# Forecasting electricity demand in South Africa: A critique of Eskom's projections

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## ABSTRACT

Within a short period, Eskom has applied to the National Energy Regulator of South Africa (NERSA) for the third time since the 2008 electricity crisis, proposing a multiyear price determination for the periods 2010–2011 and 2012–2013. The new application, submitted at the end of September 2009, motivated for the debate of strategies with which the consequences of the proposed price hikes could be predicted, measured and controlled. In his presentation to Parliament in February 2009, Eskom's then CEO, Mr Jacob Maroga presented the current energy situation in the country, the reasons for the crisis in 2007–2008, as well as the challenges of the future. The purpose of this paper is to contribute some new ideas and perspectives to Eskom's existing arguments regarding the demand for electricity. The most important issue is the fact that Eskom does not sufficiently take into account the impact of the electricity prices in their electricity demand forecast. This study proposed that prices have a high impact on the demand for electricity (price elasticity of -0.5). Employing similar assumptions for the country's economic growth as Eskom, the results of the forecasting exercise indicated a substantial decrease in demand (scenario 1: -31% in 2025 and scenario 2:-18% in 2025). This study's findings contrasted significantly with Eskom's projection, which has extensive implications as far as policy is concerned.

## INTRODUCTION

In September 2009, Eskom applied to the National Energy Regulator of South Africa (NERSA) for the third time since the 2008 electricity crisis, with a proposal consisting of three increases of 45% each, followed by three smaller ones, to be implemented over a five-year period. However, after deciding to delay the construction of their Kusile power station, Eskom has since revised these proposals, reducing the initial three increases to 35%. This study was undertaken before this recent decision was made public, though, and therefore its calculations were based on Eskom's initial proposal.

Since 2007, Eskom has experienced a lack of capacity in the generation and reticulation of electricity. As a result, in the first quarter of 2008, blackouts became common place in the country, with damaging effects on South Africa's economy — the economic growth of the first quarter of 2008 fell to 1.57% from 5.4% in the last quarter of 2007.[1] Eskom argued that government's refusal to fund the expansion of the electricity capacity in the country was the main cause of the crisis, thus Eskom requested a multibillion Rand budget to increase capacity and avoid similar problems in the future.

The paper is divided into four main sections. In the first section, we emphasise the main points of Eskom's presentation[2] to Parliament and those in its 2008 Annual Report[3]. In the next section, we provide a number of reasons underlying the crisis. A critical analysis of the presentation focused upon the electricity demand forecast is provided in the next section. This section also indicates the possible consequences of doubling the price of electricity in the following four years (as has been requested by Eskom), by presenting the impact of price elasticity. Finally, the policy implications and conclusions are discussed.

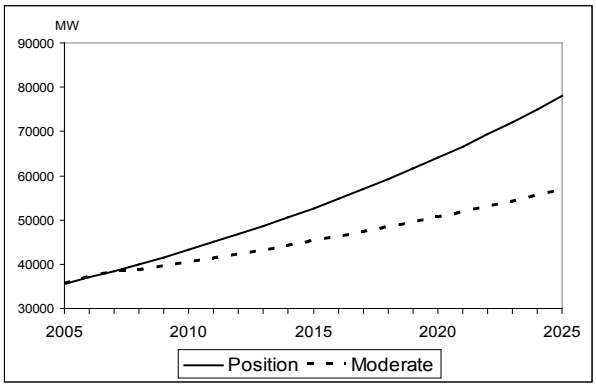
### Presentation of Eskom's CEO to the Parliamentary Committee

In February 2009[2], Mr Maroga gave an account of the current state of affairs regarding South Africa's energy situation. He also expressed his opinions about possible future scenarios and challenges. The title of the presentation, 'Update on State of Power Security in South Africa,' stressed Eskom's effort to protect the sector from potential threats that could lead to similar problems as those the country experienced in the beginning of 2008.

The following were identified as the main challenges[2,3]:

- ensuring continuity of supply
- successful execution of the capacity expansion programme
- maintaining the financial sustainability of Eskom
- responding to climate change
- successful implementation of Electricity Distribution Industry (EDI) restructuring
- building public confidence in Eskom and the system.

The main reasons for the energy crisis of 2008 and the mismatch of electricity supply and demand were then provided. Eskom argued that substantial efforts were necessary in order to convince both the private sector and the government of the necessity of the new capacity. However, the government was not convinced of the viability of this strategy and wanted to bring independent power producers into the market. In October 2004, the government agreed to finance the building of a new plant, but due to insufficient time to finish the project, it could not be utilised to counter the deficit experienced in 2007–2008.




*Source*: Eskom presentation[2]

**FIGURE 1**
Eskom's long-term demand forecast (2005-2025)

Eskom also presented two possible scenarios which differed only in their estimation of the future economic growth. In the first scenario, the electricity growth will be 4%, supporting 6% growth of Gross Domestic Product (GDP), while in the second, electricity growth will be lower (2.3%), supporting an assumed rate of economic growth of 4%.[2]

Figure 1 shows 'Eskom's long-term demand forecast' as presented to Parliament. The demand is expected to be between 56 710 and 77 960 MW in 2025, depending on the economic growth in the country.

## Reasons for the energy crisis of 2007–2008

The main reason provided by Eskom for the energy crisis was the imbalance between electricity supply and demand. The delayed decision (in 2004) by government to fund the building of a new power station did not give enough time to Eskom to prevent the crisis. An additional contributing factor is the increase (50%) of electricity demand in the country between 1994 and 2007. This might have been partially due to the implementation of the Free Basic Electricity Policy in 2001. Another contributing factor was the expansion of the economy after sanctions were lifted.

It has also been argued by Pouris[4] that the lack of research on energy in general and on electricity in particular, could be one of the factors responsible for Eskom's predicament. Pouris[4] stated that South Africa produces only 0.34% of the international research publications reporting on topics of energy and fuels while the country contributes 0.5% of the academic research papers in all scientific disciplines internationally. Furthermore, he found that energy research literature constitutes 0.45% of the national effort. This is a relatively small share in comparison to the country's top disciplines (i.e. medicine [6.04%], plant sciences [5.07%], ecology [3.50%] and others). In the context of two indicators (see Table 1), South Africa is being outperformed by Australia, Canada, Malaysia and New Zealand. The lack of academic research in the field deprives the relevant stakeholders and government from insight and debate based on independent views.

## Electricity demand forecast and price impact

Eskom's forecast (see Figure 1) assumes that growth of electricity demand is mainly dependent on economic growth only. This assumption can be misleading, and in addition, have consequences in terms of policy. A number of extensive and international studies[5,6,7,8,9,10,11,12,13] have been undertaken to examine the relationship between electricity consumption and economic growth. They were, however, unable to agree in a general rule as to whether there is a relationship and towards which direction. For example, according to Odhiambo[14], there

**TABLE 1**
Number of publications in energy and fuel core literature and indicators

| Year | South Africa | Australia | Canada | Malaysia | New Zealand |
|---|---|---|---|---|---|
| Number of publications (Average per year 2000–05) | 23.8 | 157.3 | 322.8 | 23.6 | 29 |
| Number of publications per million population | 0.5 | 7.7 | 9.9 | 0.9 | 7.2 |
| Number of Publications per billion KWh produced | 0.1 | 0.7 | 0.56 | 0.3 | 0.7 |

*Source*: Pouris[4]

is bidirectional causality between electricity consumption and economic growth in South Africa. On the other side, Lee[15] argues that energy consumption causes economic growth.

A more serious concern is that while it can be assumed that economic growth is responsible for the status quo of electricity demand in the country, the impact of prices on demand has not been taken extensively into consideration. Mr Maroga's presentation[2] in 2009 stated that electricity prices in the country are low compared to other developed and developing countries and that energy costs are increasing all over the world. Hence, Eskom's proposal to increase the prices in the next years should be expected.

According to Eskom, the extra income from the price increase is imperative in order to cover coal costs and to fund its immediate capital expenditure programme. This assumption is based on the expectation that electricity demand will not be significantly affected by the changes in the price regime, nor in economic terms, and that the price elasticity of electricity is so close to zero as not to be significant.

Internationally, the price elasticity of electricity is highly significant, especially in studies conducted for the aggregate electricity demand. Table 2 shows the findings of a number of studies that attempted to estimate, among others, the price elasticity of electricity demand. For this group of studies the estimated average price elasticity of aggregate electricity demand in the long run is -0.52. This means that an increase of 10% in the price of electricity will decrease demand by 5%. The sectoral studies indicated a higher variability. For example, Ziramba[13] gave evidence that the demand for electricity in the residential sector might be inelastic in South Africa.

A recent study[16] on the aggregate electricity demand of South Africa estimates the impact of the price of electricity on electricity demand until 2030. In order to create a model of electricity demand, or demand for energy generally, a co-integration analysis is done, as has been employed vastly in the literature.[7,9,10,12] Our model follows the Engle-Granger methodology.[a]

Apart from the other variables used, res_coint represents the co-integrating vector to specify the Error Correction Model.

**Long run:** Electricity demand
$= \alpha_0 + \alpha_1$ income $+ \alpha_2$ price of electricity $+ \mu$ [Eqn 1]

**Short run:** Electricity demand
$= \beta_0 + \beta_1$ res_coint(-1) $+ \beta_2$ income $+ \beta_3$ population [Eqn 2]

a.In the past, researchers were using linear regressions to estimate relationships among non-stationary time series data. However, Engle and Granger (both Nobel laureates in 2003) showed that these regressions are proven to be spurious and therefore, not representing the reality. They introduced the concept of co-integration, which exists if two or more series are themselves non-stationary, but a linear combination of them is stationary. For more details on the procedure proposed by Engle-Granger, also be referred to Inglesi.[16]

**TABLE 2**
Selected results of electricity demand studies

| YEAR | AUTHORS | COUNTRY | PERIOD | SECTOR | LONG-RUN PRICE ELASTICITY | SHORT-RUN PRICE ELASTICITY |
|---|---|---|---|---|---|---|
| 1987 | Pouris[5] | South Africa | 1950–1983 | aggregate | -0.9 | N/A |
| 1991 | Donatos & Mergos[6] | Greece | 1961–1996 | residential | -0.58 | -0.21 |
| 1998 | Diabi[7] | Saudi Arabia | 1980–1992 | aggregate | -0.12 | N/A |
| 2004 | Hondroyiannis[8] | Greece | 1986–1999 | residential | -0.41 | -0.14 insignificant |
| 2004 | Filippini & Pachauri[9] | India | 1993–1994 | residential | -0.29 | N/A |
| 2005 | Narayan & Smyth[10] | Australia | 1969–2000 | aggregate | -0.541 | -0.263 |
| 2006 | De Vita et al.[11] | Namibia | 1980q1–2002q4 | aggregate | -0.54 | -0.26 |
| 2007 | Zachariadis & Pashourtidou[12] | Cyprus | 1960–2004 | residential | -0.43 | insignificant |
| | | | | commercial | -0.3 | insignificant |
| 2008 | Ziramba[13] | South Africa | 1978–2005 | residential | -0.04 insignificant | -0.02 insignificant |

*Source*: Inglesi[16]

By employing annual data for 1980–2007, the results showed that the long-run determinants for the South African electricity demand are income and the price of electricity. The short-run dynamics of the system are influenced by the economic growth (GDP) and the population growth.

**Long run:** LCONS
= 0.415080*LRYD - 0.564388*LPRICE_ELEC +...
7.362757 [Eqn 3]

**Short run:** DLCONS
= -0.243863*RES_COINT(- 1) + 0.819622*DLGDP +...
3.466989* DLPOP - 0.049693 [Eqn 4]

Where LCONS is the electricity consumption, LRYD is the income, LPRICE_ELEC is the price of electricity in real terms, LGDP is the Gross Domestic Product (GDP) and finally, LPOP is the population of the country. The letter L before the name of the variables shows that all the variables are linearised and in the short run, the variables used are differentiated once in order to be stationary.

The forecast of electricity use for 2025, comparable to that of Eskom, employed two scenarios. The first assumed that economic growth will average 4% for the period 2009–2025, and that population growth will remain at 1% per annum. The second scenario proposed accelerated growth of 6% over the period 2009–2025.

The price elasticity of electricity in our model is estimated to be -0.56, showing that prices have an important effect on demand.

The assumption was that the price will increase and double from 2008 to 2011 (as per Eskom's request), and then it will remain constant until 2025.

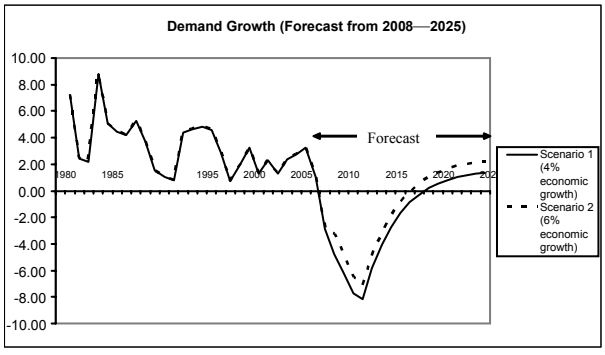



**FIGURE 2**
Electricity demand growth for South Africa (2008–2025)

Figure 2 shows that the growth of electricity demand will be negative for the period during which the prices are increasing. As soon as the prices remain constant, electricity growth becomes positive. According to this forecast, electricity demand will decrease by 31% from 2008 to 2025 (scenario 1) and by 18% (scenario 2) from 2008 to 2025. This decrease is also shown in Figure 3 where the electricity demand is shown.

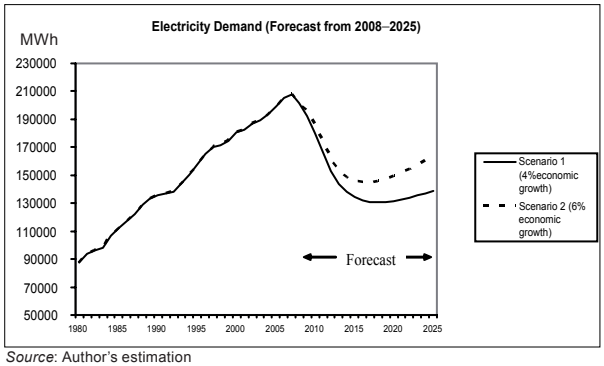
In scenario 1, demand reaches its lowest point (132 103 MWh) in 2018. Subsequently, it starts rising again. In scenario 2, the electricity demand decreases until 2017 (144 636 MWh), before it starts rising again, as illustrated in Figure 3.

## DISCUSSION AND CONCLUSION

At the end of September 2009, Eskom proposed a new price determination until 2013. Recognising the possible economic implications, it proposed an approach which will consist of three increases of 45% each, which are then to be followed by three smaller increases, over five years. In this article, we argued that future electricity demand in South Africa may be affected by the prices suggested by Eskom.

Government has the option of funding expansion, either mainly through price increases, or through treasury allocations. The appropriate mechanism and the mix will be dependent on the understanding of the relationship between electricity demand, prices and economic growth. In the case of electricity demand being the result of economic growth, prices may become the appropriate mechanism. This means that the increase in prices most probably would have an effect on the demand, a fact that should be taken into account in future policy design.

The effects of price increases on electricity demand are not taken extensively into account in Eskom's projections. The historical evolution of prices may partially explain the phenomenon. From 1987 to 1991, real prices decreased by 14%, which was




*Source*: Author's estimation

**FIGURE 3**
Electricity demand in South Africa: 1980–2025

followed by another decline of 20% over the period 1992 to 1996. In 2000, Eskom increased prices by only 5.5%. However, as the trend moves from a decreasing price environment into an increasing one, prices should be expected to have a substantial effect. The importance of price in the demand for electricity is exhibited by recent events. Data released by Statistics South Africa show that the estimated consumption of electricity in South Africa declined 7% year-on-year during January 2009.[17] However, it was not only the price of electricity that affected the demand in the last quarter, but also the closure of some mining operations and the fall in international commodity markets.

It should be emphasised that our projections do not mean that Eskom will not need to build new electricity capacity. The existing power stations are aging and need to be replaced. It is estimated that a capacity of 20 000 MW needs to be replaced over the next 15 years.

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## REFERENCES

1. South African Reserve Bank. Quarterly bulletin December 2008. South African Reserve Bank; 2008.
2. Maroga J. Update on state of power security in South Africa. Eskom's presentation to parliament. South Africa; 2009.
3. Eskom. Annual Report 2008. Eskom; 2009.
4. Pouris A. Energy and fuels research in South African universities: a comparative assessment. The Open Inf Sci J. 2008;1:1–9. Available from: UPSpace.
5. Pouris A. The price elasticity of electricity demand in South Africa. Appl Econ. 1987;19(1):269–277.
6. Donatos GS, Mergos GJ. Residential demand for electricity: the case of Greece. Energ Econ. 1991;13:41–47.
7. Diabi A. The demand for electric energy in Saudi Arabia: an empirical investigation. OPEC Rev. 1998;22:13–29.
8. Hondroyiannis G. Estimating residential demand for electricity in Greece. Energ Econ. 2004;26:319–334.
9. Filippini M, Paschauri S. Elasticities of electricity demand in urban Indian households. Energy Policy. 2004;32:429–436.
10. Narayan PK, Smyth R. The residential demand for electricity in Australia: an application of the bounds testing approach to co integration. Energ Policy. 2005;33:467–474.
11. De Vita G, Endresen K, Hunt IC. An empirical analysis of energy demand in Namibia. Energ Policy. 2006;34:3447–3463.
12. Zachariadis T, Pashourtidou N. An empirical analysis of electricity consumption on Cyprus. Energ Econ. 2007;29:183–198.
13. Ziramba E. The demand for residential electricity in South Africa. Energ Policy. 2008;36:3460–3466.
14. Odhiambo NM. Electricity consumption and economic growth in South Africa: A trivariate causality test. Energ Econ. 2009;31(5):635–640.
15. Lee CC. Energy consumption and GDP in developing countries: a co-integration panel analysis. Energ Econ. 2005;27:415–427.
16. Inglesi R. Aggregate electricity demand in South Africa: conditional forecasts to 2030. Appl Energ. 2010;87:197–202.
17. Statistics South Africa. Electricity generated and available for distribution; 2009.

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