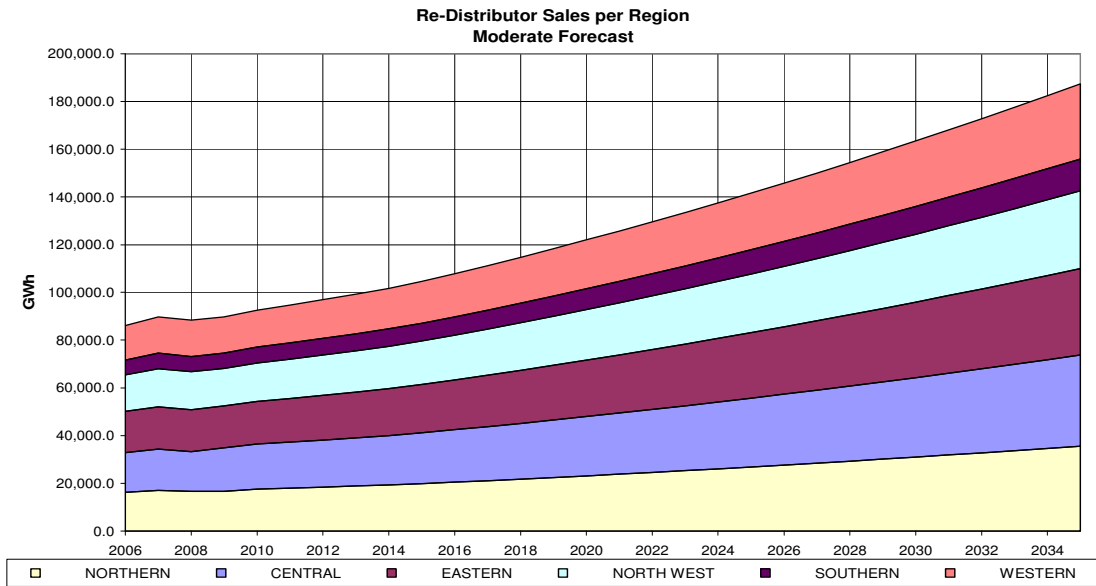
Graph 3



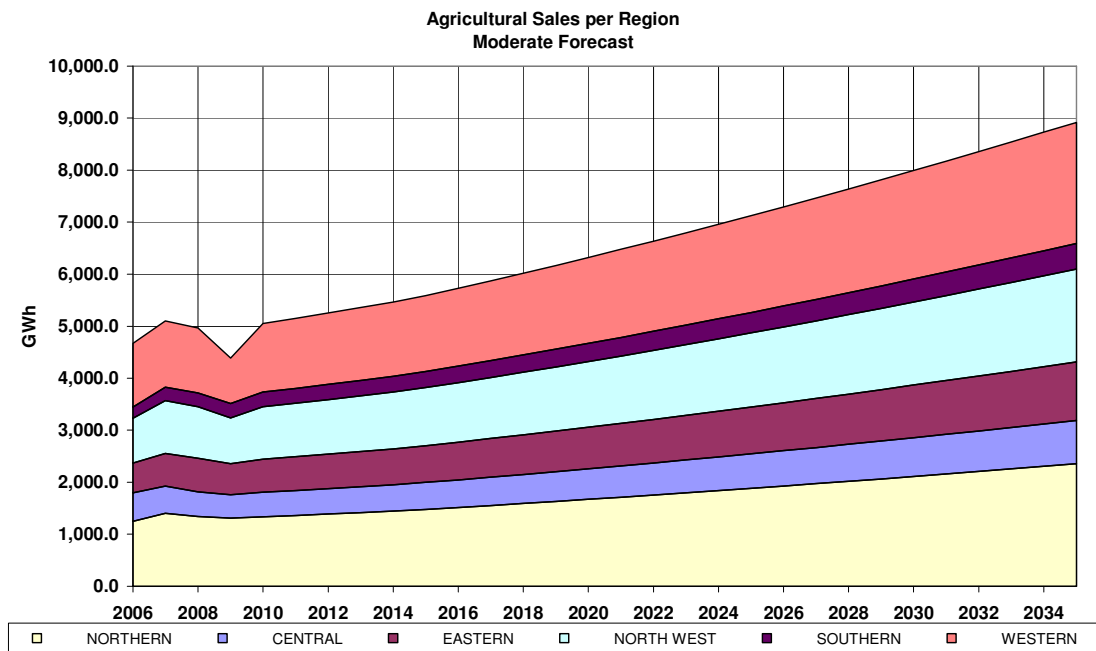
Graph 4



Graph 5



Graph 6



ANNEXURE 2: PRICE ELASTICITY

Elasticity of the demand for electricity with respect to the price of electricity is defined as the ratio of the percentage rate of change in electricity consumption to the percentage rate of change in the price, assuming all the other factors which affect the electricity consumption are unchanged. It is referred to as the *own* price elasticity of the demand for electricity.

Price elasticity is one way to *estimate* the impact of electricity price on electricity consumption. It has many limitations as pointed out in an Eskom study completed in 2003. It is a purely statistical method and provides estimates based on what has happened in the past. Even if the price elasticity values were accurately calculated values, they would have been of limited value to forecast the impact of price. What also complicates the matter is that there is short term price elasticity and long term price elasticity. Other energy carriers should also be included through cross-price elasticity.

A better way to estimate the impact of the electricity price on electricity consumption is to use input-output tables, which measure the direct, indirect and imputed impact of price. The input-output tables are in the form of a matrix consisting of between about sixty to ninety individual sectors of the SA economy. Again, the values are estimates and reflect only what happened in the past. It is not easy to use these estimates in the forecast of electricity consumption.

Another way is to incorporate the impact of electricity price into the forecast of GDP growth. This way takes into account the impact on the economy as a whole and not on electricity consumption only. Recently most economic forecasts have started including the impact of the electricity price increases. These economic forecasts are used in the development of the long term electricity demand forecasts. Even the SA Reserve Bank has incorporated the price increases into their inflation projections.

The price of electricity is not expected to rise by 25% per annum every year until 2035. It is assumed that the price increase will fall back to a figure closer to the general inflation rate towards the end of the medium term.

The SO model account for the impact of the higher price increases over the medium term in the forecast by:

- Making use of the forecasted GDP growth, where the impact of the higher increases on the economy as a whole has been quantified.
- The electricity intensity will also reflect an impact due to saving and efficiency efforts.
- The combination of the above two factors will result in a decreased sales forecast as a result of the higher than expected electricity price increases.