

Current and Forthcoming Issues in the South African Electricity Sector

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ABSTRACT

One of the contentious issues in electricity reform is whether there are significant gains from restructuring systems that are moderately well-run. South Africa's electricity system is a case in point. The sector's state-owned utility, Eskom, has been generating some of the lowest-priced electricity in the world, has largely achieved revenue adequacy, and has financed the bulk of the government's ambitious electrification program. Moreover, the key technical performance indicators of Eskom's generation plants have reached world-class levels. Yet the sector is confronted today with serious challenges. South Africa's electricity system is currently facing a very tight demand/supply balance, and the distribution segment of the industry is in serious financial trouble. This paper provides a careful diagnostic assessment of the industry and identifies a range of policy and restructuring options to improve its performance. It suggests removing distribution from municipal control and privatizing it, calls for vertical and horizontal unbundling, and argues that the cost-benefit analysis of different structural options should focus on investment incentives and not just current operating efficiency.

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“Electricity supply throughout the world is undergoing a revolution. This is being caused mainly, but not solely, by electricity utilities having to meet new pressures resulting from global markets and governments opening up their countries to foreign investors to help fund power sector expansion and development. As a result, utilities are having to see themselves as businesses, and act accordingly. South Africa is not immune from these forces, and will have to move broadly in line with developments taking place in the rest of the world, while also ensuring that the industry evolution meets South Africa’s special requirements. However, in South Africa the main drivers for change are potential economic efficiency gains, and technological change (e.g. different economies of scale in power plant construction and new information and control technologies).”

Source: *White Paper on the Energy Policy of the Republic of South Africa*, 1998.¹

I. Introduction and Preliminary Observations

The primary objective of this report is to examine the structure of the South African electricity supply industry and to analyze public policies designed to improve its performance. Our focus on the electricity industry is motivated by its critical role for sustained economic growth, poverty alleviation, and international competitiveness. South Africa’s electricity sector has played a particularly important role in the country’s industrialization and economic development. The origins of the sector at the beginning of the twentieth century, for example, were driven primarily by the requirements of the booming mining industry.² With its abundance of coal reserves, South Africa has a distinct comparative advantage in energy supply that has contributed to growth opportunities for the economy as a whole. Indeed, low-priced electricity generated from coal-fired stations has been one of the country’s key competitive advantages.

The sector’s main operating entity, Eskom, appears to be an efficient and well-functioning utility even when judged by advanced industrial country standards. Eskom has: (i) been generating some of the lowest-priced electricity in the world (in 2005, for example, the average electricity tariffs in South Africa for both domestic and industrial customers were the lowest among the countries surveyed by the International Energy Agency); (ii) managed to meet and in some years actually exceed the government’s ambitious electrification targets with significant cost reducing innovations—within a decade (starting in the early 1990s), the number of domestic electricity customers more than doubled making South Africa’s recorded electrification rates the highest in world while at the same time dramatic reductions in the capital investment costs of rural connections were achieved through careful network planning and significant technological innovation (between 1995 and 2001, the average cost of rural electrification declined by 40 percent in real terms); and (iii) at the same time, the utility exhibited robust financial and operational performance—during the past twenty years Eskom has earned between 8 and 12 percent pre-tax rate of return on its assets, its debt/equity ratio declined from 2.06 in 1980, 1.6 in 1995, 0.3 in 2003, and to a record low of 0.18 in 2005, while during most of the same period the utility reduced its prices in real terms (since the late 1980s, Eskom’s average tariff increases have been consistently below inflation until

¹ http://www.dme.gov.za/publications/wp_ene/whitepaper1998.htm

² Spalding-Fecher, R. 2002. “Energy and Energy Policies in South Africa: An Overview”. *NER Quarterly Journal* 1: 1-18.

2003 when the trend was reversed). In fact, Eskom has been entirely self-financed through internal reserves and debt raised on the domestic and international capital markets without explicit government guarantees. Thus, unlike most other state-owned utilities, it has not been draining the state budget nor has it caused diversion of scarce public resources from other social purposes. Finally, as a result of an number of supply-side management initiatives during the 1990s, Eskom's generation plant performance improved substantially and by early part of this decade several of its technical performance metrics (e.g. Unit Capability Factor, Unplanned Capability Loss Factor, and Unplanned Automatic Grid Separations per 7000 operating hours) had reached world-class levels (in some instances well above the international best quartile).

Thus, there is much to applaud to applaud in South Africa's electricity sector. Since the end of apartheid, it has been operating in a manner that reflects genuine commitment to the public interest. However, even within such a well-run electricity system several problems have emerged which, if not adequately addressed, could seriously undermine its future performance.

First, while the generation and transmission segments of the industry (under the control of Eskom) have been operating efficiently, the distribution segment (mostly under the control of the municipalities) has been marred by serious structural inefficiencies and has been in serious financial trouble for a number of years now. One of the key structural deficiencies of the electricity distribution industry (EDI) has been excessive fragmentation--there were (and still are) too many, poorly-run and non-viable municipal distributors suffering from severe debt problems, high-levels of non-payment for services, insufficient asset management, and lack of appropriate technical resources.³ After several years of studies and consultations, the Cabinet approved in June 1999 a plan to merge the large number (over 380) of municipal distributors and Eskom's distribution businesses into six Regional Distribution Companies (REDs). The Cabinet's decision to rationalize South Africa's electricity distribution industry represented a significant policy response to an urgent national imperative. And it held the promise of remedying the unfavorable microeconomic conditions and poor governance that were largely responsible for the poor performance of the EDI under its previous, highly fragmented structural configuration. However, implementation of the Cabinet's decision has been

Ineffective cost recovery and chaotic billing systems at the municipal level are serious economic and political issues in South Africa. There are strong implications for future municipal viability, civic compliance more broadly, as well as the prospects for poverty alleviation and private sector participation with municipalities.

The continuing uncertainty regarding the status of the distribution industry is likely to exacerbate the problems of inadequate investment and deterioration of system reliability.

³ Balgobind, P. 2003. "National Summit on Maintenance of Electricity Distribution Networks: Speeches by the Minister of Minerals and Energy, Ms Phumzile Mlambo-Ngcuka and the CEO of the NER, Dr X. H. Mkhwanazi". NER Quarterly Journal 2: 3-8.

painfully slow and convoluted. The first RED was established only in 2005 and only on paper. Moreover, recent draft Cabinet memos and interventions by National Treasury officials have created some uncertainty and confusion about the consolidation model that will ultimately be implemented. In any case, it is far from clear that the South African municipalities should be in the business of operating and owning technically-complex and capital intensive local electricity networks, whose efficient functioning requires proper and continuous maintenance supported by financial discipline, revenue adequacy, and technical expertise. All restructuring and related reform efforts in the electricity supply industry will not amount to much unless they address the revenue adequacy issue at the distribution end. The merger and consolidation of municipal distributors might not adequately address the municipalities' governance and nonpayment problems, and especially their traditional dependence on electricity revenue to fund other services (which diverted resources away from critical maintenance of distribution assets).

Second, after having been stranded with surplus capacity for over two decades (due to overinvestment from the late 1970s to the early 1990s), today South Africa's electricity system is confronted with a very tight demand/supply balance and thus its adequacy and reliability are in jeopardy. This is evidenced by the alarming decline in the system's reserve margin (to just 8.5 percent in 2004) and the recent blackouts in several areas of the country.⁴ For the electricity system to meet the demands of South Africa's expanding and modernized economy, and to further reduce the country's power divide (a dark shadow cast by the long history of apartheid), it will require substantial new investment especially in generation but also in transmission and distribution. Thus, investment decisions need to be urgently made with respect to new generating capacity that will entail critical choices among alternate electricity generation technologies. These decisions will have profound macroeconomic, security, and environmental implications. The emerging international experience raises some doubts as to whether the vertically-integrated, state-owned monopoly is the most appropriate market structure for making economically efficient new generation and other investment decisions—

Increasing power shortages in South Africa could pose a serious threat to sustained economic growth and international competitiveness.

In the face of the substantial new investment that will be required in South Africa's electricity sector in the next few years, the cost-benefit analysis of different structural and other policy options should focus on investment incentives and not just on current operational efficiency.

both with respect to size and also the choice of technology. It is increasingly argued that with workable markets, private market participants investing their own funds might be better overall in balancing risks and rewards than would central planners. The applicability, if any, of this international experience to the unique circumstances of South Africa needs to be carefully assessed. The poor investment decisions by Eskom during the 1980s make a most compelling case for such reassessment.

⁴ A well-run electricity system should have a reserve margin of about 15 percent to allow for planned maintenance and unplanned shut-downs.

Third, the new Electricity Regulation Bill that was introduced into Parliament in August 2005 could undermine the coherence and independence of the sector's regulatory structure. Chapter IV of the Bill, if enacted, will take away the statutory authority to regulate prices from the National Energy Regulator (NER) and place it in the hands of the municipalities which would exercise that authority under the guidance of the Minister of Minerals and Energy.⁵ Regulatory responsibilities that must be coherently and delicately harmonized should be kept within a single agency and not be counterproductively splintered. The Bill's proposed demarcation of responsibilities between the Ministry of Minerals and Energy, the municipalities, and NER (which would be charged with monitoring and regulating the performance and compliance of the municipalities to the requirements of the Act), is confusing and will likely undermine regulatory clarity—the provisions for NER's monitoring function are too complex. Moreover, to ensure regulatory stability, an indispensable precondition for attracting private investment, it is imperative to mitigate political intrusion on the sector's tariff policies. In the face of the sector's substantial requirements for new generating capacity, any rational tariff policy will have to be increasingly based on forward looking economic costs—i.e. the reliance on historical book values of generating and other assets which facilitated the low prices of the last two decades will inevitably to come to end. Thus, the realignment of prices with underlying long-term costs (that are based on forward looking incremental costs and not just historical book values) is rapidly becoming necessary—both for the financial viability of the sector and for the public interest. Effective regulation requires independence of the regulators from political influences--the posture of the regulatory agency must be one of an impartial, objective, non-political enforcer of policies set forth in the controlling statutes, free of transitory political influences. Thus, the proposed role of the Ministry of Minerals and Energy in the regulatory arena will inevitably increase regulatory risk, especially as perceived by potential private investors. And the combination of regulatory and operational functions on the part of the municipalities will clearly conflict with the creation of a "level playing field" in the sector. Also, some of the municipalities might lack the technical expertise to carry out their regulatory functions. Thus the Bill's proposed statutory framework will lead to capacity problems.

In view of the socioeconomic characteristics of South Africa's electricity users, radical, across-the-board tariff rebalancing schemes can seriously conflict with social fairness. Meanwhile, to facilitate the needed capacity expansion, the electricity system must meet certain revenue adequacy criteria. Thus, policymakers in South Africa are confronted with a difficult and apparently irreconcilable dilemma: their own understandable predilections, supplemented by powerful political pressures, have motivated them to encourage low prices that will increasingly become incompatible with any rational capacity expansion program to address the country's growing power shortages.

⁵ The Bill recently passed both houses of Parliament but without its controversial Chapter IV which defines the powers and duties of the municipalities. The omission of Chapter IV was mainly due to procedural issues. The Government is currently preparing an amendment to the Bill to deal with this issue.

Fourth, the extent of Eskom's vertical and horizontal market dominance is at variance with international policy developments in the electricity sector and is a primary impediment to the future competitive developments in the sector. Historically the electricity industry has had a monolithic structure, with a single entity owning generation and transmission capacity and performing all system operations and administrative functions. However, due to technological and other fundamental economic changes, the conditions that generated this model no longer exist in most countries. Thus, especially over the past decade, views have changed dramatically on how electricity should be owned, organized, and regulated.⁶

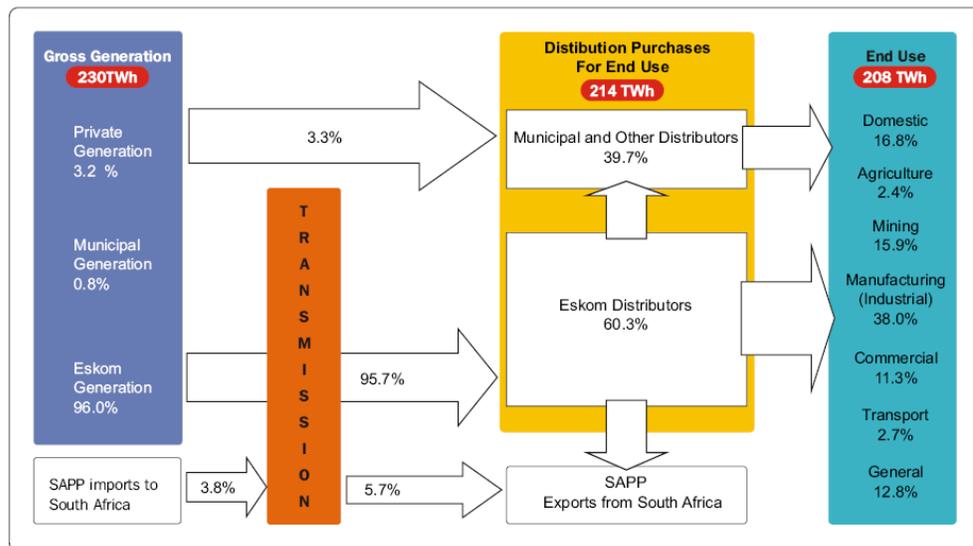
Eskom as an integrated utility will have strong incentives and ability to make it very difficult for other entities to participate in South Africa's electricity business. Private entities will simply be reluctant to enter into the electricity industry and make substantial sunk investments if the industry's essential facilities are controlled by Eskom—a competitor in the downstream provision of electricity services to final users. Also, Eskom's continued vertical and horizontal market dominance may inhibit the effective integration of electricity markets in the Southern African Development Community (SADC). Integration of electricity markets can yield significant benefits to South Africa by exploiting complementarities in primary energy endowments and giving access to lower-cost regional supplies, reducing supply risks through the provision of multiple links between system loads and cross-country generating resources, and sharing generation reserve margins among several utilities or countries. The other countries of the region may consider Eskom's large size as posing too serious of a threat to the survival of their smaller national utilities. Thus, integration may be viewed as likely to facilitate Eskom's dominance and monopolization of the entire regional electricity market. Moreover, as a vertically-integrated utility, Eskom will generally have strong incentives for self-dealing and self-preference (e.g. for its own generating stations) and thus could hinder the interchange of power in the region and the extent of cross-border competition that could emerge.

⁶ Newbery, D. 2001. "Issues and Options for Restructuring the ESI". University of Cambridge, Department of Applied Economics, Cambridge, U.K.

II. The Structure of the Electricity Industry in South Africa

The electricity industry of South Africa is dominated by the state-owned, vertically-integrated utility, Eskom, an energy giant even by international standards. It accounts for over 50 percent of the electricity generated in the entire African continent. In 2005, it ranked: 11th in the world in terms of installed generating capacity—39,810 MW just below Spain’s Endesa (43,000 MW) and Brazil’s Eletrobras (40, 854 MW); and 7th in terms of generating sales—207 TWh, after Japan’s TEPCO (281 TWh) and Germany’s RWE (230 TWh).⁷ Eskom’s Kendal generating unit has installed capacity of over 4 GW making it the largest coal-fired station in the world.

Figure 1 Energy flows in the electricity industry of South Africa: 2004



Source: National Electricity Regulator (2004).

Figure 1 illustrates the extent of Eskom’s horizontal and vertical market dominance. It enjoys a near monopoly in both generation and transmission accounting for approximately 96 percent of South Africa’s total installed generating capacity and 96 percent of generated electricity. It also controls virtually 100 percent of the system’s transmission assets. And while in distribution Eskom’s dominance is less pronounced, it still supplies about 60 percent of electricity to final customers with the remainder 42 percent of supply provided by 187 local authorities.^{8, 9} These local authorities buy the majority of their power in bulk from Eskom while a few of them are also generating

⁷ Eskom Annual Report 2005.

⁸ National Electricity Regulator (2004). Electricity Supply Statistics for South Africa. Pretoria.

⁹ Eberhard, A. (2004). “The Political Economy of Power Sector Reform in South Africa”. Working Paper #6, Center for Environmental Sciences and Policy, Stanford University.

small amounts of electricity in their respective areas of jurisdiction. A few large industries have private generation facilities producing power for their own use.

Figure 2 Energy sources used in electricity generation in South Africa

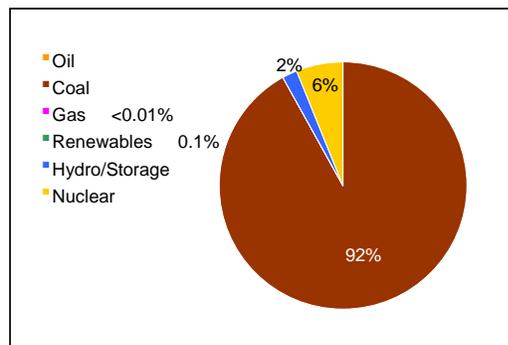
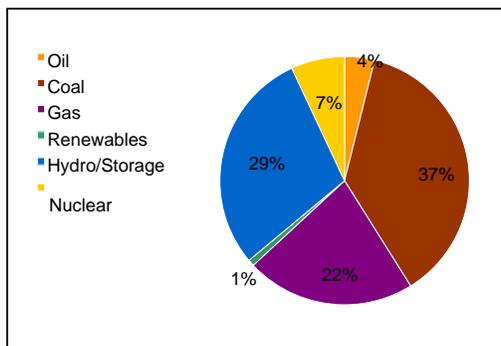


Figure 3 Energy sources used in electricity generation in the world



South Africa is blessed by abundant coal. The country has the world’s seventh largest recoverable coal reserves—approximately 55 billion short tons, about 5 percent of the world total.¹⁰ It is the world’s sixth largest coal producer—245.3 million short tons (mmst) in 2002. Out of the 171.6 mmst of coal consumed in 2002, 90 percent was used for electricity generation and the production of synthetic fuels.¹¹ South Africa, on the other hand, does not have natural gas fields. As a result, the profile of energy sources used in South Africa for the generation of electricity looks quite different from that of the rest of the world (figures 2 and 3). The bulk of South Africa’s electricity is generated from coal fired stations which in 2003 accounted for 92 percent of the gross energy sent out (202.5 TWh out of a total of 219.2 TWh—figure 2). During the same year, nuclear power accounted for 6 percent (12.7 TWh), with bagasse, hydro and pumped storage making up the remaining 2 percent (4 TWh).¹² Gas turbines made a negligible contribution.¹³ In the rest of the world, during 2002, coal accounted for 37 percent and natural gas for 22 percent of electricity generation.

Eskom is by far the largest domestic consumer of coal. In 1994, the power utility used 110 mmst out of the total of 242.8 mmst produced by the South African mines. By 2009, it is expected that South Africa will burn between 120 mmst and 130 mmst a year

¹⁰ In recent years, the reliability of this figure has been questioned. In 2004, the DME initiated a study to assess the country’s true reserves. Energy Research Centre (University of Cape Town). 2004. *Energy for Sustainable Development: South African Profile*. Phase 1 final report.

¹¹ Energy Information Administration (2005). Country Analysis Briefs: South Africa (www.eia.doe.gov/emeu/cabs/safrica.html).

¹² National Electricity Regulator (2003). *Electricity Supply Statistics for South Africa*. Pretoria.

¹³ This might change in the near future as imported gas from Mozambique comes on stream.

for electricity generation. Eskom’s power stations were designed to burn low-grade coal which in 2004 was priced at R55 per ton as compared to the higher grade exported coal whose price varied between R200 and R400 per ton during the same year.¹⁴ While this reliance on low-quality coal enhanced South Africa’s export potential--in 2002, South Africa was the world’s third largest net coal exporter (73.7 mmst)--it also created serious environmental challenges. As a result, in recent years Eskom has sought to diversify into other forms of energy and renewable energy resources. Still, the biggest portion of its plant mix consists of coal fired base load power stations—11 operational stations with a total capacity of 32,066 MW. Two other coal fired stations—Grootvlei and Komati—with a total installed capacity of 2,200 MW have been mothballed, but are now being returned to service. Moreover, the Camden Power Station is in the process of re-commissioning two of its production units which would add 1,600 MW of capacity to the system.

Table 1 Eskom’s plant mix

Operational coal fired stations	Arnot: 2 100MW Duvha: 3 600MW Hendrina: 2 000MW Kendal: 4 116MW Kriel: 3 000MW Lethabo: 3 708MW Majuba: 4 110MW Matimba: 3 990MW Matla: 3 600MW Tutuka: 3 654MW	Middelburg, Mpumalanga Witbank, Mpumalanga Hendrina, Mpumalanga Witbank, Mpumalanga Kriel, Mpumalanga Sasolburg, Free State Volksrust, Mpumalanga Ellisras, Northern Province Kriel, Mpumalanga Standerton, Mpumalanga
Mothballed coal fired stations	Camden: 1 600MW Grootvlei: 1 200MW Komati: 1 000MW	Ermelo, Mpumalanga Balfour, Mpumalanga Middelburg, Mpumalanga
Nuclear station	Koeberg: 1 840MW	Melkbosstrand, Western Cape
Conventional hydro stations – Orange River	Gariep: 360 MW Vanderkloof: 240 MW	Norvalspont, Free State Petrusville, Northern Cape
Pumped storage schemes	Drakensberg: 1000 MW Palmiet: 400 MW	Bergville, KawZulu Natal Grabouw, Western Cape
Gas fired stations	Acacia: 171MW Port Rex: 171MW	Cape Town, Western Cape East London, Eastern Cape
Total Installed Capacity: 41,860 MW (38,060 MW net)		

Source: Eskom Generon Communication GFS 0004 (2005).

Eskom operates Africa’s only nuclear power station, Koeberg, with installed capacity of 1,840 MW and located near the major load center of Cape Town, at the opposite end

¹⁴ Eskom (2005). Engineering News: 14 June 2005.

of the country from the coal reserves of Mpumalanga.¹⁵ Its plant mix also includes (table 1): two conventional hydroelectric stations, Gariiep and Vanderkloof, with a joint capacity of 2,000 MW;¹⁶ two pumped storage schemes, Drakensberg and Palmiet, with combined capacity of 1,400 MW which play a critical role for meeting peak demand, system balancing and control; and two gas turbine stations, Acacia and Palmiet, with total capacity of 342 MW (these stations consist of Boeing 707 jet engines that use kerosene as their primary fuel).

Eskom exports electricity to Botswana, Mozambique, Namibia, Zimbabwe, Lesotho, Swaziland, and Zambia. In 2004, approximately 13 TWh (about 6 percent of the total produced by Eskom stations) of electricity were exported to neighboring countries while 9.8 TWh were imported during the same period.¹⁷ In 1998, Eskom signed an agreement with the Zambia Electricity Supply Corporation which allows South Africa to import Zambia's excess power—300 MW during peak power generation periods.¹⁸

Eskom has been operating an internal pool market for over seven years. The primary objective of the Eskom Power Pool (EPP) was to facilitate optimal dispatch by providing a competitive trading platform where prices are determined by the competitive bidding of participating generators.¹⁹ However, the extent to which the EPP could lead to a competitive market within a vertically integrated monopoly has been clearly limited by the fact that all the participating generators are Eskom power stations. The national transmission network is entirely owned by Eskom and comprises of about 27,000 Km of high tension (132 to 765 kV) lines the bulk of which (15,200 Km) is at 400 kV. The distribution network consists of approximately 379,000 Km of low voltage lines. Eskom owns 288,000 Km of distribution lines (1 to 132 kV), with the remaining 91,000 Km of low voltage lines (mostly below 1 kV) being owned by the municipalities.²⁰

Until recently, the distribution segment of the industry was highly fragmented. Municipalities in South Africa have the constitutional right to supply electricity within their local boundaries. Eskom has legislative rights to supply electricity throughout South Africa where municipalities are not supplying. The municipal segment of the distribution sector is characterized by a large variance in size—it includes a small number of very large and a large number of very small distributors. In 1998, more than 120 municipal distributors supplied electricity to less than 1000 customers and more than 90

¹⁵ The Koeberg nuclear power station consists of two units each with a 3-loop Framatome Water Pressurized Reactor (PWR) whose condensers are cooled by seawater. The station boasts the largest turbine generators in the Southern Hemisphere and is considered one of the safest of the world's top-ranking PWR's.

¹⁶ South Africa can be classified as a generally dry country, and thus has very little perennial hydropower potential.

¹⁷ In 2004, these sales to countries in Southern Africa included: Botswana (1,699 GWh), Mozambique (8,076 GWh), Namibia (1,515 GWh), Zimbabwe (532 GWh), Lesotho (12 GWh), Swaziland (697 GWh), Zambia (403 GWh). Eskom Annual Report 2005.

¹⁸ MBendi *Information for Africa* (2005). South Africa: Electrical Power.

¹⁹ Van Harmelen G and R. Surtees (2003). "Internet Based Energy Trading in Southern Africa." AMEU 58th Convention.

²⁰ National Electricity Regulator (2003). Electricity Supply Statistics for South Africa. Pretoria.

municipalities had electricity revenue of less than R1 million per annum.²¹ It is generally accepted that electric power distribution is characterized by significant economies of scale. Thus, most of these municipal distributors suffer from substantial average cost disadvantages due to their small scale of operation. Indeed, the 1998 White Paper reported that average distribution costs ranged from 23.9 cents per kWh for distributors of less than 1 GWh in annual sales to only 13.4 cents per kWh for distributors of more than 1000 GWh—a 46 percent average cost differential largely reflecting basic economies of scale that were simply lost.²²

The bulk of the electricity in South Africa is consumed by the industrial sector which in 2003 accounted for almost 40 percent of total electricity consumption (figure 1). The next two largest consumers, mining and residential, accounted for 17.9 and 17.6 percent of total electricity sales ((MWh) respectively and have been showing the greatest growth in demand in recent years. The industrial and mining sectors are even more important for Eskom, having accounted in 2003 for over 48 and 30 percent of the utility's electricity sales respectively, while the domestic and commercial customers accounted for just over 7 and 6 percent of its sales, respectively.

²¹ Davidson and Mwakasonda (2003). "Southern Africa Sub-regional Study: South Africa and Zimbabwe." Energy & Development Research Centre, University of Cape Town.

²² http://www.dme.gov.za/publications/wp_ene/whitepaper1998.htm

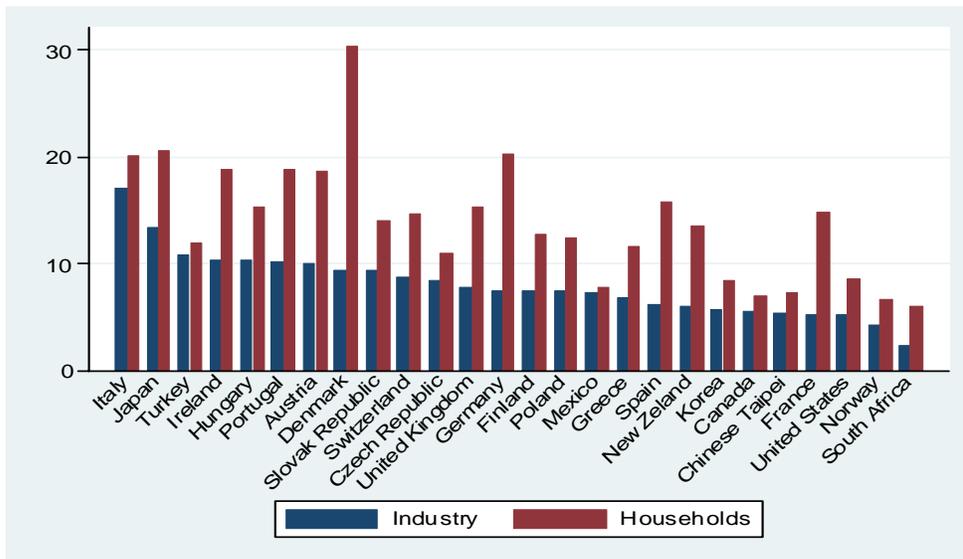
III. The Performance of the Electricity Industry

Eskom’s performance appears to be highly efficient, especially when judged by African standards. It has been generating some of the lowest priced electricity in the world and managed to fulfill the government’s ambitious electrification program while maintaining a solid and consistent financial performance. However, there are some questions regarding the efficiency of Eskom’s planning and management of generating capacity and overall investment program.²³

Price, Cost, and Financial Performance Trends

Average electricity tariffs in South Africa for both domestic and industrial customers are very low by international standards. In 2005, they were the lowest among the

**Figure 4 Average retail electricity prices, 2005 or latest information available
US cents / kWh**



Source: IEA (2005).

countries surveyed by the International Energy Agency (figure 4).²⁴ In terms of world best practice, Eskom has had the lowest observed average price for industrial electricity

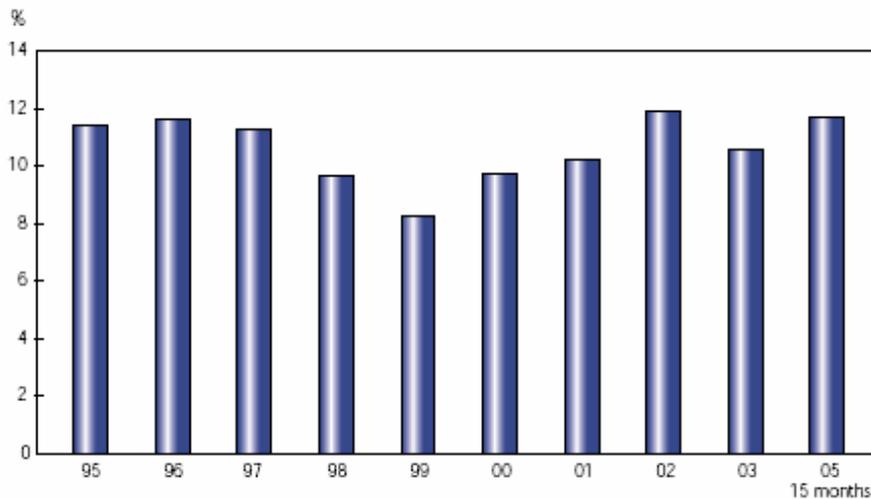
²³ Eberhard, A. and M. Mtepa. 2003. “Rationale for Restructuring and Regulation of a ‘Low Priced’ Public Utility: a Case Study of Eskom in South Africa.” *International Journal of Regulation and Governance* 3(2): 77-102

²⁴ International Energy Agency (IEA). 2005. *Key World Energy Statistics*. . A recent World Bank study also shows that South African average end-user prices (US cents/kwh) are one of the cheapest in the world at 3 cents for residential and 2 cents for non-residential customers. By comparison, these user prices in upper middle income countries are, on average, about 9 and 7 cents, respectively, while SSA rates are 6 and

for a number of years now. For example, in 1994 its average price was 5.67 AU cents per kWh as compared to other low priced utilities: BC Hydro, Canada (6.04 AU cents); South Power, New Zealand (7.19 AU cents); TransAlta, Canada (7.32 AU cents); Duke Power, USA (7.77 AU cents); SEAS, Denmark (8.15 AU cents).²⁵

In contrast to most other state-owned electric utilities, Eskom has been entirely self-financed through internal reserves and debt raised on the capital markets. And while it has been providing some of the cheapest electricity in the world, Eskom has exhibited very robust financial performance. For most of its recent history the company achieved financial viability—revenues have been adequate to cover its pertinent costs including operating expenses, capital charges, and a return on equity.²⁶ In fact, during the past twenty years, Eskom has earned between 8 and 12 percent pre-tax rate of return on its assets (figure 5). In 2004/05 the company posted a record net profit and claimed its best

Figure 5 Eskom rate of return on total assets



Source: Eskom. 2005. *Annual Report*.

financial performance in its 80 years of existence. Performance was driven by strong sales volumes boosted by robust demand from mining companies in the face of high commodity prices and buoyant economic growth. In June 2005, Moody's upgraded Eskom's domestic currency debt to A1 and foreign currency debt to A2, laying the ground for access to cheaper capital to finance its investment program.²⁷

5 cents. The world average is 9 cents for residential customers and 6 cents for non-residential customers. See: Bogetic, Z. and J. Fedderke. 2006. "International Benchmarking of South Africa's Infrastructure Performance". World Bank Policy Research Working Paper Series No. 3830.

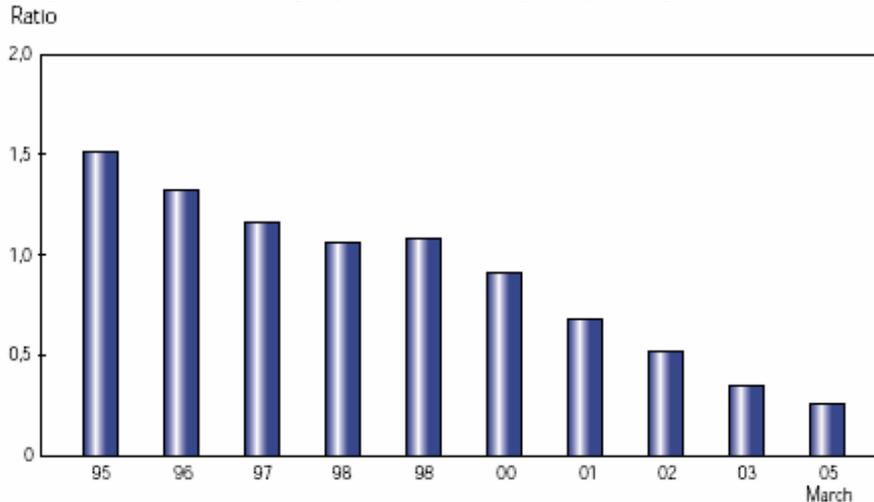
²⁵ Bureau of Industry Economics. 1995. *International Benchmarking--Overview 1995*. Report 95/20, Australian Government Publishing Service.

²⁶ It is important to note that in determining the revenue requirements for financial viability, the rate of return obtained by comparison with other utilities/industries must be applied to a rate base which covers the economic replacement cost of all facilities.

²⁷ Creamer Media's *Engineering News*. 2005/06/29.

The strengthening of Eskom's balance sheet is further evidenced by its debt/equity ratio which declined over the years from 2.06 in 1980 to 1.5 in 1995, and 0.3 in December 2003. It improved further to a new record low of 0.18 in March 2005 (figure 6). This places the company in a favorable position to undertake the huge capital expansion program that is planning to embark on in the very near future.

Figure 6 Eskom debt/equity ratio, including long-term provisions



Source: Eskom. 2005. *Annual Report*.

It is important to note that this exceptional improvement in Eskom's financial performance was brought about while the utility reduced its prices in real terms. Indeed, since the late 1980s, Eskom's average tariff increases have been consistently below inflation until 2003 when the trend was reversed (table 2). This pricing behavior reflected a compact between the government and a state-owned monopoly that has not been subjected to the detailed regulatory scrutiny that is generally imposed on the private electricity utilities of other countries.²⁸ In fact, between 1987 and 1995 (the year the National Electricity Regulator, NER, was established as the successor to the Electricity Control Board) Eskom was not subject to any formal regulation.²⁹ It simply proposed tariff adjustments to cover its declared costs that were not subjected to the traditional regulatory audit. Still, price increases were consistently kept during that period below the prevailing rate of inflation.

²⁸ For example, in 1995 Eskom effectively committed itself to reduce the real price of electricity by 15 percent over five years. (Eskom. 2003. *Generation Communication*. GFS 0014, Revision 1).

²⁹ Eberhard and Mtepa, *ibid*.

Table 2 Eskom average tariff increase compared to Consumer Price Index (CPI)

Year	Eskom average price increase (%)	Inflation rate (%)
1987	12.00	16.20
1988	10.00	12.90
1989	10.00	14.50
1990	14.00	14.30
1991	8.00	15.60
1992	9.00	13.70
1993	8.00	9.90
1994	7.00	8.80
1995	4.00	8.70
1996	4.00	7.30
1997	5.00	8.60
1998	5.00	6.90
1999	4.50	5.20
2000	5.50	5.40
2001	5.20	5.70
2002	6.20	9.20
2003	8.43	5.80

Source: van Heerden et al (2005).³⁰

Continuity and Quality of Supply

Continuity of electricity supply is characterized by the number and duration of supply interruptions, while quality of supply is measured in terms of acceptable values of voltage and frequency. Reliability refers to the ability of the power system to provide an adequate and secure supply of electrical energy at any point in time—or equivalently, the degree to which the performance of the elements in a bulk system results in electricity being delivered to customers within accepted standards and in the amount desired. In recent years, the reliability of electricity supply has become increasingly important to all classes of users—both businesses and households rely on electronic devices to perform an enormous range of tasks, both basic and advanced. Supply interruptions can lead to loss of production and suspension of trading. The cost of interruptions to industrial and commercial users can be high, depending on the frequency and duration of interruptions.³¹

³⁰ Heerden, J., Blignaur, J. and A. Jordaan. 2005. “On the Inflationary Effects of Higher Electricity prices in South Africa”. Mimeo.

³¹ The production of aluminum, for example, requires alumina and uninterrupted supply of electricity. Any interruption in the supply of electricity to an aluminum smelter lasting longer than 6 hours can cause substantial damage to it. Pots are used in the process of transforming alumina into primary aluminum. Pots cool off when they are deprived of electricity for six consecutive hours, which could cause the molten aluminum in the pot to solidify. Another industry that is very sensitive to the quality of electricity supply is semiconductors. The production of chips not only requires a lot of energy, but also a very stable supply of

Continuity of Supply

The continuity of electricity supply is influenced by the performance of all stages of electricity supply: generation, transmission and distribution.

Box 1 Key Technical Performance Indicators

Unit Capability Factor (UCF)

Unit capability factor is the percentage of maximum energy generation that a plant is capable of supplying to the electrical grid, limited only by factors within control of plant management. A high unit capability factor indicates effective plan programs and practices to minimize unplanned energy losses and to optimize planned outages, maximizing available electrical generation.

Unplanned Capability Loss Factor (UCLF)

Unplanned capability loss factor is the percentage of maximum energy generation that a plant is not capable of supplying to the electrical grid because of unplanned energy losses (such as unplanned shutdowns, outage extensions or load reductions). Energy losses are considered unplanned if they are not scheduled at least four weeks in advance. A low value for this indicator indicates that important plant equipment is reliably operated and well maintained.

Unplanned automatic grid separations per 7000 operating hours (UAGS)

This indicator expresses how often a generator is separated from the external grid, in both an unplanned and automatic (manual actions are excluded manner); it is given as a rate per 7000 operating hours, thereby taking into account the wide variety of operating regimes.

Source: UNIPEDA (2001).

Generation Plant Performance

Traditionally, the primary measures of plant reliability have been the Equivalent Availability Factor (EAF) and the Equivalent Forced outage Rate (EFOR) in North America (NERC), and the Unit Capability Factor (UCF) and the Unplanned Capability Loss Factor (UCLF) in Europe (UNIPEDA). In analyzing Eskom's generation plant performance we will adopt the UNIPEDA technical performance indicators (box 1).

One key step towards meeting the objective of providing reliable electricity is to maintain and improve the availability of generating units. In the late 1980s, Eskom's generation plant performance had deteriorated, there was a high incidence of costly plant damage, and excessive unit trips, to the extent that by 1989 its Unplanned Capability Loss Factor (UCLF) reached the unacceptably high rate of 14 percent (figure 7).

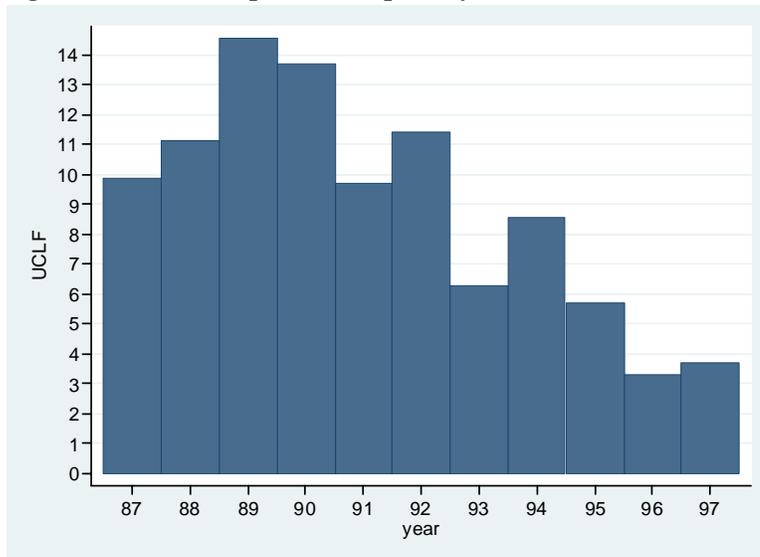
Similarly, during the same year, Eskom's Unit Capability Factor (UCF) stood only just above 78 percent, and by 1990 it declined further to around 75 percent (figure 14).³² These low plant availability rates resulted from many base load units requiring enhanced maintenance due to breakdowns. During 1990, Eskom's generating units

energy. It is a continuous-process industry, so power interruptions can lead to the loss of production in progress.

³² The unexpected bad weather during 1998 was also a major contributor towards the deterioration in these measures.

experienced on average 7 unplanned automatic grid separations (UAGS)—more than double the international best quartile which was below 3—indicating a large number of supply interruptions per operating period (7000 hours) and hence a low reliability of service provided to the electrical grid.

Figure 7 Eskom’s Unplanned Capability Loss Factor (UCLF)



In response to the deterioration in plant performance, Eskom undertook a series of actions and supply-side management initiatives. Key among these initiatives was Eskom’s generation plant availability improvement program which became known as “90 : 7 : 3”. The goal of this program was to make the system’s representative plant available to supply power, on average, 90 percent of the time (Unit Capability Factor); limit the planned plant shutdowns for maintenance to 7 percent of the time (Planned Capability Loss Factor); restrict plant breakdowns and other unforeseen outages to 3 percent of the time (Unplanned Capability Loss Factor).

The “90 : 7 : 3” initiative led to significant improvements in plant performance. UCLF declined from the unacceptably high rate of 14 percent in 1988 down to 3.6 percent at the end of 1997 (figure 7). By 2002 it was further reduced to a world class rate of 3 percent. Similar improvements were obtained in plant availability, especially during 1995-1998, by reducing planned and unplanned outages. By 1998, Eskom’s power stations reached an average generating unit UCF of 93 percent, just below the international best quartile but well above the international medial rate for that year. There was some deterioration after 2000 and during 2004-2005 the UCF rate fluctuated around 90 percent (figure 8). The decline in average generating unit UCF during 2003 was primarily due the catastrophic failure of the turbine generator of Unit 2 at Duvha Power Station. Some of the observed deterioration may also be attributable to deliberate decisions by Eskom to optimize plant availability across its portfolio in favor of low cost

production. Still, despite these abnormal plant failures, Eskom was still able to meet the significantly increased load growth during 2003.³³

Figure 8 Eskom’s Plant Unit Capability Factor (UCF)

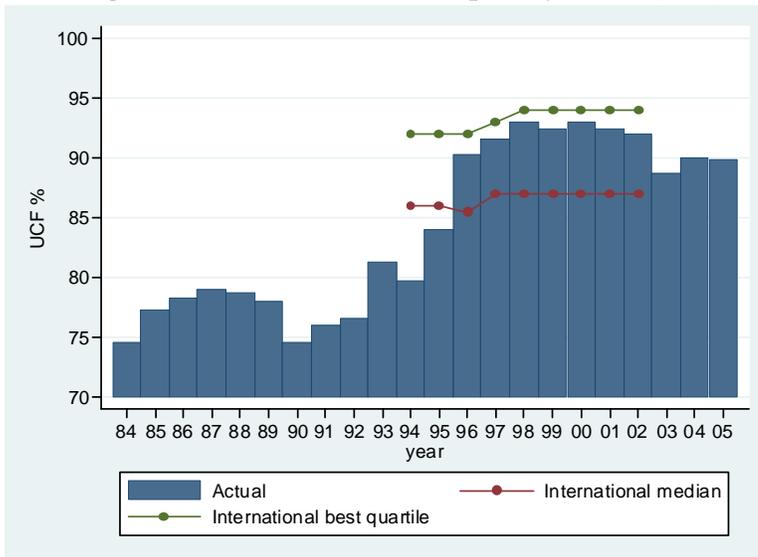
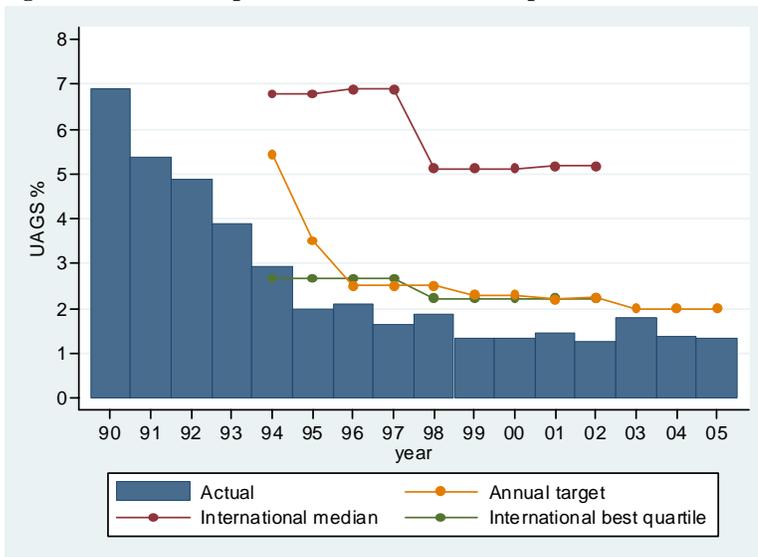


Figure 9 Eskom’s Unplanned Automatic Grid Separations (UAGS)



Further evidence that the “90 : 7 : 3” initiative led to significant improvement in technical performance and availability is provided by the dramatic decrease in the

³³ Eskom. 2005. *Annual Report*.

number of supply interruptions per operating period (7000 hours) that Eskom achieved especially between 1990 and 2000 (figure 9). After 1995, its generating units have experienced fewer interruptions than even the international best quartile indicating world-class plant management and maintenance. In 2000, Eskom peaking stations set new records by claiming only 0.58 separations per 7000 hours well below the international best quartile for that year.

Distribution System Performance

Distribution problems can be divided into two main categories: (i) those affecting distribution lines--the potential causes of faults on distribution lines include storm / wind damage, lightning strikes, fallen trees or branches, bushfires, and animal incidents (large birds causing short circuits); those affecting distribution equipment such as transformers and related plant—unexpected load growth in particular locations can cause overloading of distribution transformers leading to overheating and failure in extreme weather conditions.

Box 2 Distribution Network Reliability Indices

System Average Interruption Frequency Index (SAIFI)

The SAIFI of a network is the average frequency of sustained interruptions per customer.

$SAIFI = (\text{Total number of customer interruptions p.a.}) / (\text{Total number of customers served})$

System Average Interruption Duration Index (SAIDI)

The SAIDI of a network, commonly referred to as customer minutes of interruption or customer hours, indicates the average duration of a sustained interruption the customer would experience per annum.

$SAIDI = (\text{Sum of customer interruption durations p.a.}) / (\text{Total number of customers served})$

Customer Average Interruption Duration Index (CAIDI)

The CAIDI of a network is the average time needed to restore service to the average customer per sustained interruption.

$CAIDI = (\text{Sum of customer interruption durations p.a.}) / (\text{Total number of customer interruptions p.a.})$

Momentary Average Interruption Frequency Index (MAIFI)

The MAIFI of a network indicates how often on average (frequency) the customers served would experience a momentary interruption (MI) per annum.

$MAIFI = (\text{Total number of customer MI p.a.}) / (\text{Total number of customers served})$

Source: Kueck et al (2004).³⁴

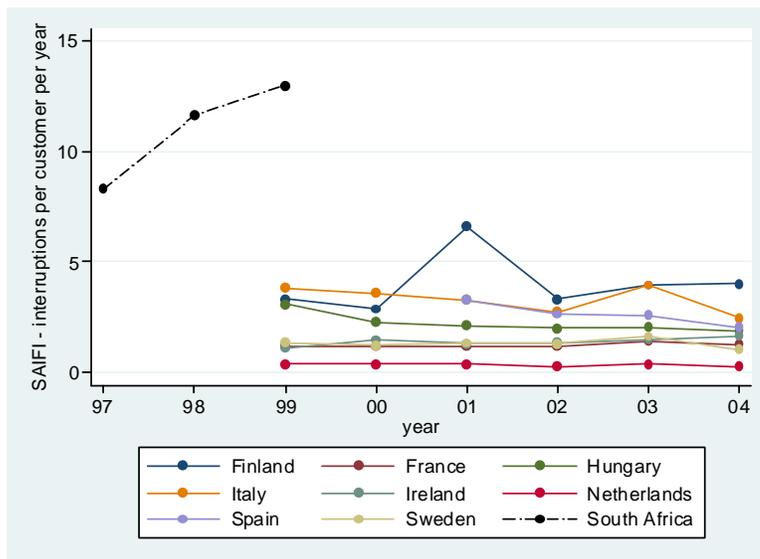
Frequency of sustained interruptions is perhaps the most important cause of consumer dissatisfaction with utility performance. The measure most commonly used to record interruption data is the System Average Interruption Frequency Index (SAIFI). The duration of sustained interruptions is another strong factor in customer dissatisfaction

³⁴ Kueck, J, Overholt, Kirby, B., Overholt, P. and L. Markel. 2004. *Measurement Practices for Reliability and Power Quality*. ORNL/TM-2004/91, Oak Ridge National Laboratory, Oak Ridge, Tennessee.

with reliability. As with SAIFI, the most commonly employed measure to record interruption data is the System Average Interruption Duration Index (SAIDI)--box 2.³⁵

An analysis of Eskom’s distribution performance during 1997-1999 indicates that the number and duration of outages (SAIFI and SAIDI) were very high by international standards. In 1999, for example, the average frequency of sustained interruptions in South Africa was 12.97 as compared to .40 in the Netherlands, 1.15 in Ireland, 1.22 in France, 1.38 in Sweden, 3.09 in Hungary, 3.32 in Finland, and 3.81 in Italy (figure 10). During the same year, the average time of customer interruption was 1796.4 minutes in South Africa as contrasted to 26 minutes in the Netherlands, 156.4 minutes in Spain, 165.8 minutes in Sweden, 191.8 minutes in Italy, 198 minutes in Finland, 273.6 minutes in Ireland, 411.0 minutes in Hungary, and 459.0 minutes in France (figure 11).³⁶

Figure 10 System Average Interruption Frequency Index (SAIFI)



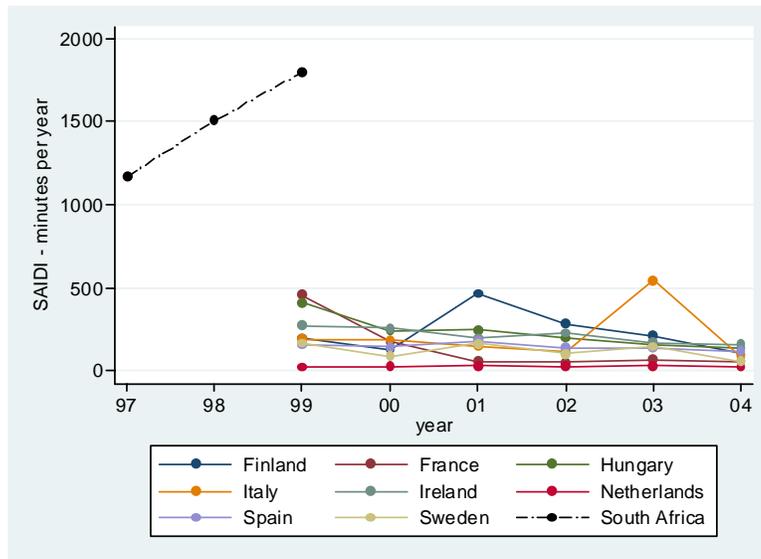
The deterioration in Eskom’s reliability metrics from 1997 to 1999 (SAIDI increased from 19.50 hours in 1977 to 29.94 hours in 1999, and SAIFI from 8.30 interruptions in 1977 to 12.97 interruptions in 1999) was attributed by its management to the: (i) increase in the number of customers, which were typically prepaid customers at the end of weak networks, resulting in poorer performance of these networks; (ii) ageing of plant; and (iii) unexpectedly bad weather (heavy rain and floods) during 1998 and

³⁵ A major drawback to reliability metrics is the difficulty of comparing them from one geographic area to another and exactly how to apply the input data in making the necessary calculations. There are also concerns about how to normalize the indices for adverse weather.

³⁶ Council of European Energy Regulators (CEER). 2005. *Third Benchmarking Report on Quality of Electricity Supply*. Brussels, Belgium. Ref: C05-QOS-01-03.

1999. These negative trends led to a revision of the company's emergency preparedness plan and refurbishment program, as well the establishment of a new outage management system (OMS).³⁷

Figure 11 System Average Interruption Duration Index (SAIDI)



Sources: Eskom Annual Report (various years) and CEER (2005).³⁸

In early 2000, the number of blackouts and brownouts began to increase. These problems were largely attributed to the deteriorating condition of the distribution networks and their effective decapitalization due to the decreasing amounts that were budgeted and spent on maintenance by the provincial and local governments. The NER conducted a number of surveys to assess the experience of electricity users and evaluate their interactions with the utilities. It was found that:

- an increasing number of customers were not happy with their supply
- reliability and availability of electricity was the main reason
- customers claimed that the situation was deteriorating over time
- utilities did not give customers the attention they deserved
- some claimed that there was a visible lack of maintenance.

The NER also contacted representative bodies of various customer categories according to the government's Standard Industrial Classification. The main findings of this survey were:

³⁷ Eskom. 1999. *Annual Report*.

³⁸ CEER (2005), *ibid*.

- more than 53 percent of respondents were not happy with interruption frequency and durations
- 48 percent were not satisfied with response times to repair faults
- 28 percent of respondents felt that they were not adequately consulted or informed about planned outages
- 47 percent of respondents indicated that power quality was not adequate (low voltage and dips).

*

A separate survey was circulated to all distribution licensees (235 at that time) who were requested to provide data on network performance. The survey found that:

- the quality of information submitted varied drastically
- only 30.7 percent of distributors responded and since the data requested was based on “of the shelf” information, it was concluded that these performance data were not being collected
- of the data supplied on 26 percent could be described as of reasonable quality, in terms of completeness and accuracy
- 49 percent of respondents did not meet the minimum requirements for restoration of supply
- 45 percent of respondents failed to identify areas requiring corrective action and only 2 percent were able to indicate what corrective actions they were taking
- network performance in rural areas was found to be much worse than in urban areas
- a general lack of understanding of Power Quality and Performance issues was identified
- those who based their responses on estimations demonstrated that their network performance was deteriorating
- there was no common yardstick for measuring performance
- some utilities were storing performance data only for annual submissions to NER, thus losing the value of analysis and corrective action
- investigations on large power interruptions were being done or only done on NER request.³⁹

The experience with supply interruptions in South Africa highlights the crucial role of the distribution system in the security and availability of supply to customers. In general, the higher voltage systems (EHV, 132 kV and transmission systems) have duplicate supplies so that most faults at these voltages do not result in an interruption of supply to customers. Almost all planned interruptions to supplies occur due to work on the LV and HV distribution networks. Especially the HV system can have a large impact on overall system performance because much of it does not have duplicate or alternative supplies and each fault can affect a large number of customers. And while each LV fault

³⁹ This section is based on Balgobind, P. 2003. “National Summit on Maintenance of Electricity Distribution Networks”. National Electricity Regulator. *Quarterly Journal* 2(2): 3-7.

does not affect as many customers as those at HV, still the poor condition of the LV system in South Africa might be responsible for the bulk of supply interruptions.

Power Quality

Power quality (PQ) refers to the powering and grounding of sensitive equipment in a manner that is suitable to the operation of that equipment. It may also be defined as the measure, analysis, and improvement of bus voltage, usually a load bus voltage, to maintain that voltage to be sinusoid at rated voltage and frequency.

Electronic loads are susceptible to transients, sags, swells, harmonics, and momentary interruptions. In the past, these disturbances were not cause for great concern. However, today's heavy reliance of businesses and households on sensitive electronic devices has rendered the *quality* of electric service as important as its *reliability*. In view of the increased digital load, and the increased sensitivity of that load, events such as voltage sags, impulses, harmonics, and phase imbalance are now power quality concerns with a new significance attached to them, especially because they can have a huge economic impact.⁴⁰ Therefore, any analysis and discussion of electricity system reliability must also include an assessment of power quality.

While reliability indices are well-defined (they describe clearly defined events) and widely used, power quality metrics are more controversial and frequently outdated. South Africa has played a leading role in power quality standardization. The Quality Supply Standards, NRS-048, published during the period 1996-1998 (in five parts) provided the basis for evaluating the quality of supply delivered to customers by the industry, and the means for determining whether utilities meet the minimum standards required by the National Electricity Regulator.⁴¹ This, it provided an improved power quality management foundation. It is worth noting that the NRS-048 has been used and extensively referenced by other countries in Africa as well as by international technical bodies.

The introduction of NRS-048 in 1996, paved the way to detailed power quality contracts at individual customer interfaces and bulk supply points. These contracts included both utility and customer (emission) commitments. In order to fulfill its contractual obligations, Eskom initiated a formal power quality monitoring program. As a result, around 114 transmission and distribution (T&D) interface points (132 kV and 88 kV) are being monitored on a continuous basis. The quality parameters being measured are those associated with voltage waveform (regulation, harmonics, unbalance) and voltage dips (box 3)⁴².

⁴⁰ For example, just a few years ago, a voltage sag would be frequently classified as a drop by 40 percent or more for 60 cycles, but today, it may be a drop of 15 percent for only 5 cycles.

⁴¹ The 1996 edition of NRS 048 was developed mainly by the regulated utilities themselves with some input from end-users. In 2003, NRS-048-2 was developed by joint working group comprising the National Electricity Regulator, utilities, and end-customers.

⁴² Eskom groups voltage sags into five classes: class Y (80%-90% magnitude, 20ms-3sec duration); class X (40%-80% magnitude, 20ms-150ms duration); class S (40%-80% magnitude, 150ms-600ms duration); class T (0-40% magnitude, 20ms-600ms duration); class Z (0-80% magnitude, 600ms-3sec duration).

Box 3 Power Quality Indices

Total harmonic distortion (THD)

THD is the ration of the RMS value of the sum of the individual harmonic amplitudes to the RMS value of the fundamental frequency.

Unbalance

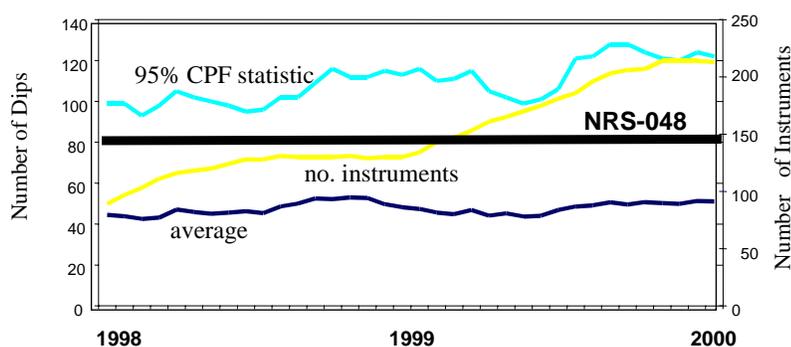
The unbalance is a condition in a poly-phase system in which the rms values of the line voltages (fundamental component), and/or the phase angles between consecutive line voltages, are not equal.

Voltage dips

Voltage dips, also called sags, are brief reductions in AC main voltage and are characterized by a pair of data: retained voltage or depth and duration--reduction of the supply voltage to a value between 90% and 1% of the declared voltage, followed by a voltage recovery after a short period of time whose duration is 10 ms-1 min.

Source: Cigre (2004).⁴³

Figure 12 Dip performance vs NRS-048 limits
(Type X dips for network voltages between 44kV and 132 kV)



Source: Koch et al (2003).

Voltage magnitude performance improved substantially through the use of PQ instruments providing data directly to the national control center. When NRS-048 was implemented in 1996, there was a large measured gap between actual performance and the limits set in the standard. These gaps led to customer unhappiness and complaints about the quality of power supply. One quality metric that was particularly problematic

Source: Voltage Sag Indices – Draft 2 working document for IEEE P1564, November 2001 (http://grouper.ieee.org/groups/sag/IEEEP1564_02_01.doc).

⁴³ Joint Working Group Cigre C4.07/Cired. 2004. *Power Quality Indices and Objectives—Final WG Report*.

for the utility was the number of voltage dips which were consistently higher than the limits set by NRS-048 (figure 12).⁴⁴

From Eskom’s perspective its inability to meet the dip voltage limits set by NRS-048 implied that such limits were unrealistic and could not be achieved without substantial upgrading investment in the network. In response to these difficulties of managing dip performance, and after extensive consultations with the various stakeholders (utilities, equipment manufacturers, end-users, standards bodies, etc.), NER, in 2002, issued a new Directive on Power Quality.⁴⁵ Under this new PQ framework, the transmission and distribution utilities were no longer required to meet global dip limits. Instead the focus shifted away from the number of dip events on how the utility interacts with its customers, and the causes of specific events that affect sensitive customers. Network planning, operation, and maintenance management received increased attention. The implementation of high priority maintenance and reliability projects led to improvements in waveform quality and disturbance indicators (table 3).

Table 3 Eskom’s power quality indicators

	Waveform quality			Disturbance			
	Regulation	Unbalance	Harmonics	Type X dips	Type S dips	Type T dips	Type Z dips
2000	95.8 (n.a.)	99.1 (n.a.)	100 (n.a.)	86.8 (n.a.)	92.6 (n.a.)	97.1 (n.a.)	94.1 (n.a.)
2001	95.8 (95)	99.1 (95)	100 (95)	92.6 (95)	95.6 (95)	100 (95)	98.5 (95)
2002	98 (95)	98.4 (95)	100 (95)	98.8 (95)	96.4 (95)	100 (95)	95.2 (95)
2003	98.7 (97)	99.2 (97)	100 (97)	98.6 (96)	100 (96)	100 (96)	100 (96)
2004	98.9 (96.2)	99.5 (97)	100 (98)	97.6 (96.2)	99.4 (96.2)	99.4 (96.2)	99.4 (96.2)
2005*	99.5 (n.a.)	100 (n.a.)	100 (n.a.)	96.3 (n.a.)	96.3 (n.a.)	99.4 (n.a.)	98.8 (n.a.)

Source: Eskom, Annual Report (various years).

Operating Efficiency

This section examines Eskom’s labor and capital productivity and compares them to other utilities from around the world.

Labor Productivity

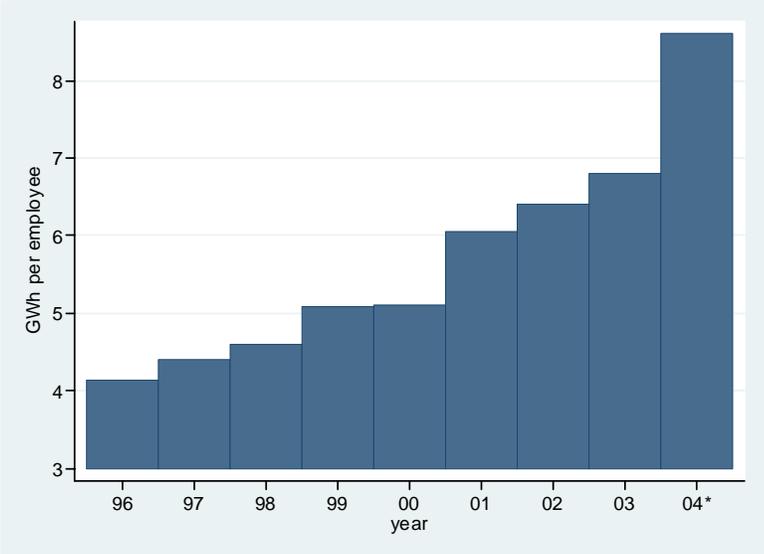
In many developing and transition economies (DTEs), state ownership in the electricity sector has been associated with extraordinarily high excess employment.

⁴⁴ Koch, R., Sigwebela, I. and H. Geldenhuys. 2003. “A Summary of South-African Experience with Power Quality Management”. *CIREN 2003, Round Table on Power Quality at the Interface T&D*.

⁴⁵ National Electricity Regulator. 2002. “NER Power Quality Directive”. *Directive of the South African Electricity Regulator*, Revision 1.5, April 2002.

Efficiency and competitiveness require eliminating redundant jobs. As part of the restructuring and privatization process, many utilities in the DTEs implemented labor rationalization programs that led to substantial shedding of excess employment. It is important to note that in South Africa, there was an over 50 percent reduction in the number of workers employed by the publicly owned electricity utility Eskom from over 66,000 in 1985 to 32,800 in 2000 (and a further reduction of 17 percent from 2000 to 2003).⁴⁶ These reductions led to dramatic increases in labor productivity since they were taking place while Eskom was experiencing a robust growth in sales. Labor productivity in South Africa’s electricity supply industry, as measured by sales per employee, more doubled between 1996 and 2004 (figure 13).

Figure 13 Eskom’s sales per employee (GWh/employee)



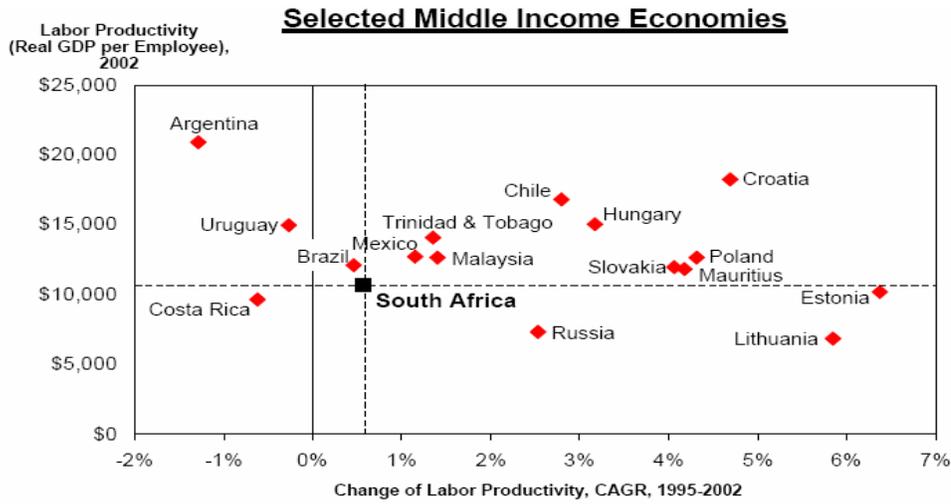
* The figure refers to the 15-month period from 1 January 2004 to 31 March 2005
 Source: Eskom Annual Report (various years).

The above increases in the labor productivity of the electricity supply industry were obtained during a period when South Africa registered only very modest overall labor productivity growth, falling behind many other African economies and raising serious concerns about the country’s eroding competitive position. Indeed, during 1995-2002, South Africa’s labor productivity growth was low and lagged all but the South American economies in its income group (figure 14).

Despite the impressive gains in labor productivity of recent years, Eskom still ranks well below many systems from the advanced industrial countries (figure 15).

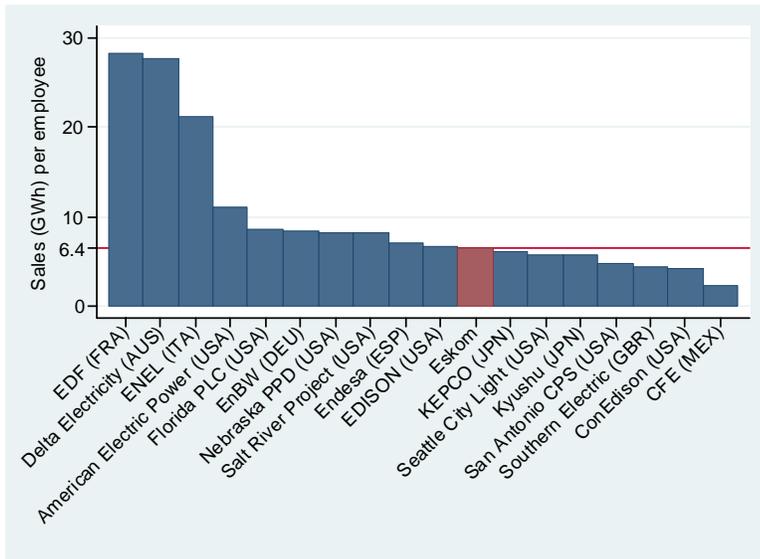
⁴⁶ Eberhard and Mtepa (2004), *ibid.*

Figure 14 Comparative labor productivity performance



Source: Porter (2003).⁴⁷

Figure 15 Electricity sales per employee for Eskom and selected international utilities, 2002



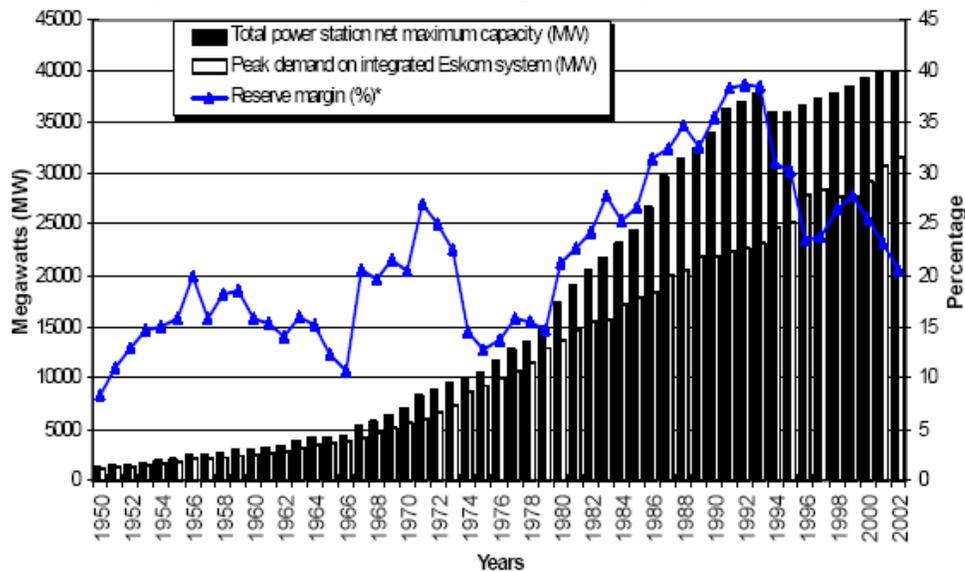
⁴⁷ Porter, M. 2003. "The Competitive Advantage of South Africa". Presentation, Johannesburg, South Africa.

Capital Productivity

The measurement of capital productivity in electricity generation is complicated by the fact that electricity is not storable and is subject to peak demands both daily and seasonally. A variety of indicators have been traditionally employed providing information on different aspects of capital asset performance. Two of the most widely indicators are the capacity factor or generation load factor and the reserve plant margin (RPM). The capacity factor is the total energy produced for a specified period relative to the total possible amount of energy that could have been produced for the same period.⁴⁸ Thus it shows the average utilization of available generating capacity for electricity production in a year. The RPM is meant to indicate the ability of the electricity system's generation plant to cope with the estimated peak (instantaneous) demands on the system.⁴⁹

A high capacity factor indicates that a generator is operating close to effective plant capacity. Given that generation is very capital intensive, excess capacity can be very costly.

Figure 16 Growth in Eskom's net capacity and peak demand



Source: Eberhard (2004).⁵⁰

For over two decades, from the early 1970s to the mid 1990s, Eskom implemented a sustained and very extensive capacity expansion program. This expansion

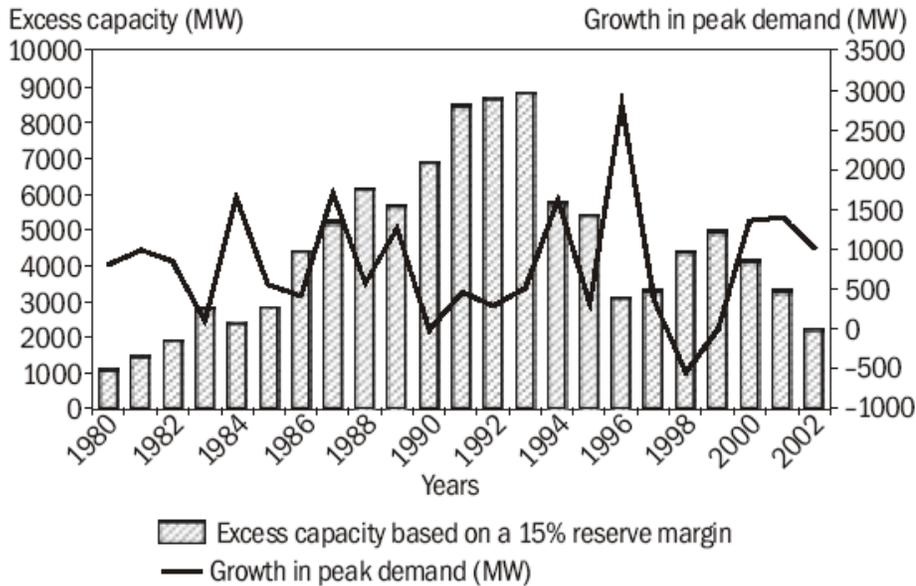
⁴⁸ Total period energy generated (MWh)*100 / Total installed capacity (MW)*period hours.

⁴⁹ It is measured by: 1. summing the supply capacities of all power stations able to operate at any time during a particular interval of time (usually the three winter months or the three summer months); 2. dividing by the total power station sent out supply required to meet the maximum peak (instantaneous) demand estimated for that interval of time; 3. taking away 1.

⁵⁰ Eberhard (2004), *ibid.*

was stimulated by the substantial changes in the relative prices of primary energy sources that followed the oil shocks of the 1970s. A state-led drive to flesh out as much oil as possible from the economy led to a significant growth in electricity demand as energy-intensive industries were encouraged to shift from oil to coal-based electricity.⁵¹ Annual growth in peak demand ranged between 6 and 16 percent between 1972 and 1982. The prospect of potential power shortages led Eskom engineers and planners to a power station construction spree. By the end of 1983, 22,260 MW of additional generation capacity had been ordered, double the operating capacity during that year.⁵² The growth in capacity expansion was especially striking between 1974 and 1993 (figure 16).

Figure 17 Eskom’s excess capacity and growth in peak demand



Source: Eberhard and Mtepa (2003).

For over 20 years, Eskom has had surplus generating capacity. It is true that a fundamental design attribute of electricity markets, in both the franchise monopoly and the liberalized market eras, is the requirement to construct and maintain extra generating capacity. This is due to the inherent fluctuation and uncertainty in demand and supply, the non-storability of electric power, and the long lead-time for capacity expansion. When generating capacity just equals an electric market’s coincident peak demand, there is no room for error. If the coincident peak demand exceeds projections, or if generating plants expected to be available are not, shortages and blackouts result. From a technical perspective, generation adequacy can be achieved by requiring electric utilities to

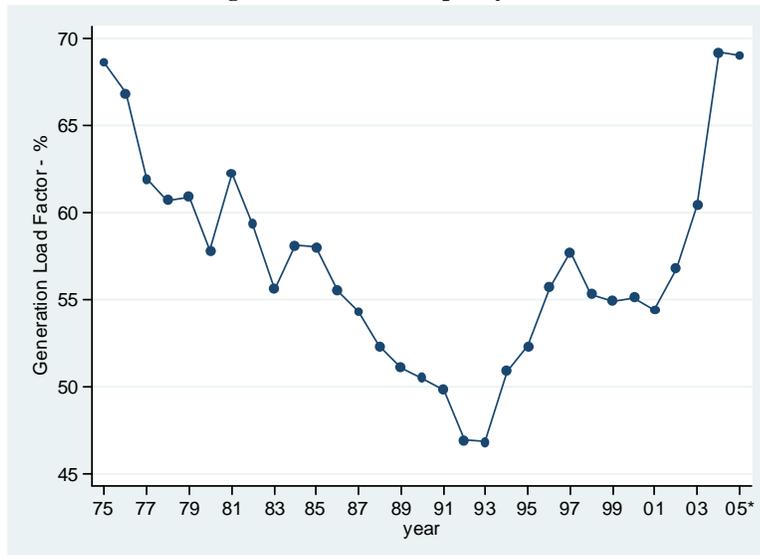
⁵¹ This shift away from oil was also motivated by the increasing isolation of the government of South Africa and the economic sanctions that were imposed by the international community in retaliation to apartheid.

⁵² Eberhard and Mtepa (2003).

maintain capacity reserves—generally set about 15 percent above the forecast, coincident, non-interruptible demand peak. The cost of such reserve capacity is traditionally recovered through an insurance premium against interruption in the rates paid by retail customers. In most countries, the optimal market equilibrium with respect to capacity and reserve margin is not reached much of the time. Also, it is widely accepted that the social cost of overinvestment (higher electricity cost) is small relative to the social cost of underinvestment (shortages and blackouts that can have hugely disruptive effects with severe economic and social consequences). Thus, if some deviation from the optimum level of capacity is inevitable, society should err on the side of overinvestment.

Sub-optimal use of generation capital is not unique to Eskom. State-owned utilities, in particular, have historically had difficulty making economically efficient new generation capacity investment decisions.⁵³ However, Eskom’s capacity expansion program was too excessive relative to demand growth. From 1980 to 2000, its reserve margin rates far exceeded those dictated by reliability and adequacy considerations. In the early 1990s, those reserve margin rates fluctuated just below 40 percent (figure 16). The presence of excess capacity over and far above the generally required rate of 15 percent reserve margin for such a long time period clearly signifies gross inefficiency in investment (figure 17). It also raises serious questions about the sector’s governance structure and the manner in which decisions were made with respect to capacity requirements and the allocation of the costs of reserve margins.

Figure 18 Eskom’s capacity factor



* refers to period Jan. 2004 – Mar. 2005.

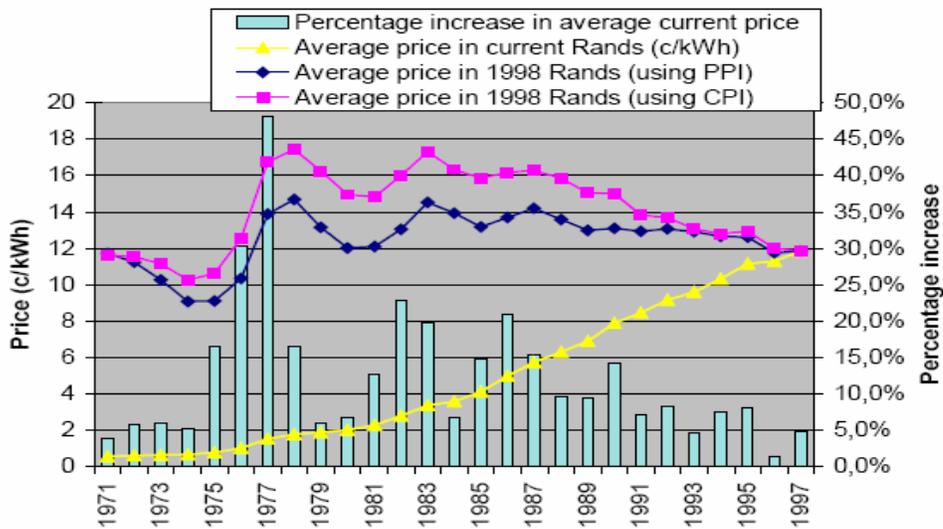
Source: Eskom Annual Report (various years).

⁵³ Wolak, F. 2005. “Market Design and Price Behavior in Restructured Electricity Markets: An International Comparison”.

The costs of Eskom’s capacity expansion program (which run until the mid 1990s), the concomitant increase of its debt burden, the lower than expected demand (Eskom’s load factor declined precipitously from 1975 to 1993—figure 18), and the utility’s monopoly position, naturally generated pressures for price increases. As it is typical of utilities with monopoly power, Eskom simply passed the costs of its poor investment decisions on to consumers. By the late 1970s, electricity prices in South Africa increased drastically from a band of around 11 c/kWh to approximately 16 c/kWh (1988 values). This represented an increase of 45 percent in real terms (figure 19).⁵⁴

The substantial price increases from 1975 to 1978 were followed by another round of increases in the early 1980s (figure 19). This second round of price increases led to a public outcry and ultimately to the establishment of the De Villiers Commission of Enquiry into Eskom’s activities. The Commission was critical of the utility’s governance and management structures, electricity forecasting methods, investment decisions and accounting.⁵⁵ In particular, the Commission concluded that Eskom’s investment planning was highly defective and that it substantially overinvested in generating capacity.

Figure 19 Historic Eskom prices and average price increases



Source: Steyn (2001).

⁵⁴ Steyn, G. 2001. *Administered Prices—Electricity*. A report for national Treasury.

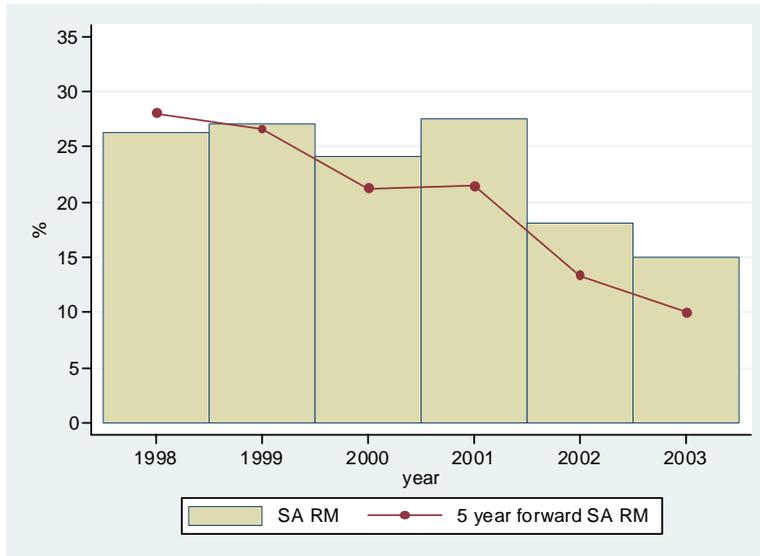
⁵⁵ Cassim, R., Akinboade, O., Niedermeier, E. and F. Sibanda. 2004. *Sustainable Development: The Case of Energy in South Africa*. Trade Knowledge Network Paper, International Institute for Sustainable Development., Winnipeg, Manitoba, Canada.

Security of Supply

A system's installed generating capacity can be considered adequate when peak demand for electricity is covered by an adequate reserve margin--the difference between the peak load and the portion of electric resources that are expected to be able to operate during the peak load. If planned maintenance can be performed outside the seasonal peak, the reserve margin must allow for forced (unplanned) outages of generating plant—the system's operating reserve must be sufficient to withstand the loss of the largest plant.

As figure 20 indicates, by 2002 South Africa's high spare capacity and more than adequate reserve margin came to an end. The system's five-year forward committed plant reserve margin has been declining to below the active plant reserve margin since 2000 when the last generating unit was placed in operation.⁵⁶ This forward reserve margin declined from about 30 percent in 1998, to 13.6 percent in 2002, and just over 10 percent in 2003, indicating a very tight demand/supply balance (figure 20).

Figure 20 South African reserve margin



Source: Vundule *et al* (2003).

Environmental Performance

The generation of electricity from fossil fuels, notably coal and natural gas, is a major and growing contributor to the emission of carbon dioxide—a greenhouse gas that

⁵⁶ Vundule, C, Boeije, W. and E. Viljoen. 2003. "Proposed Key Performance Indicators for the Electricity Industry in South Africa". *NER Quarterly Journal* 4: 14-29.

contributes significantly to global warming. Coal-fired generation releases more carbon per kilowatt-hour than natural-gas-fired and oil-fired generation. Because of its heavy reliance on cheap, low-grade coal, Eskom is the primary source of greenhouse emissions in South Africa. The coal-fired stations in South Africa were designed to remove dust and other particles from the waste gases but none are fitted with scrubbers to remove oxides of sulfur and nitrogen. This was because the use of scrubbers would increase the cost of electricity substantially. For example, Eskom estimated that if desulphurization plants were to be installed at all of its coal-fired power stations, the cost of electricity would go up by as much as 20 percent.⁵⁷

Eskom's coal-fired power stations are responsible for 66 percent of the 6,000 tons of sulfur dioxide (SO₂) pollution that is spewed into South Africa's atmosphere daily. By comparison, the country's four oil refineries together are responsible for only 1.6 percent.⁵⁸ Furthermore, most of Eskom's power stations are located within a 100 km radius in Mpumalanga and this concentration exacerbates the pollution problem.

In recent years, Eskom has implemented a variety of measures to mitigate the adverse environmental impacts of coal combustion. Through improved technology (e.g. the use of electrostatic precipitators) more than 99 percent of the ash is extracted from the combustion gases before it is released into the atmosphere.⁵⁹ The cleansed gas is released through chimney stacks that are tall enough to ensure that the oxides of sulfur and nitrogen are released above the natural inversion layer of the atmosphere (approximately 250 meters above ground) where atmospheric conditions are more favorable for their dispersal and dilution. However, although this reduces ground level concentration of these pollutants, they can combine with moist air and rain at higher levels and cause acid rain in areas far from the source of pollution.

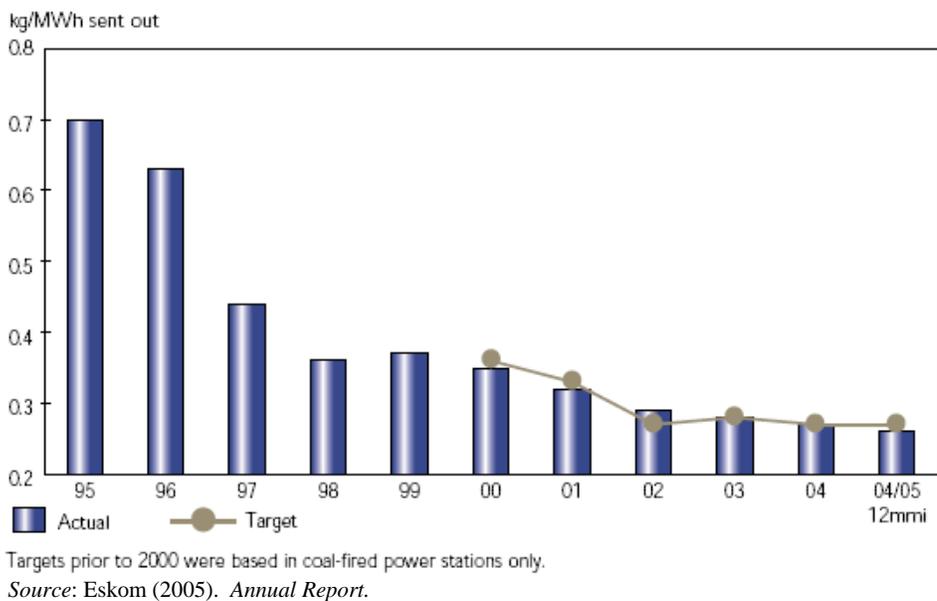
During the past decade, Eskom has made considerable progress in reducing particulate emissions (figure 21). Thus, although between 1999 and 2003 the electricity generated by its coal-fired stations increased by 6,697GWh, total particulate emissions were reduced from 1999 levels. In the last few years, Eskom has consistently met its internal relative performance targets for particulate emissions which during 2005 were reduced to 0.26 kg/MWh sent out.

⁵⁷ The economic and social tradeoff becomes immediately obvious. At the same cost, electricity could be provided to approximately 240,000 people in township areas. If, on the other hand, these people without electricity they would have to rely on traditional fuels which can also generate significant levels of pollution.

⁵⁸ Gosling, M. 2005. "Eskom to Blame for Most Sulphur Pollution". *Cape Times*: August 24, 2005.

⁵⁹ The operation of electrostatic precipitators is based on the principles of magnetism. The dust-laden gasses pass through a chamber where the dust particles are ionized by a high voltage negative direct current. The charged dust particles are removed from the gas stream onto the collecting electrodes. Intermittent blows cause the particles to drop into dust hoppers located below the electrodes. [Eskom. 2005. "Particulate Emission Control at Coal Fired Power Station". Generation Communications: GFS 0021, Revision 3 (June 2005)].

Figure 21 Eskom's relative particulate emissions



The Electrification Program

The government that came to power after the first democratic elections in 1994 expressed a strong commitment to a new multiracial, multicultural and democratic South Africa. It was also equally determined to redress the social and economic inequities that were perpetuated by several decades of apartheid policies. An important goal of the newly-elected government's Reconstruction and Development Programme (RDP) was to substantially increase the access to basic services by the poor and other disadvantaged groups that comprised the majority of the country's population.

"Access to electricity for all" was a key election slogan of the African National Congress (ANC), the party that won the election. In 1993, only 36 percent of the country's population, mostly in the urban areas, was connected to the electricity grid. This low coverage ratio is not surprising since under the apartheid system, the main focus of power sector policy was on heavy industry, mining, and

An accelerated and sustainable electrification programme must provide access to electricity for an additional 2.5 million households by the year 2000, thereby increasing the level of access to electricity to about 72% of all households.

ANC, 1994. The Reconstruction and Development Programme--A Policy Framework

the white households that comprised approximately 12 percent of the total population. In the rural areas, while the dwellings of white households were mostly electrified, their black counterparts had to rely on traditional fuels such as wood, coal, paraffin, animal and crop wastes. The heavy use of such traditional fuels was associated with high levels of indoor air pollution, which in turn led to increased levels of respiratory infections, especially among women and young children who generally spend most of the day at home. Pneumonia, in particular, imposed a serious burden on the South African health services. However, with the introduction of the National Electrification Programme (NEP) in 1994, electrification rates have increased dramatically. Indeed, the NEP has proven to be one of the world's most effective policies for electrifying low-income households in urban and rural areas.⁶⁰

Accelerated Electrification--Phase 1 of the NEP, 1994-1999

During the late 1980s and early 1990s, Eskom initiated its "Electricity for All" campaign to start addressing the backlog and severe inequities in electricity provision.⁶¹ This electrification program commenced at the same time as the country's political balance began to shift and a definite political change from apartheid to a broadly based political democracy was underway. The program's stated electrification goals were increasingly seen as too modest in view of the great disparities in electricity provision that were perpetuated by the "separate development" policies under the apartheid system. Thus, in the changing political environment of the early 1990s, the progress achieved by Eskom's "Electricity for All" initiative was seen as being too slow.

An extensive consultative process to formulate a new energy policy for South Africa began well before the democratic elections and government change of 1994. Indeed, prior to 1994, many groups were working with the ANC towards formulating a more socially equitable national energy policy.⁶² For example, in February 1992, the Energy and Development Research Centre (EDRC) of the University of Cape Town organized a meeting on electrification in South Africa under the auspices of the Department of Economic Planning of the ANC. The meeting brought together members of the industry, trade unions, municipalities, university researchers and other policy makers, and civic organizations. One of the important ideas that emerged from the meeting was to convene a national conference on electrification and to create a negotiating forum between government and business, labor, and opposition groups. After two national conferences on electrification involving most stakeholders and more than 70 organizations, the National Electrification Forum (NELF) was launched in 1993 to facilitate the consultative process and develop an implementable strategy for the

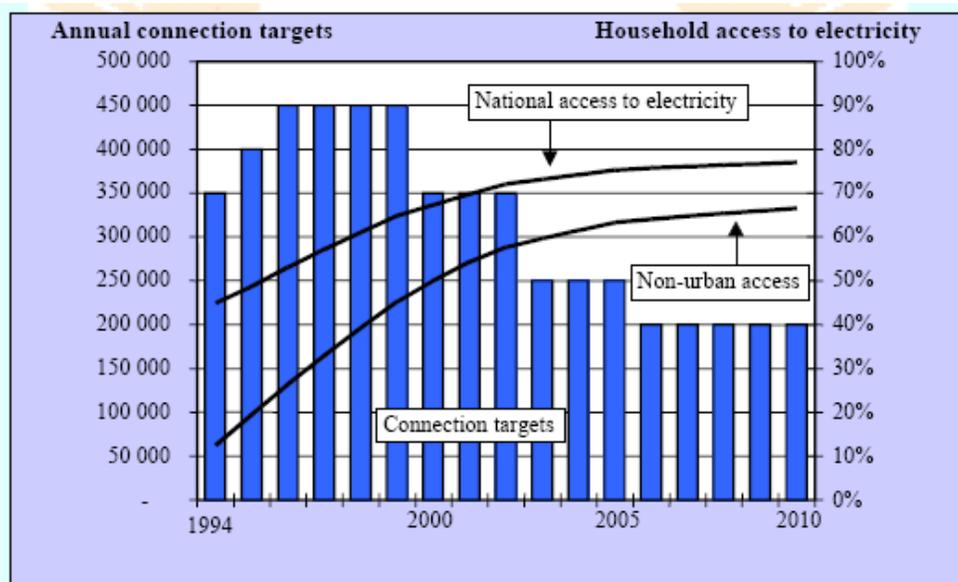
⁶⁰ Gaunt, C.T. 2005. "Meeting electrification's social objectives in South Africa." *Energy Policy*, 33 (10): 1309-1317.

⁶¹ Mare, P. 1999. "Eskom Electrification Beyond 1999". Domestic Use of Electrical Energy Conference 1999.

⁶² University of Cape Town (Energy Research Centre). 2004. *Energy for Sustainable Development: South African Profile*. Phase 1 final report.

accelerated electrification of South Africa.⁶³ The primary goal of this strategy was to increase access to electricity services in the underdeveloped urban, peri-urban and rural

Figure 22 The goals of 1994-1999 National Electrification Program



areas where the black (80 percent of the population) lived.

The NELF played an important role in identifying the key issues facing the electricity sector and was very instrumental in achieving a consensus for addressing these challenges. One of the most important outcomes of these deliberations was a compact between the government and the electricity supply industry to connect 2.5 million new households to the national grid between 1994 and 1999, thereby increasing the national level of access to electricity to about 70 percent (figure 22). The expansion was to be funded entirely by the industry itself and implemented by Eskom and the municipalities.⁶⁴ Large-scale farms were also to play some role by connecting their farm workers where necessary. Its main targets were the rural and low-income urban areas, as well as, all schools and clinics. A total of 25,900 rural schools and 2,000 health clinics were identified for electrification.

Under Eskom’s “Electricity for All” program, approximately 618,000 new households were connected between 1991 and 1993.⁶⁵ Thus progress was slow. During

⁶³ Eberhard, A. 2003 “The Political, Economic, Institutional and Legal Dimensions of Electricity Supply Industry Reform in South Africa”. Working Paper Series, Center for Environmental Science and Policy, Stanford University.

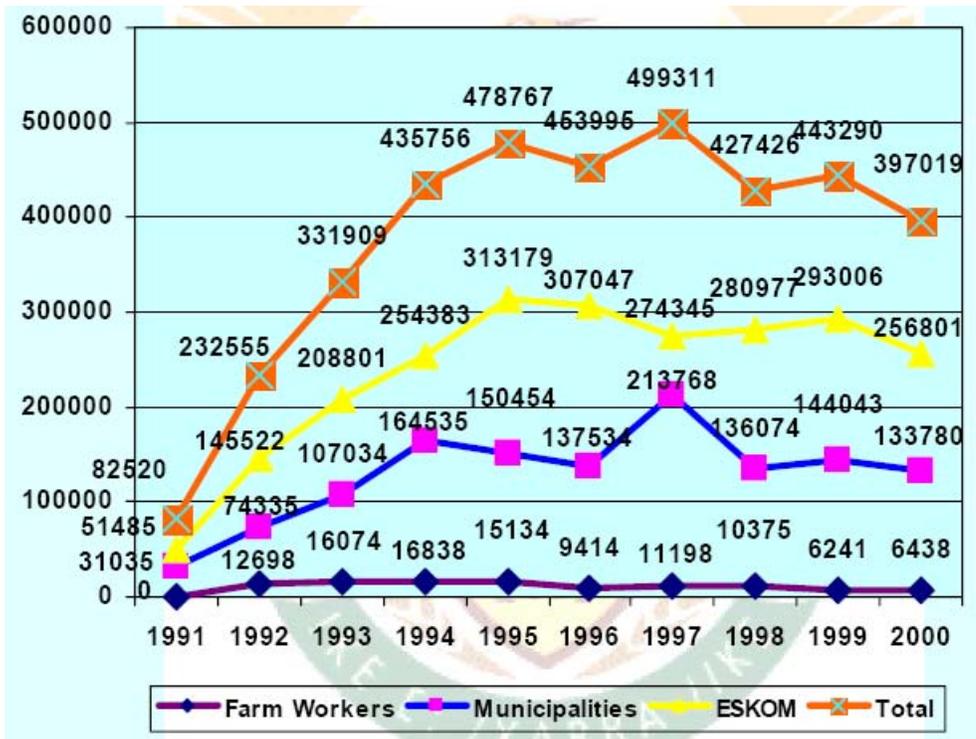
⁶⁴ It should be noted that Eskom had also made a commitment to reduce electricity tariffs by 15 percent, in real terms, during the same period.

⁶⁵ National Electricity Regulator. 2000. *Lighting Up South Africa*.

Phase 1 (1994-1999) of the NEP, on the other hand, over 2.8 million households were connected to the electricity grid, increasing the level of electrification from 36 percent in 1994 to 68 percent at the end of 1999. The urban areas, served mainly by the municipalities, were already substantially electrified by 1990. Eskom, on the other hand, had fewer than 112,000 domestic customers in 1990.⁶⁶ Thus, the new connections were mostly extended by Eskom, which accounted for about two-thirds of them (figure 23).

The accelerated electrification program was executed with funds raised by Eskom through internal cross-subsidies and a surcharge on electricity sales, as well as, through debt financing by Eskom and the different municipalities. Under an agreement negotiated by the National Electricity Regulator (NER), Eskom was to transfer R300 million per annum (escalating at the rate of the approved Eskom tariff increases) to the municipalities for 5 years to help finance their electrification projects. Thus, Eskom effectively financed the bulk of the electrification program. The electrification fund was administered by the NER. A committee consisting of staff and members of NER's Board, representatives from the South African Local Government Association,

Figure 23 Annual new household connections



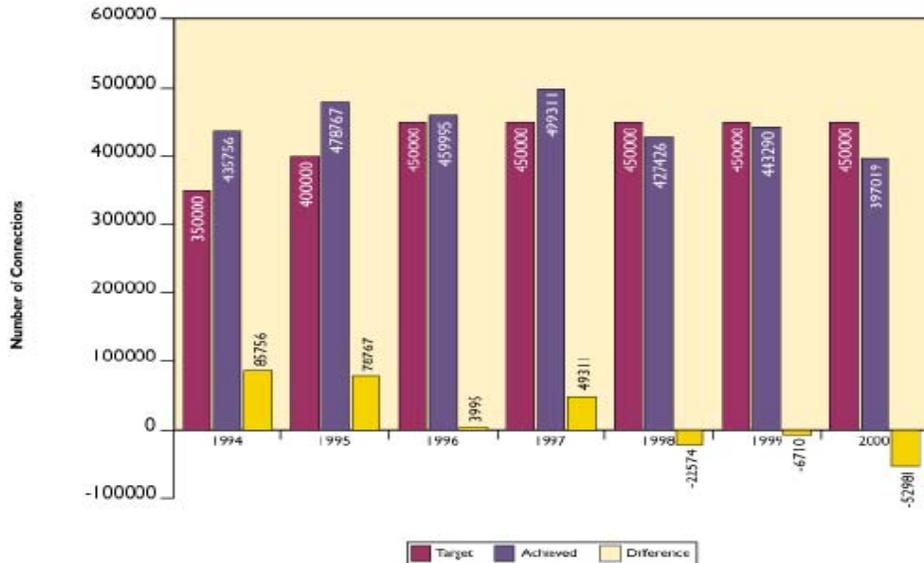
Source: <http://www.uneprisoe.org/RETSouthAfrica/NationalElectrificationProgram.pdf>

⁶⁶ Eskom. 1990. *Annual Report*.

Development Bank of Southern Africa, Association of Municipal Electricity Undertakers, and the Department of Minerals and Energy, approved the criteria for the fund's allocation and the actual final distributions.

A comparison of the NEP's targets with the actual connections reveals that the yearly targets were exceeded from 1994 to 1997 (figure 24). Even though the targets were not met in 1998 and 1999, still by the end of 2001, over 3.4 million new households were connected to the electricity grid. The total capital invested between over the 7-year period amounted to R8.9 billion and the average cost per connection was around R2,867.

Figure 24 Electrification targets and connections: 1994-2000



Source: NER (2000). *Lighting Up South Africa*.

There is much to applaud in South Africa's electrification program—from its planning and ambitious targets to its significant cost-reducing innovations and responsiveness to the requirements and needs of the customers. Thus the program's success was not limited to the impressive gains in coverage within the span of just a few years. Dramatic reductions in the capital investment costs of rural connections were achieved through careful network design and planning that matched technology and capacity more closely to customer needs and demands. These innovations included the application of single-phase distribution and the extensive use of pre-payment metering.^{67, 68}

⁶⁷ Single Phase Earth Return System (SWER) distribution employs a single metallic conductor and uses the earth as a return conductor. With good soil conductivity, SWER systems with an aluminum conductor (size 75 mm²) could typically transfer about 500 kW at distances up to 25 km at voltages of 19.1 kV. With a cheaper steel conductor (22 mm²) SWER could transfer 200kW about 25 km at 19.1 kV and a maximum

Between 1995 and 2001, the average cost of rural electrification declined 40 percent in current terms and 70 percent after adjusting for inflation (figure 25).⁶⁹ Moreover, by 2001 the average costs per rural and urban connections were roughly the same (table 4)—thus raising doubts about the longstanding notion that rural electrification is much more expensive than urban electrification.⁷⁰

Figure 25 Average cost per connection: 1994-2001

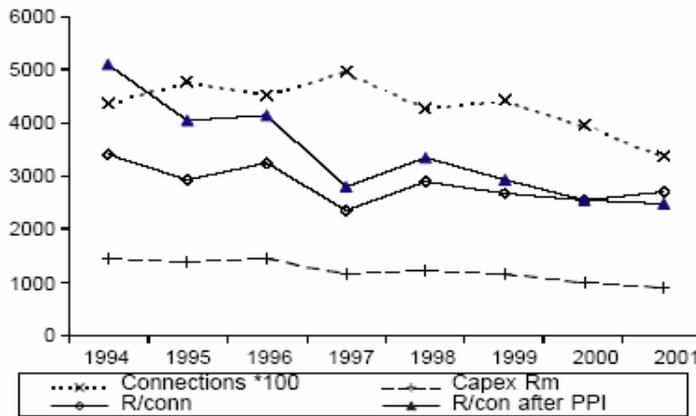


Table 4 Average cost per connection: 1995 and 2001

National average cost/connection (Rand current)	Year 1995	Year 2001
Urban	2170	2674
Rural	3568	2622

Source: Gaunt (2005).

voltage drop of 5 percent. Single-phase distribution systems could yield cost reductions of up to 40 percent in comparison to the standard three-phase designs. Eskom adopted the single-phase strategy for electrifying rural areas like the Northern Province, Eastern Cape, and KwaZulu Natal. By 2004, at least 100,000 customers had single-phase service in South Africa. [StonePowerAB. 2004. Cost Effective Electrical Networks. www.stonepower.se/Lowcostnetworks.htm.]

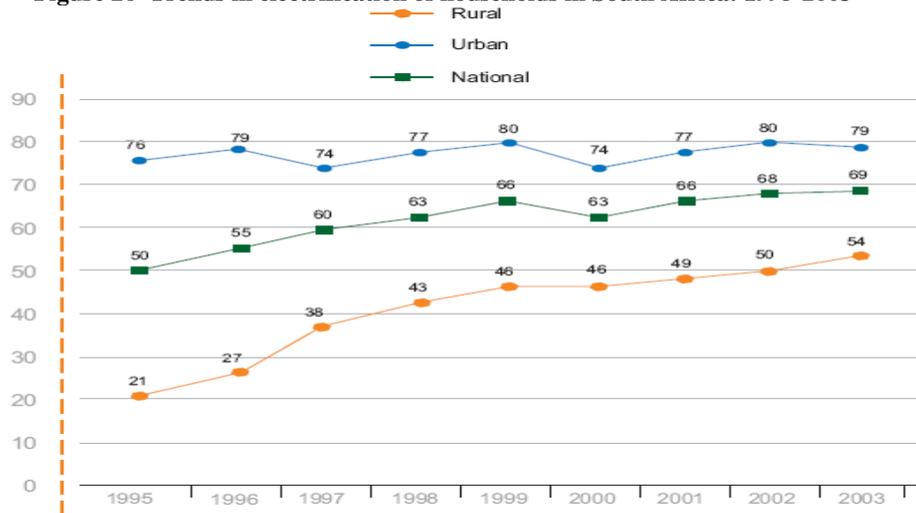
⁶⁸ The pre-payment system consists of : (i) pre-payment meters also called Electricity Dispensers (EDs) that are installed in the customers' premises; (ii) vending machines, also known as Credit Dispensing Units (CDUs), where the customer can purchase electricity credit; and (iii) Data Concentrators that collect the transaction data from the CDUs. Every ED has a unique serial number. The customer buys a credit token from a CDU, takes it home, and enters it into his ED. If the token is valid (each token is purchased for a specific ED) then the ED adds the credit purchased to the credit currently in the ED. Eskom also offers a numeric token for its machines—a simple piece of paper with a 20-digit number printed on it. This number is entered into the ED via its keyboard. Numeric tokens have the advantage of facilitating credit sales over the telephone. World Business Council for Sustainable Development (2204). *Eskom: Electrification for All*.

⁶⁹ The Producer Price Index (PPI) was used for calculating the real connection costs. The base year was 2000 and the average PPI in 1994 was 66.7.

⁷⁰ Gaunt (2005), *ibid*.

By targeting the disadvantaged and rural households, the NEP made a substantial contribution towards reducing the huge “energy divide” in South Africa between the urban and mostly poor and disadvantaged rural areas (figure 26). In 1995, 76 percent of the urban and only 21 percent of the rural households were connected to the national electricity grid. By 2003, the percentage of electrified households in the rural almost tripled to 54 percent while those in the urban areas rose only slightly to 79 percent.⁷¹

Figure 26 Trends in electrification of households in South Africa: 1995-2003



Source: NER (2003).

Despite the increased access to electricity, many of the newly connected households were simply too poor to benefit substantially from it. Electricity consumption has been much lower than initially anticipated and well below the level needed for financial break-even. Approximately 56 percent of the households connected to the national grid have been found to consume less than 50 kWh of electricity per month.⁷² A consumption level of 350 kWh was assumed under the NEP planning. As a result, the electrification of the poor and rural areas is not financially viable (table 5).

Electrification Beyond 1999—Sustainability Challenges

The National Electrification Program has arguably been one of the most successful elements of the South African Reconstruction and Development Program. Within a decade, the number of domestic electricity customers doubled making the

⁷¹ The fluctuations around the peak in electrification reached in 1999 were primarily due to changes in the estimates of population and number of households. For example, the estimated number of households in 2000 was adjusted substantially on the basis of information obtained from the 1999 October Household Survey.

⁷² Prasad, G. and H. Ranninger. 2003. “The Social Impact of the Basic Electricity Support Tariff”. Domestic Use of Energy Conference, Cape Town, 2003. Cape Technikon: 17-22.

electrification rates during Phase 1 the highest in the world. And this was achieved without external funding. Disadvantaged urban and rural areas, as well as schools and clinics without electricity, were connected to the national grid. However, more urban than rural areas were electrified as the latter are further from the grid and more dispersed (figure 27). Thus, a significant urban-rural electricity divide remained at the end of Phase 1 of the NEP when over 54 percent of the rural households still had no electricity connection.

Table 5 Summary of key NEP financial and economic indicators

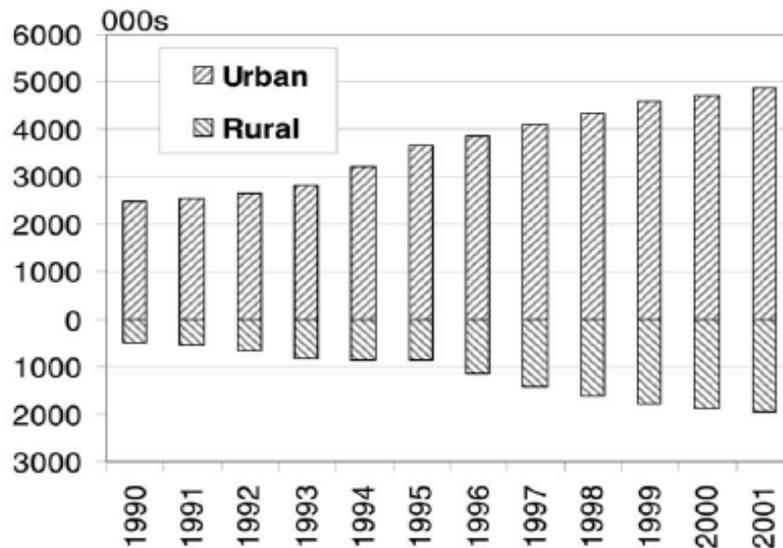
	<i>NW Prov Mmabatho</i>	<i>N Prov Venda</i>	<i>W Cape Khayelitsha</i>	<i>N Cape Kimberley</i>	<i>Kz/Natal Durban</i>	<i>Gauteng Orange Farm</i>	<i>TED Mpumalanga</i>	<i>E Cape KwaNobuhle</i>
Financial NPV/cust (R)	(2 081)*	(1 164)*	(915)*	(447)	(1 482)	(1 777)	710	(242)
Economic NPV/cust (R)	(1 060)*	1 197*	(427)*	354	(100)	(703)	1 221	(217)
Econ Ben/cost ratio**	0.86*	1.20*	0.93*	1.06	0.99	0.84	1.19	0.96

* Actual capital costs for programmes in the NW Province, N Province and W Cape were not available, and were rather 'back-calculated' from average cost per connection. Financial and economic figures for these programmes therefore cannot be considered accurate.

** A ratio of greater than 1 indicates that the economic benefits outweigh the costs.

Source: Borchers et al (2001).⁷³

Figure 27 Urban and rural electrification connections: 1990-2001



⁷³ Borchers, M, Qase, N., Gaunt, T., Mavhungu, J., Winkler, H., Afane-Okese, Y. and C. Thom. *National Electrification Programme 1994-1999: Summary Evaluation Report*. Department of Minerals and Energy, Republic of South Africa. http://www.dme.gov.za/energy/pdf/efficiency/Summary_Objectives.pdf

Source: Gaunt (2005).

Phase 2 of the electrification program was started in 2000. Its main target was to provide 300,000 new households with electricity connections every year.

Performance Problems in the Distribution Industry

While the generation and transmission segments of the industry have been operating reasonably efficiently, the electricity distribution industry (EDI) has been marred by serious structural problems and has been in serious financial trouble for several years now.

Structural Inefficiencies

The total number of local authorities was reduced, through amalgamations, from over 800 to just below 380 in 2001.⁷⁴ Thus, approximately 360 municipalities, Eskom, and about 13 private distributors were at one time engaged in the business of distributing electricity in South Africa. The authority of municipalities to engage in the provision of infrastructural services like roads, water and sanitation, health services, and electricity is supported by the Constitution. With respect to electricity services, the Constitution states that “A municipality has executive authority in respect of, and has the right to administer...electricity reticulation.”⁷⁵ Only a very few municipalities have been generating their own power. The majority of them have been purchasing power from Eskom for resale to consumers within their boundaries.

Until recently, therefore, the distribution industry was highly fragmented with one very large, several medium-sized, and too many very small, financially non-viable, and poorly-run municipal distributors. These structural arrangements in the EDI were not the result of any rational planning and thus formed no coherent pattern. Not surprisingly, consumers have been facing significantly different tariffs and quality of service standards across the country. In particular:

- the reliability of supply and the ability of municipal distributors to offer secure service to low income households has differed markedly across the country;
- significant disparities have existed in the structure of tariffs and these differences exhibited little or no relationship to the quality of service provided, the cost of supply, or consumers’ ability to pay (table 6);
- unfair discrepancies have existed between Eskom Distribution and municipal distributors purchasing tariffs from Eskom Transmission--to the benefit of some large customers, but the detriment of the domestic and low-income consumers.

⁷⁴ The number of municipal councils was further reduced to 284 by 2005. Oxford Analytica (2005), *ibid*.

⁷⁵ Eberhard, A. 2005. “New Electricity Regulation Bill Proposes Radical Changes”. AMEU Bulletin September 2005.

Financial Viability

In recent years, the municipal distribution companies have been experiencing serious financial problems. Many of them have been saddled with mounting debts, large arrears to Eskom for the bulk supply of electricity, and some have been effectively on the brink of bankruptcy. Inevitably, these chronic financial difficulties have undermined the ability of these distribution entities to provide adequate and reliable electricity service and to expand coverage. There are several factors that contributed to the deteriorating financial performance of the municipal electricity distributors.

Many of the municipal distribution companies are financially non-viable as a result of operating inefficiencies, lack of technical capacity, theft, and a history of non-payment by users.

Table 6 Sample municipal electricity tariffs, 2003-04

Municipality	Residential			Business (r/kWh)
	Basic tariff per month (R)	Monthly charge (r/kWh)	Free service (r/kWh)	
City of Cape Town	32,70	0,29	0,00	Various
City of Johannesburg	60,99	0,26	0,35	0,31
City of Tshwane	0,00	0,36	0,36	0,29
Ekurhuleni	n/a	0,38	0,00	n/a
eThekweni	0,38	0,38	n/a	0,43
Nelson Mandela	0,30	0,30	0,30	0,36
Buffalo City	9,60	0,34	0,00	0,40
George	n/a	0,33	0,33	0,46
Klerksdorp	32,66	0,35	n/a	0,44
Polokwane	0,00	0,04	0,02	0,04
Matjhabeng	50,56	0,33	n/a	n/a
Mbombela	40,00	0,40	n/a	0,33
Mogale City	1,10	0,23	n/a	0,32
Rustenburg	22,00	0,33	0,33	0,40
Sedibeng	n/a	0,30	0,00	0,37
Stellenbosch	n/a	0,36	0,36	0,42
Steve Tshwete	n/a	0,17	0,35	0,17

Source: Trends in Intergovernmental Finances: 2000/01 - 2006/07.

When the ANC-led government assumed office in 1994, it inherited a relatively disorganized and racially segregated public finance system. The former government policies did not promote, or arguably inhibited, the level of commercial and industrial activity in black areas that would yield a tax base sufficient to support adequate municipal services. Moreover, a practice of non-payment arose in the black municipalities (perhaps as a protest against the social policies under apartheid) that exacerbated the financial plight of those municipalities. The new government promptly introduced a medium-term expenditure program that sought to reduce the national fiscal

deficit, extend the tax base, and improve revenue collection. This stabilization program was then extended to the provincial level. However, it was not until 2000 that a new system of local government was implemented to replace the diverse and racially segregated structures that operated in the apartheid era. The pace of implementation and reform at the local level has been slow for several reasons:

- Under the new local government system, well-off former ‘white’ areas, generally well served by physical infrastructure, were merged with impoverished and underdeveloped black townships. This created additional strain, both financially and physically, on the capacity of local councils to deliver services and businesses, including the supply of electricity.
- In the 1980s, a culture of non-payment of local rates and user charges developed in many black areas. The local government deficits were written off by central government. Despite the political legitimacy of the new authorities, the non-payment culture persisted post-1994 and, in some instances, spread beyond the black areas, thereby perpetuating the problem of indebtedness.
- The national shortage of skills and experience in running representative and accountable governmental structures is particularly evident at local level, and has inhibited the implementation of reforms.⁷⁶

Prior to 1996, the government provided an operating subsidy to the municipalities. This subsidy was not adjusted to reflect inflation and in some cases it actually declined even in nominal terms. Thus, despite the consolidation many of the newly created municipalities could not cope financially or technically in many areas of service provision, including electricity distribution.⁷⁷

In the early years of the transformation, the EDI as a whole seemed to be financially solvent. For example, in 1996 total revenues exceeded total costs by nearly R 1.2 billion, net of the more than R 1.3 billion in electrification costs incurred that year. Still, because of the manner in which these revenues were distributed, many of the smaller municipalities were revenue inadequate. In 1994, four municipalities earned 50 percent of the surplus, 22 municipalities earned 75 percent and the top 100 earned 99 percent of the total, respectively. This left the remaining 300 municipalities collectively earning less than 1 percent of the total surplus for that year. The 12 largest municipalities accounted for approximately 75 percent of all electricity sales in the municipal sector.

⁷⁶ Oxford Analytica. 2004. “SOUTH AFRICA: Local government faces financing problem.” January 30 2004.

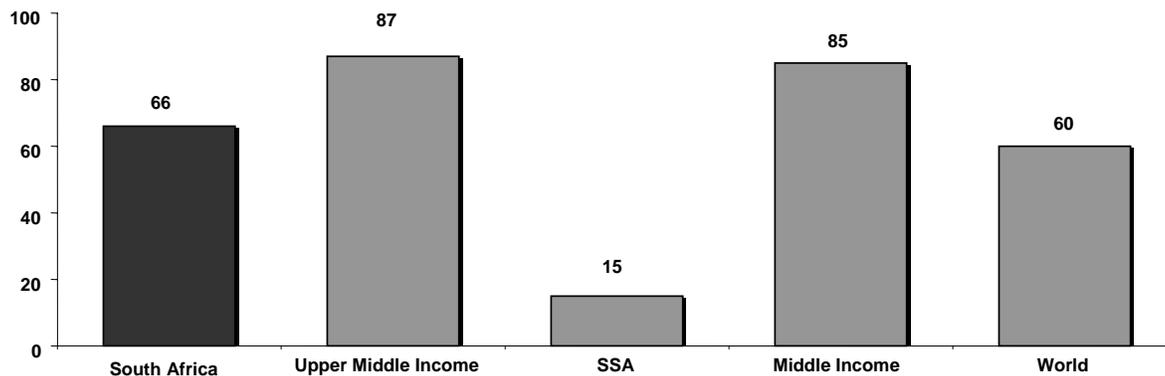
⁷⁷ Galen, P. 1998. “Grappling with Change: The South African Electricity Supply Industry.” National Renewable Energy Laboratory. Golden, Colorado.

International Benchmarking of South Africa's Electricity Performance

Overall Assessment

Overall, South Africa's performance in the electricity sector (measured by the seven indicators discussed below) compared to the upper-middle income country benchmark is relatively weak in terms of access, but favorable in terms of technical efficiency (i.e., percentage of system losses) and pricing. The relatively low access reflects in large part the legacy of apartheid, that left large segments of the population—especially the poor—outside the network of basic service provision. Since 1994, a significant area of policy success has been to increase service access, but the level remains behind the average expectation for upper middle-income countries. Low aggregate losses reflect solid internal technical efficiency of the electricity network, but this hides the problem of outages in specific areas, even in large cities such as Johannesburg. Low prices reflect the comparatively low cost of South Africa's electricity (produced almost exclusively from low-grade coal) and the fact that a good part of the capital stock has already been depreciated as there has been little investment in the sector over the past two decades. The overall picture, therefore, suggests that despite recent gains, one of the main weaknesses in South Africa's electricity sector lies in access which remains limited, particularly in terms of service delivery to the poor.

Figure 28 Access to electricity (% of population)



Access

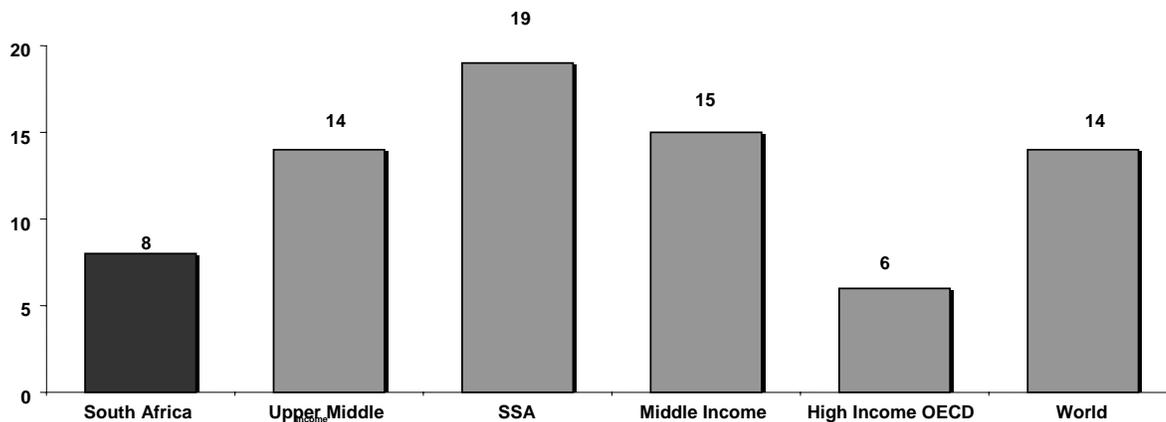
Not surprisingly, South Africa's access to the electricity network is superior to the rest of Sub-Saharan Africa (SSA) with 66 percent of the population having access, compared to 15 percent for region as a whole (figure 28). Access has also risen

substantially in South Africa, from some 30 percent ten years ago reflecting the success to date of the policy of widening access to the electricity network. Nevertheless, South Africa’s level of overall access remains significantly behind—by about a third—its own income group of upper middle-income countries (87 percent). A related (and corroborating) statistic focusing on households indicates that about 65 percent of all households in South Africa report having access to electricity compared to 23 percent for the SSA region and 74 percent for the upper middle-income countries.

Affordability--Pricing

South African average end-user prices (US cents/kwh) are some of the cheapest in the world at 3 cents for residential and 2 cents for non-residential customers. By comparison, these user prices in upper middle income countries are, on average, about 9 and 7 cents, respectively, while SSA rates are 6 and 5 cents. The world average is 9 cents for residential customers and 6 cents for non-residential customers. In South Africa, the low user prices do not seem to reflect obvious underpricing, as is the case in many developing countries with the attendant quasi-fiscal losses. Instead, it is a consequence of the low cost structure of what is considered a well-run state electricity company (Eskom) and the fact that part of the capital stock has already been depreciated as there has been little investment in the sector over the past two decades; hence, the fixed cost component of the electricity cost/price in South Africa is very low.

Figure 29 Electricity transmission and distribution losses (% of total output)



Technical Performance

Measured by the percentage of aggregate transmission and distribution losses, technical efficiency of the electricity sector is strong. Electric power transmission and

distribution losses account for 8 percent of total output in South Africa, which outperforms both SSA (19 percent) and upper middle income countries (14 percent). Indeed, this aggregate performance is more comparable to the high-income group of OECD countries (6 percent). As a result of an number of supply-side management initiatives during the 1990s, Eskom's generation plant performance improved substantially and by early part of this decade several of its technical performance metrics (e.g. Unit Capability Factor, Unplanned Capability Loss Factor, and Unplanned Automatic Grid Separations per 7000 operating hours) had reached world-class levels (in some instances well above the international best quartile). However, this aggregate picture must be qualified: for the 30 percent of the population not having access, this aggregate technical efficiency does not matter. In addition the increased prevalence of power outages in specific communities, even within Johannesburg, associated with the poor maintenance and the state of the distribution network under the control of local governments further qualifies the technical efficiency of the distribution network.

Investment Needs in South Africa's Electricity Sector

To put the discussion of the sector in the broader context of the infrastructure scale up and investment needs, in this section, we briefly present a panel-based projection of the large investment needs in the electricity sector for two growth scenarios: (i) current growth scenario of 3.6 percent per annum and (ii) accelerated growth scenario of 6 percent per annum. We base our prediction of the required stocks and flows of electricity network infrastructure on an estimated long-run demand model using a 52-country panel. The panel was limited to low- and middle-income countries, in order not to bias the estimated infrastructure demand upward through the inclusion of high-income countries.⁷⁸

The Current Growth Scenario

Our forecasts indicate that the electricity production would grow from 4,815.47 kwh per capita in 2002 to 6,453.19 kwh per capita in 2010. The average annual forecast growth rate for electricity production based on the estimated long-run relation during 2003-2010 is 3.7 percent.

Using the upper bound cost structure, we predict that total value of the electricity generating stock is going to increase from US\$ 7.26 billion (R 47.17 billion) in 2002 to US\$ 9.52 billion (R 61.88 billion at an exchange rate of R6.5/\$1) in 2005, and then to US\$ 14.64 billion (R 95.18 billion) in 2010. Therefore, required average annual

⁷⁸ We estimated the following empirical specification of equation

$$\ln\left(\frac{I}{P}\right)_{i,t} = \alpha + \beta_y \ln YPC_{i,t} + \sum_{k=1}^3 \beta_k YS_{i,t} + \delta Z_{i,t} + \varepsilon_{i,t}$$

where I denotes the electricity infrastructural measure, P population, YPC per capita real GDP, YS sectoral shares in GDP, where we consider agriculture (YAG), manufacturing (YMAN), and services (YSERV), and Z denotes a vector of additional explanatory variables.

investments in electricity over the period 2003-2010 are of the order of \$ 0.52 billion (R 3.37 billion) or about 0.2% of GDP. It should be noted that this covers only generation, excluding transmission and distribution and operations and maintenance expenditures.

How do these investment requirements compare with local estimates of investment needs? For electricity, Eskom has estimated average annual investment needs in electricity generation, which are approximately of the order of \$US1.0 billion, but this includes the cost of investment and rehabilitation of transmission and distribution and a margin for peak demand (Eskom 2005). Therefore, our estimates related to electricity production only appear broadly in line with the ones prepared by Eskom. It should also be noted that while our estimates rely on a robust, multi-country estimate of demand for electricity that is used to forecast South Africa's needs using projected demand variables, Eskom's estimates rely on engineering projections based on South Africa's time series of electricity consumption.

An Accelerated Growth Scenario

The above forecasts are based on the consensus IMF and World Bank predicted growth rate of South African GDP in the medium term before the adoption of the accelerated and shared growth policy agenda. The forecasts also include corresponding growth rates in the agricultural, manufacturing and services sectors.

We now consider the investment needs in electricity under an alternative, accelerated growth scenario, with the average annual GDP growth rate of 6 percent identified by the South African government as a policy target. The purpose is to illustrate how electricity infrastructure investment requirements would change if a significantly accelerated growth scenario were to materialize in the coming years. Such an exercise is relevant and timely for two reasons. First, South African economy has been growing at an accelerated average annual growth rate of about 4 percent per year since 2004 and the short term outlook remains strong. Second, the officially adopted accelerated and shared growth initiative of the South African government is aiming for just such 6 percent annual growth, albeit suggesting that might only be attainable after 2010. Our illustrative, accelerated growth scenario features a more ambitious growth path of 6 percent already achieved during the period 2006-2010. As such, our two growth scenarios discussed in the paper should cover the range of possible growth paths in this period with associated investment requirements in electricity.

The forecast of electricity generating stock under our accelerated scenario now indicates that electricity production would grow from 4815.47 kwh per capita in 2002 to 8179.43 kwh per capita in 2010 (over 25 percent greater than the earlier forecast). The required average annual investments over the period 2005-2010 are now of the order of \$0.96 billion (R6.23 billion), almost double the forecast under the lower, current GDP growth rate.

The main implication of considering the accelerated scenario is that it implies considerably higher electricity investment requirements to sustain the virtuous circle of

productive infrastructure investments and growth. Our estimates indicate that average annual investment requirements in electricity production would rise to the order of about \$1.0 billion, which is close to what Eskom currently projects. However, it should be noted that Eskom's estimates include transmission, distribution, rehabilitation, and peak requirements, probably of the order of at least about \$US500 million. In a nutshell, if the accelerated scenario were to materialize in the short term—and South Africa is already growing at 5% per annum—it is possible that Eskom's current investment plans would fall well short of investment needs. In that case, Eskom's scale, timeline, and financing structure of its investment scale up will need to be revised. Equally important, there would be a need to develop robust estimates of the cost of rehabilitation and maintenance of (and institutional requirements) of the distribution network under the control of the local governments.

IV. Regional Integration in Southern Africa

In April 1980, the governments of nine Southern African countries--Angola, Botswana, Lesotho, Malawi, Mozambique, Swaziland, Tanzania, Zambia and Zimbabwe--established the Southern African Development Co-ordination Conference (SADCC). The SADCC was formed with four principal objectives:⁷⁹

- to reduce Member States' dependence, particularly, but not only, on apartheid South Africa;
- to implement programs and projects with national and regional impact;
- to mobilize Member States' resources, in the quest for collective self-reliance; and
- to secure international understanding and support.

The SADCC was catalytic in cultivating a climate of confidence and trust among the member states and provided a clear demonstration of the tangible benefits of regional cooperation. However, the SADCC leaders increasingly recognized that even greater welfare gains could be realized through deeper forms of regional integration which entail the removal of tariffs and quantitative restrictions to trade and the harmonization of legal, regulatory and institutional frameworks. Thus they came to realize that although the co-ordination conference had served them well and had demonstrated the crucial need to cooperate in their development efforts, the time had come to give the SADCC a legal and more formal status. And to shift the focus of the organization from co-ordination of development projects to a more complex task of integrating the economies of member States. To that end, the Declaration and Treaty establishing the Southern African Development Community (SADC) was signed on July 17, 1992 in Windhoek, Namibia.

The objectives of SADC are to:⁸⁰

- Achieve development and economic growth, alleviate poverty, enhance the standard and quality of life of the people of Southern Africa and support the socially disadvantaged through regional integration;
- Evolve common political values, systems and institutions;
- Promote and defend peace and security;
- Promote self-sustaining development on the basis of collective self-reliance, and the interdependence of Member States;
- Achieve complementarity between national and regional strategies and programs;
- Promote and maximize productive employment and utilization of resources of the Region;
- Achieve sustainable utilization of natural resources and effective protection of the environment;

⁷⁹ <http://www.sadc.int/english/about/history/index.php>

⁸⁰ *ibid*

- Strengthen and consolidate the long standing historical, social and cultural affinities and links among the people of the Region.

Thus, the ultimate objective of SADC is to build a Region in which there will be a high degree of harmonization and rationalization to enable the pooling of resources to achieve collective self-reliance in order to improve the living standards of the people of the region.

The Southern African Power Pool

Cooperation and trade in the electricity sector among the countries in the Southern African region can be traced back to the 1950s. Most of the electricity exchange took place under long-term bilateral contracts between vertically integrated utilities. These contracts were often complex and too difficult to administer. Power system interconnections and cross-border electricity exchanges initially involved around some of the major hydropower resource development projects. These included:

- The Kariba South hydropower station on the border between Zambia and Zimbabwe. It led to the installation of a 330kV transmission network in the two countries and a 330kV line linking the power station to Zambia's copper mine area in the mid-1960s;
- The Inga hydropower station in the DRC.⁸¹ It supplies electricity to countries in the Southern African region through a 500 kV HVDC linking Inga to Kolwezi and then through a 220 kV line linking DRC to Zambia.
- Mozambique's Cahora Bassa hydroelectric dam which was built in the 1970s. It was mainly intended to supply electricity to South Africa through a HVDC line linking the power station to the Apollo sub-station near Johannesburg. The HVDC was damaged during the civil war in 1985, but was rehabilitated in 1997. It has also been supplying electricity to Zimbabwe through a 330 kV line.

A drought hit the Southern African region in 1992 which led to severe electricity shortages due to reduced hydro generation. This highlighted the vulnerability of the individual countries pursuing a policy of self-sufficiency and emphasized the need for a more formal regional power cooperation. It also highlighted the potential benefits of cross-border electricity exchange due to the diverse primary energy endowments of the region. The mix of coal-fired stations in South Africa (and in the future in Botswana), hydro power on the Zambesi River (Zambia-Zimbabwe border), the Kuene River (Angola-Namibia border), and on the Congo river, potential oil- and gas-fired stations in Angola, and Gas in Namibia and Mozambique provide diverse primary energy resources which could dramatically mitigate the risks to the electricity supply in the region posed by the drought and other natural disasters. For example, during periods of drought, coal-fired power from South Africa and Botswana can be used to save water in Kariba Lake, with the Kariba Power Station being used at such times for peaking purposes only.

⁸¹ The Inga station comprises a 351 MW plant (Inga 1) commissioned in 1972 and a 1424 MW plant (Inga2) which has been in operation since 1982.

The Southern African Power Pool (SAPP) is the first regional pool to be set up outside North America and Western Europe (figure 30).⁸² It was formally created in 1995 when the majority of member countries of the SADC member states signed an Inter-Governmental Memorandum of Understanding. Membership to SAPP is limited to the national utilities of the twelve continental members of SADC and it includes: Angola's Empresa Nacional de Electricidade (ENE); Botswana Power Corporation (BPC); DRC's Societe Nationa d'Electricite (SNEL); Lesotho Electricity Supply Commission (LEC); Malawi's Electricity Supply Commission (ESCOM); Mozambique's Electricidade de Mocambique (EDM); Namibia Power (NamPower); South Africa's Electricity Supply Commission (Eskom); Swaziland Electricity Board (SEB), Tanzania Electircity Supply company (Tanesco); Zambia Electricity Supply Corporation (ZESCO); and the Zimbabwe Electricity Supply Authority (ZESA).

Objectives and Roles of SAPP

The objectives of SAPP are to:⁸³

- Provide a forum for the development of a world class, robust, safe, efficient, reliable and stable interconnected electrical system in the Southern African region;
- Co-ordinate and enforce common regional standards of quality of supply;
- Promote measurement and monitoring of systems' performance;
- Harmonize relationships between member utilities;
- Facilitate the development of regional expertise through training programs and research;
- Increase power accessibility in rural communities; and
- Implement strategies in support of sustainable development priorities.

To meet these objectives the members of SAPP sought to define its role as:⁸⁴

- Coordinating the planning and operation of the electric power system among member states
- Reducing both capital and operating costs through coordination;
- Increasing system reliability through emergency support when required; and
- Providing a forum for regional solutions to electrical problems.

In February 2000, the SAPP Coordination Center commenced operations in Harare, Zimbabwe. The Center's primary objectives are to facilitate electricity trading in the Southern African region and to provide a focal point for SAPP activities, especially through the technical oversight of pool operations. In particular,

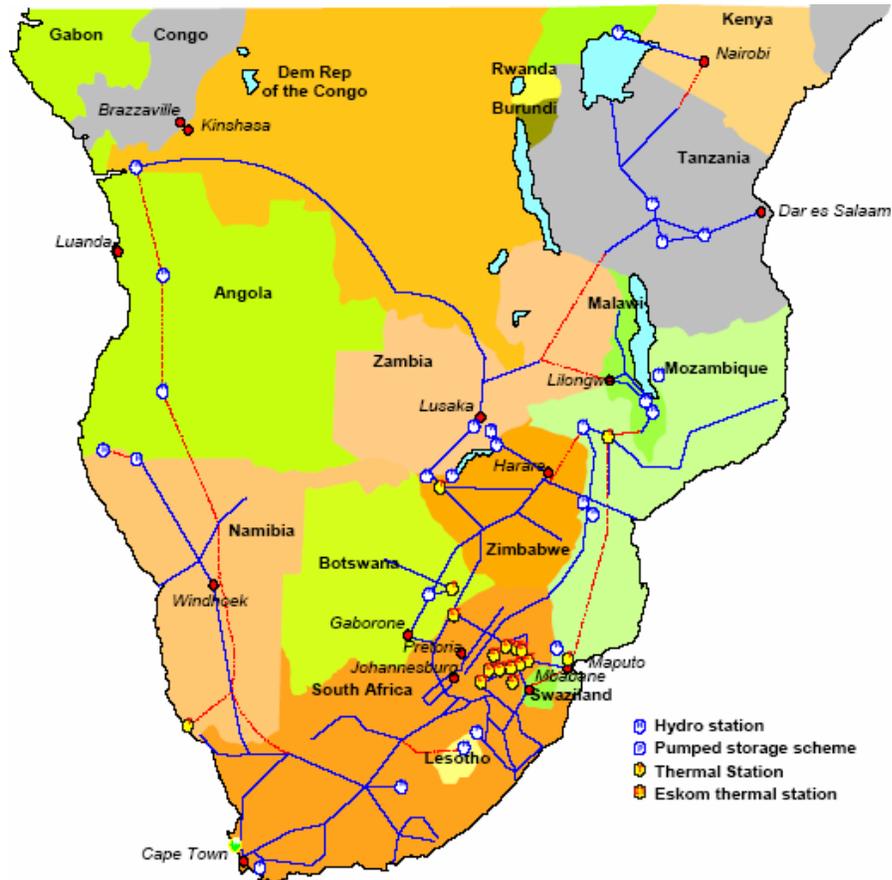
⁸² O'Leary D., Charpentier, J-P and D. Minogue. 1998. "Promoting Regional Power Trade—The Southern African Power Pool". Public Policy for the Private Sector Note 145. World Bank, Washington, D.C.

⁸³ <http://www.sapp.co.zw/>

⁸⁴ United Nations Economic Commission for Africa. 2004. *Assessment of Power-Pooling Arrangements in Africa*. Sustainable Development Division.

the Center is responsible for opening and developing a spot market for electricity in the region and for managing the transformation of the pool from a cooperative to a competitive pool with an open market for electricity.⁸⁵ It monitors the operation of the pool, transactions between its members, time correction procedures, inadvertent power flows, adherence of members to capacity obligations, availability of communications links between the member control centers, and the calculation and implementation of reserves.

Figure 30 Southern African Power Grid



⁸⁵ *ibid*

Box 4 The Benefits of an integrated regional electricity market

Integration of electricity markets can yield significant benefits by:

- exploiting complementarities and comparative advantages in primary energy endowments and thus facilitating more efficient utilization of existing generating resources and giving access to lower-cost supplies;
- reducing supply risks through the provision of multiple links between system loads and cross-country generating resources;
- sharing generation reserve margins among several utilities or countries;
- reducing environmental degradation;
- providing the basis for actual and potential competition, and hence increased efficiency, in national markets that are otherwise too small to permit significant competitive entry;
- exploiting economies of scale through large regional projects; reducing investment requirements through sharing of reserve capacity;
- facilitating benchmarking of costs, managerial efficiency, and operational practices;
- and by advancing domestic policy reform, enhancing credibility, and helping countries overcome policy commitment problems and technical capacity constraints.

Complementarity of Primary Energy Endowments

The Southern African region is endowed with diverse energy resources and the different endowments of these resources among member states of SADC provide a strong rationale for promoting regional electricity trade and ultimately integrating the regional electricity markets.

There is a huge and largely undeveloped hydro capacity in Angola, Mozambique, Tanzania, and especially the DRC. These regional hydro resources include the Inga Reservoir in the DRC, the Cahora-Bassa Reservoir in Mozambique, and the Kariba dam on the border between Zambia and Zimbabwe. It should be noted that less than 3 percent of DRC's potential hydro capacity is actually exploited (table 7)--this hydroelectric power potential is estimated to be as high as 150,000 MW.⁸⁶ The Congo River's huge potential for hydroelectric power could play an important role in providing power for the region.

The South African region has an abundance of coal (over 20 percent of the world's recoverable reserves), primarily located in Botswana, Malawi, Mozambique, South Africa, Swaziland, Tanzania, Zambia and Zimbabwe (table 7). South Africa's recoverable reserves are estimated at 55 billion short tons. Botswana has huge potential reserves of over 210 billion short tons. Its Mmamabula coal mine has the potential to become an important energy source for the entire region. The planned Mmamabula power plant is expected to have between 2,400 and 3,600 megawatt capacity.⁸⁷ Moatize

⁸⁶ Expo Times. 2003. Tapping Africa's Epicentre of Energy-21/02/2003 (www.expotimes.net).

⁸⁷ Namibia Economist. 2006. "Whose Power Comes First?" January 27, 2006.

in northwestern Mozambique is considered to be the largest unexplored coal province in the world with an estimated 2.4 billion tons of reserves. In 2003, regional coal production reached 269 million short tons (Mmst), of which South Africa produced nearly 264 Mmst. South Africa also consumed the majority (97 percent) of the region's coal in 2003.⁸⁸

Table 7 Hydro and coal resources in the Southern African Region

	Large Hydro Potential (MW)		Coal Resources (Mil. Tones)	
	<i>Installed Capacity</i>	<i>Potential Capacity</i>	<i>Proven</i>	<i>Estimated</i>
Angola	980	18,267	n.a.	n.a.
Botswana	n.a.	n.a.	32,112	212,000
DRC	2,416	97,584	n.a.	n.a.
Lesotho	75	3,000	n.a.	n.a.
Malawi	304	900	22	1,000
Mozambique	2,184	6,398	n.a.	3,000
Namibia	240	520	350	n.a.
South Africa	668	n.a.	55,000	n.a.
Swaziland	40	440	208	1,000
Tanzania	630	4,700	304	1,200
Zambia	1,670	6,683	30	1,000
Zimbabwe	750	7,200	11,000	26,625
Total	10,024	145,692	99,026	245,825

Source: Mathangwane (2005).⁸⁹

Natural gas continues to grow in importance and is a resource that exists variously throughout the region. Significant reserves are located in Angola (1 Tcf), DRC (35 Bcf), Mozambique (4.5 Tcf), Namibia (2.2 Tcf), South Africa (1 Bcf) and Tanzania (800 Bcf). Mozambique is likely to become a major producer of gas in the region in the medium term. Its three offshore gas fields Pande, Temane, and Buzi have estimated recoverable reserves in the order of 2.1 Tcf, 1.0 Tcf, and 10Bcf respectively. Actual gas production was limited to an insignificant amount from the Pande field which supplied some local villages.⁹⁰ In 2000, the National Hydrocarbon Company (ENH) of Mozambique and the South African company Sasol Petroleum International signed an agreement on the joint development of the Pande and Temane natural gas fields and on a gas pipeline to transport gas from these fields to the Gauteng area in South Africa. The 865 km pipeline opened in July 2004 and brought South Africa a step closer to diversifying its energy sources.⁹¹ Namibia is another potentially major producer of natural gas. The Kudu gas field is located on the Namibian continental shelf offshore of southern Namibia (170 km from Oranjemund) in a water depth of 170 metres. A gas-in-place of 1.3 trillion cubic feet has been proven to 90% confidence level, which is

⁸⁸ Energy Information Administration. 2005. *The Southern African Development Community*. Country Analysis Brief.

⁸⁹ Mathangwane, F. 2005. "Facilitating Access to Power in SADC and Ensuring the Region's Bright Future". Presented in the Regional Electricity Investment Conference, Windhoek, Namibia.

⁹⁰ Mbendi. 2005. Mozambique: Oil and Gas Industry.

⁹¹ http://www.southafrica.info/doing_business/economy/infrastructure/naturalgas-pipeline.htm

sufficient to operate an 800 MW nominal capacity combined cycle gas turbine (CCGT) power station for a period of 22 years on base load. Probable gas-in-place volumes at a confidence level of 50% are sufficient to operate a 1,600 MW CCGT plant for at least 25 years.

The Scope for Regional Integrated Resource Planning

The scope for regional development and for optimizing the electricity system from a regional perspective is enormous. And the creation of SAPP clearly marked an important step toward realizing the benefits of such regional electricity planning.

South Africa's Eskom--which accounts for over 80 percent of generation in the region--relies heavily on expensive (at least relative to hydro) and polluting thermal power from domestic coal. Trading arrangements between South Africa and the hydro-rich northern countries could be mutually beneficial, providing cheaper electricity for the former and revenue boosting for the latter. Obvious examples for regional cooperation would include: the hydroelectric potential of the DRC, Mozambique, Zambia and Zimbabwe; the Pande, Temane and Kundu fields in Mozambique and Namibia; and the oil industry and hydroelectric potential of Angola.

The magnitude of potential gains from increased regional cooperation and trade is substantial. An important attribute of electricity trade is the improved reliability of supply, particularly when relying on hydro power that is vulnerable to drought. In the case of Zimbabwe, for example, the 1992 draught caused electricity shortages in 1993 that cost the country's economy US\$ 435 in lost export earnings--nearly 10 percent of its GDP.⁹²

A 1993 joint study by SADC and the World Bank estimated that optimal use of regional resources and installations could provide savings of US\$ 1.6 billion over 10 years in comparison with a scenario under which each country would pursue its power development plans separately.⁹³ It should be noted that South Africa, which accounts for the bulk of the power produced in the region, was not included in that study. Thus, the potential gains available now through South Africa's participation in regional planning are likely to be significantly higher.

Recent studies utilizing the optimization model RIEP (Regional Integrated Electricity Planning) developed at the University of Stuttgart quantified the benefits of regional co-operation in Southern Africa to savings of at least US\$2.2 billion or 5 percent of the expected total costs over a period of 20 years. Under a scenario of high electricity demand growth, savings of over US\$ 4 billion could be realized through regional planning. Approximately 40 percent of the estimated savings would result from lower investment costs and 60 percent from lower operating costs. The potential economic and social benefits of co-operation become even larger when environmental factors are

⁹² Robinson, P. 1994. *Economic Integration in Southern Africa*. Volume 2, Chapter 5.

⁹³ World Bank. 1993. Joint UNDP/World Bank, Energy Sector Management Assistance Program (ESMAP). SADC Project AAA3-8, Phase II.

explicitly taken into account in regional planning. Including external costs of US\$ 4 to 15 per ton of CO₂ would lead to changes in investment patterns which in turn would reduce carbon emissions by 22 to 55 percent by the year 2015. Under that scenario, the hydro potential of the northern sub-region would be utilized rather than the new fossil power plant of South Africa.⁹⁴

In 2001, a 20-year generation and transmission expansion plan was completed for the Southern African region. The coordinated plans required the expenditure of \$US 8 billion, while the sum of the individual utility expansion plans required US\$ 11 billion. Thus, a saving of US\$ 3 billion could be realized through regional coordinated planning.⁹⁵

However, despite the substantial potential economic benefits of regional co-operation, and the ambitious policy pronouncements by the national leaders of SADC, the actual electricity trade flows in the region have been fairly modest so far. There are several factors that have inhibited the effective integration of electricity markets and electricity trading in the Southern African region.

Prerequisites for Successful Integration of Electricity Systems

The development of an effective regional electricity market requires:

- Sector unbundling. Both public and private vertically-integrated utilities generally have strong incentives for self-dealing and thus a continuing high degree of vertical integration could hinder the interchange of power and the extent of cross-border competition that could emerge. Some form of unbundling is necessary in order to avoid the possibility, for example, of network constraints being used as an excuse by vertically integrated utilities (with a general tendency for self-preference towards their own generating units) to exclude competitors and effectively erect barriers to the free cross-border flow of electricity.⁹⁶
- High-capacity intersystem tie lines. For the benefits of regional coordination and energy transfers to obtain there is a need for high-capacity transmission links. These intersystem tie lines also contribute to improved regional system stability and reliability.
- Open access to transmission. Every country should have transparent, objective and non-discriminatory rules making its transmission facilities available to regional electricity entities on a “fair and equal basis”. The publication of technical rules for connection, and a clear definition of equal treatment and non-discrimination are crucial. There is also a need for effective dispute resolution

⁹⁴ Graeber, B and D. Spalding-Fecher. 2000. “Regional Integrated Resource Planning and its Role in Regional Electricity Co-operation and Development in South Africa.” *Energy for Sustainable Development* 9 (2): 32-37.

⁹⁵ Musaba, L. 2005. Feedback from SADC Regional Electricity Investment. (www.eepublishers.co.za)

⁹⁶ It should be noted that it is also important to have an independent system operator (ISO) and competitive procurement for new generation.

process to deal with cases of refusal or suspension of access. These requirements should be ideally embedded in SAPP's Grid Code rules.

- Free choice of supplier. Purchases and sales should be non-discriminatory. Any restrictions to regional power transactions should be based only on explicitly agreed-upon quality and safety standards with buyers and sellers paying for the losses and congestion they create in the system.
- Harmonization of regulation and market structures. Disparities of regulatory treatment across borders can introduce distortions that hinder both electricity trade and the aggregate flows of investment to the sector on regional basis. Similarly, market opening and restructuring must have a parallel development (reciprocity) across countries. Otherwise, significant differences in market structures (e.g. in vertical structure and the type of ownership) could hinder cross-border trade. Regulatory harmonization, the elimination of trade-distorting inefficient national regulations, and regulatory cooperation to overcome domestic constraints on regulatory capacity are essential components of regional economic integration.
- Tariff rebalancing. When there are significant cross-subsidies embedded in the structure of tariffs, regional trading that may appear to be economically advantageous may actually be inefficient. Even suppliers with inefficiently high costs may find exporting profitable in reaction to pricing that has the mandate of providing a flow of subsidies.
- Harmonization of administrative procedures. National permissions, concession and approval procedures related to national or cross-border infrastructure should be harmonized. When administrative procedures vary significantly across countries, it is very difficult to assess and implement cross-border projects.

Structural Weaknesses of Bilateral Electricity Exchange in SAPP

Cross-border electricity trade in the Southern African region has been mostly in the form of bilateral agreements between vertically-integrated state-owned utilities, simultaneously performing the three primary functions of generation, transmission and distribution. Inter-utility trading is dominated by Eskom both as an electricity exporter and importer, HCB as an energy exporter, and ZESA as an energy importer (table 8).

Eskom exports power to Botswana (BPC), Mozambique (EDM), Zimbabwe (ZESA), Namibia (NamPower), Lesotho (LEC), Swaziland (SEB) and, since 2002, Zambia. Exports to Mozambique increased substantially since 2000—from 68 GWh in 1999, 1331 GWh in 2000, and 3899 GWh in 2001 to 8076 GWh and 10,108 GWh in 2004 and 2005 respectively (table 9). This was primarily due to electricity supplied to the Mozal Aluminum Smelter in Maputo. Exports to Zimbabwe, on the other hand, have been declining since 1999 because of ZESA's imports from Mozambique's Cahora Bassa Power Plant.

Table 8 Current SAPP bilateral power trading agreements

Exporter	Importer	Agreed Power (MW)
Democratic Rep. of Congo (SNEL)	Zimbabwe (ZESA)	100
	South Africa (Eskom)	110
Zambia (ZESCO)	South Africa (Eskom)	300
South Africa (Eskom)	Zimbabwe (ZESA)	150
	Botswana (BPC)	190
	Namibia (Nampower)	400
	Mozambique (EDM)	159
	Swaziland (SEB)	250
	Lesotho (LEC)	85
Mozambique (HCB)	Zimbabwe (ZESA)	500
Zambia (ZESCO)	Botswana (BPC)	0
ZPC (Hwange Power Station)	Zimbabwe (ZESA)	0

Source: SAPP Coordination Center

Table 9 Eskom's exports to neighboring utilities (GWh, 1995-2005)

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
BPC	340	685	748	689	934	986	1183	1124	1390	1699	2111
EDM	600	596	680	385	68	1331	3899	3907	5875	8076	10108
ZESA	154	2267	2790	1521	1564	788	371	298	793	532	598
Others(*)	1892	2006	2221	1498	1318	767	1257	1627	2115	2647	3191
All	2986	5554	6439	4093	3884	3872	6710	6956	10173	12954	16008

Source: Eskom Annual Report (various years).

(*) Others include NamPower, LEC, SEB, ZESCO, and sales to the Short-term energy market.

Note: Figures for 2005 refer to the 15-month period between January 2004 and March 2005.

The main weakness of the current system of electricity exchange in SAPP is not because it is dominated by long-term bilateral agreements rather than a real-time spot market. It is primarily due to the fact that the bilateral exchanges are undertaken by state-owned, vertically-integrated utilities.

Under-investment, in large part caused by under-pricing has been one of the key explanatory factors for the deteriorating performance of state-owned electricity systems throughout the world. For almost two decades, most of the state-owned utilities in SAPP have not made any new major investments in power generation expansion despite the rise in power demand. This is true of both the hydro-based utilities (which continued to rely on hydropower stations commissioned during the 1950s and 1960s) as well as the region's dominant thermal-based utility, Eskom. As a result, in recent years some of these utilities have been facing major difficulties in fulfilling their contractual obligations for sustainable electricity supply to their importing partners.

The state-owned utilities involved in the bilateral power exchanges continued to plan and execute their capacity expansion on the basis of national sufficiency rather than a regional perspective. Thus, they did not invest in new capacity that was sufficient to both meet the growing domestic demand and their contractual obligations. The generation capacity constraints that resulted in the exporting countries ultimately compromised the reliability and security of regional supply. The inadequacy of regional generating capacity has become more serious with the tightening of the demand/supply balance in South Africa (box 5).

Electricity sector reforms, including increased private sector participation and competitive restructuring (unbundling) could make a significant contribution towards reducing the inadequacy of regional generation capacity. The SAPP member countries are at different albeit mostly early stages of restructuring their electricity systems (table 10). Their utilities are still predominantly vertically integrated and state-owned. Because

Box 5 Koeberg Repairs Put Namibia in Energy Crunch

ESKOM's decision to shut down its Koeberg power plant for maintenance poses a major power threat to Namibia and has steadily pushed up supply costs.

"I don't want to say we are in a crisis, but there's a major challenge facing us," NamPower MD Leake Hangala says.

Namibia could be forced to load-shed in future to deal with the decision to shut down Koeberg.

Already one unit has been out of action since the end of last year and the second unit will shut down next month for repairs.

This means NamPower will have to alternate the areas that will have to go without power during peak hours. Namibia's power demand is about 500 MW.

Source: Business Day (Johannesburg), February 10, 2006.

of their financial, technical, and managerial resources, private entities could have a distinct comparative advantage relative to the monolithic, state-owned (and frequently cash-strapped) utilities in meeting the increasing power demands of the SADC economies. Moreover, the needed rebalancing of the roles of the public and private sectors in the region's electricity systems is hindered by the continuing high degrees of vertical integration of the regional utilities. Private entities will be reluctant to enter and sink substantial amounts of money in the regional electricity markets if the essential electricity facilities (e.g. transmission) are controlled by their competitors in the provision of downstream services. Competitive neutrality and a level-playing-field, important preconditions for entry and private investment, are likely to be violated in the eyes of potential investors when the regional electricity markets are dominated by public utilities that are considered to be too important for the respective national economies and the security of energy supply.

Table 10 Status of power sector reforms in SAPP member countries

SAPP Member Countries												
Power Sector Reform Activities	Angola	Botswana	DRC	Lesotho	Malawi	Mozambique	Namibia	South Africa	Swaziland	Tanzania	Zambia	Zimbabwe
New Legal Framework		IS			IM		IM	IM			IM	IM
Unbundling & IPPs				IS	IS		IP	IP				IP
Private Sector participation							IP	IP			IM	
Third Party Access												
New Regulatory Framework					IM		IM	IM	IS		IM	IP
Reorganising of distribution		IS					IS	IP		IS		IS
Tariff Reform				IS								IS
Utility Commercialisation	AS	AS	AS	AS	AS	AS	IS	IS	IS	IS	IS	IS

Restructuring in SAPP utilities
 Key: IM, Implemented IP, In progress AS, Advanced stage IS, Initial stage

Source: SAPP Annual Report 2004.

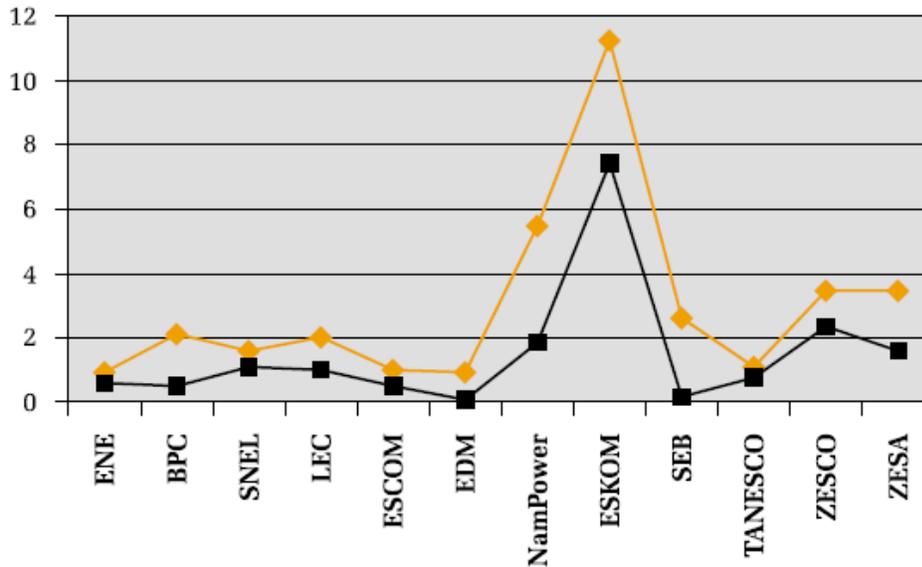
Another structural issue that might have significant implications for introducing competition in SAPP is the extent to which the regional electricity market is dominated by Eskom. In 2005, Eskom accounted for 83 percent of the installed capacity and 85 percent of electricity sales of SAPP member countries (table 11). These levels of dominance raise legitimate concerns about monopolization. Thus decisions about the horizontal and vertical structure of Eskom are like to have profound implications for the future competitive developments in the regional electricity market as well as the progress towards effective regional integration. In South Africa today pressing domestic policy concerns about looming power shortages seem to far outweigh any regionalization initiatives--despite the fact that regional cooperation could be very effective in resolving Eskom's inadequate generation capacity. On the other hand, the smaller countries might tend to view regional integration as a further step towards solidifying Eskom's regional market dominance. Thus neither the large nor the small countries of the region face the proper incentives to accelerate regional electricity integration.

Whenever utilities produce at different costs, it may be economical for them to agree to trade. However, despite the potential gains from electricity trade, the wide differential in performance between Eskom and the other SAPP utilities (figure 31) may exacerbate the fears of market dominance regional monopolization by Eskom.

Table 11 SAPP utility general statistics: April 2005-March 2006

Country	Utility	Installed Capacity	Maximum Demand	MD Growth	Sales	Sales Growth	Number of Customers	Number of Employees	Generation Sent Out	Net Imports	Net Exports	Transmission System losses	Revenue US\$ Million	Debtors Days	Rate of Return	Net Income USD Million
		MW	MW	%	GWh	%			GWh	GWh	GWh	%			%	
Angola	ENE	745	397	9	1,843	12,7	143,937	4,250	2,649	0	0	25	87,94	82	n/a	-18,58
Botswana	BPC	132	434	7,96	2583,7	7,5	152,744	2,091	977	2,006.50	0	10,96	121,8	37,79	-2,35	22
DRC	SNEL	2,442	1012	2,53	4,656	13	360,329	6,268	6,904	0	1,800.00	6,3	149,2	n/a	n/a	n/a
Lesotho	LEC	72	90	0	354	12	46,173	439	446	8	11	20	25,6	57	-0,9	-0,96
Malawi	ESCOM	285	242	6,5	970	4	135,000	2,400	1,177	0	0	19	5,319	110	1	2,218
Mozambique	EDM	233	285	7,1	1,308	11,8	338,597	2,969	147,418	1,501	1,496	5	110,9	64	n/a	n/a
Namibia	NamPower	393	491	6,51	2,976	6,5	3,403	891	1,660	1,703.0	0	8	169	34	0,97	10,4
South Africa	ESKOM	42,011	33,461	-2,2	207,921	0,8	3,758,569	29,697	221,985	8,730	13,107	8,9	5,388	22	8,4	592
Swaziland	SEB	51	172	1	852,8	2,5	48,500	667	103,5	916,8	0	16	59,7	85	4,5	5,1
Tanzania	TANESCO	839	531	4,3	2,549	10,3	550,863	4857	3674	43	0	24	188	92	n/a	n/a
Zambia	ZESCO	1,732	1,330	2,8	8,457	3,1	297,000	3,814	8,884	0	69	3,6	217,6	207	n/a	n/a
Zimbabwe	ZESA	1,975	2,066	-0,1	10,480	3,5	559,766	5,928	9,391	2,666	255,5	12,6	29,463	33	-23	-372

Figure 31 Performance of SAPP utilities



Source: SAPP Annual Report 2006.

V. International Policy Developments

After decades of structural immobility in the electricity industry, governments are allowing market forces to play a role in generation and supply. Structural change accelerated over the past decade and is now a global phenomenon. Although only a handful of countries have achieved substantive market liberalization, almost all have felt considerable domestic and international pressure to reform their electricity systems.⁹⁷

Contentious Issues and Alleged Myths

What advice can we give to a country whose electricity supply industry is still in public ownership, and where there is a genuine public debate about and commitment reform?

The decision to privatize state-owned electricity assets naturally raises a series of questions about the optimal organizational approach to transferring assets to private owners. Should all asset types, whether generation plants, high voltage and distribution networks, be privatized or should private ownership be limited to the sectors where competitive markets can be feasibly implemented? And, if markets are small, should competition be attempted? In the former case, what is the optimal degree of vertical integration between privately-owned generation, transmission and distribution activities, bearing in mind that investments or operational decisions in one market segment can have important consequences for operational efficiency in other segments? Similarly, given the need for investment and real-time operational coordination between, as well as, within geographic regions, what is the optimal level of horizontal fragmentation?

“Optimal” Restructuring Options and Success of Reform

Most of the reform programs in developing economies have sought to promote private ownership and investment, and hence to reduce the dominance of the state-owned vertically integrated enterprise—in the past, the almost universal option for organizing the electricity sector. Although increased private participation was the common denominator, there has been substantial variability in the nature of these reforms. Some countries have invited private investment in the generation sector only, financed by long-term supply contracts to state-owned utilities (e.g. China, India, Indonesia, Mexico); some have vertically separated the industry but only privatized part of the industry (e.g. Colombia, El Salvador, Kazakstan, New Zealand); while others have privatized the entire industry and additionally created competitive generation markets (e.g. Argentina, Chile, U.K.).

The degree of private sector interest, however, has been markedly mixed across countries and regions. There have been some notable successes in attracting significant levels of private investment in all sectors of the industry, (e.g., Argentina, Australia, El

⁹⁷ Kessides, I. 2004. *REFORMING INFRASTRUCTURE--Privatization, Competition, and Regulation*. A copublication of the World Bank and Oxford University Press.

Salvador, the U.K.). On the other hand, private investors have shown little interest in purchasing state-owned enterprises or in financing de novo infrastructure assets in countries such as Mexico, Turkey or the Ukraine, to name but a few. Indeed some countries, including Hungary and Venezuela, have had to postpone planned privatization programs due to lack of investor interest. Thus, in these countries, despite substantial state encouragement, governments have been unable to reverse sustained periods of under-funding in state ownership with large inflows of private capital.

As a consequence of the mixed experiences, and of the variety of alternative approaches undertaken, a debate has emerged on the design of “optimal” restructuring policies. Much of this debate has focused on classic industrial organization issues, such as the optimal degree of vertical integration between transmission, distribution and generation functions, the extent of horizontal fragmentation, the design of competitive generation markets and so on. Although policy-makers and government advisors have paid considerable attention to these and other structural issues in the development of reform programs, there is no sufficient empirical evidence to suggest that one particular structural configuration of a fully or partially privatized electricity industry is more conducive for long-term private investment than another.

The absence of a clear relationship between the structural nature of industry reforms and the success in encouraging private investment is not surprising since an assessment of the regulatory environment is excluded. An important but frequently implicit assumption in the debate on optimal restructuring policies is that the supporting regulatory institutions have a neutral impact on the players’ behavior. In practice, however, the design of the regulatory framework has a critical effect on investor’s incentives to make long-term asset commitments. The empirical pattern that does emerge from a close analysis is that the success of restructuring reforms is associated with the degree to which regulatory regimes provide a credible commitment to asset owners to resolve disputes in an independent manner and to ultimately provide a fair return on their investments.

In spite of the heated debate among advocates of particular reform policies, the experience of various countries suggests that no single organizational structure obviously trumps another. Thus, there is some controversy regarding the “optimal” structural approach. In fact, it is claimed that what Levy and Spiller (1996) call the sector’s “*regulatory governance*” regime is more important for attracting long-term private investment than the specific choice of industrial structure. The proponents of this view argue that the key to successful reforms is first to establish a credible regulatory environment, and only then to ponder on refinements of the chosen organizational structure for the industry.

Vertical Separation and Investment

It is frequently argued that due to large economies of coordination, vertical separation of transmission and generation will lead to inefficient investments.

Transmission networks play a critical role in ensuring a low cost and reliable supply of electricity. In the absence of transmission capacity constraints, electricity generated in one region is able to flow to other regions where local generation supplies are either insufficient to meet demand, for example during peak periods, or else are relatively costly compared to imports. The construction of additional transmission infrastructure can therefore serve as a partial substitute for building extra generation capacity when demand and supply imbalances are uneven across regions. For this reason, vertical integration between transmission and generation functions is sometimes seen as an efficient organizational structure, particularly when the size of the market is small. A vertically integrated owner faces incentives to invest in generation and/or transmission assets in a manner that minimizes combined generation and transmission costs, whereas under separate ownership contracting difficulties may prevent such an outcome, potentially leading to under-investment.

While efficiency rationales have thus led to proposals for vertically integrated, horizontally concentrated industry structures, concerns about the exercise of market power on the other hand have led to opposing recommendations. Difficulties in setting and regulating efficient transmission charges, so it is argued, enable vertically integrated suppliers to devise charging structures that favor their own generation plants over those of competitors in dispatch decisions. By separating the ownership of transmission and generation assets, the incentives for transmission owners to discriminate against particular generation companies are reduced, thereby encouraging efficient entry into the generation sector.

The policy of vertically integrating transmission and generation ownership is therefore no simple panacea for inducing efficient levels of investment electricity markets. Given the conflicting tensions inherent in vertical integration *and* vertical separation policies, the policy challenge is rather to design institutions that satisfactorily balance efficiency and market power concerns.

For the same reasons motivating vertical integration proposals, it has been argued that since efficient investment in national transmission networks also requires coordination *among* operators in various regions, the optimal degree of horizontal fragmentation in transmission should be low. Dynamic concerns again contradict efficiency-driven policy recommendations. Generation companies require access to transmission networks in order to compete effectively against rival generation companies. When transmission is organized as a monopoly franchise, implying that generation companies are not free to invest in their own transmission assets, transmission owners are in a position to “hold up” generators through a variety of means. Monopoly transmission owners have an incentive to extract rents from generation companies by manipulating access to the network; for example, by using uncontracted network upgrades or maintenance schedules as bargaining points. A natural solution to this problem is to remove ownership restrictions in the transmission sector to allow generation firms to invest in their own competing transmission assets, thereby creating an a priori argument for horizontal fragmentation.

Recognizing the plethora of conflicting tensions under private ownership, still others (in particular socialist European governments) have argued that the best policy is in fact to retain transmission networks under public ownership. An important assumption underpinning this proposal is that the government has less incentive to hold-up private generators than a private owner of the transmission network. However, the highly politicized nature of electricity consumption in all countries makes the industry especially susceptible to government control, irrespective of the ownership structure. Indeed, under public transmission ownership, the government may find it easier to hold-up private generation firms since it has direct control over day-to-day managerial decisions than in the private ownership case where the government may have to pressure a regulatory agency to implement its preferred policy. Thus, while public ownership may allay concerns over the exercise of private market power in transmission it also exposes generation firms to greater political hazards.

Economies of scale in generation limit the potential for competition to relatively small markets. In addition to the organization of transmission, governments have several options for reform in the generation sector. Chief among these is the decision to create a competitive wholesale generation market where sellers bid against each other to supply electricity on a continuous basis, with prices determined by a market-making mechanism. Following the lead of Argentina in the 1980s, a number of jurisdictions have made competitive generation markets a central component of privatization and restructuring programs (e.g. Australia, California, Chile, Finland, Norway, Sweden, U.K., Ukraine). Although the introduction of wholesale markets is generally perceived as being a desirable policy goal, questions have been raised about the feasibility of implementing similar reforms in smaller countries where, it is argued, only a small number of generation companies can be supported, leading to an oligopolistic situation (see Table 2). Competitive markets have been established, however, in several small countries where installed capacity is a small fraction of that in larger wholesale markets, such as Bolivia, El Salvador and Guatemala.⁹⁸ Similarly, there have been disastrous results in some large countries; in the Ukraine, for instance, repeated attempts by the government and international aid agencies to breathe life into the spot generation market have failed since 1996, and most generation trades are now arranged on an ad hoc bilateral basis among generators and distributors or final consumers.⁹⁹ Legal uncertainties about the status of contracts and private property in the Ukraine, as well as strong concerns over bureaucratic corruption,¹⁰⁰ have undermined the incentives for entrants to invest in new, more efficient generation capacity, to write long-term contracts and to engage in the spot market. The experience of the Ukraine suggests that, rather than market size, the main constraint on the feasibility of wholesale markets to operate is the ability of new generation companies to enter the market, access transmission resources on a non-discriminatory basis and enter into enforceable contracts with new or existing buyers .

Comment [pts1]: what's geographic size

⁹⁸ For further analysis of this particular issue, see Spiller, 1999.

⁹⁹ *Power Economics*, September 30, 1998; *East European Energy Report*, October 25, 1996 and August 1, 1997; *Utility Week*, June 1, 1998; *International Private Power Quarterly*, Fourth-Quarter 1998.

¹⁰⁰ *The Electricity Daily*, May 10, 1999.

Large economies of scale in distribution imply that too much fragmentation of distribution facilities will lead to high distribution costs.

Within the distribution sector, perceptions about the degree of scale economies have also led to prescriptions for the optimal level of geographic fragmentation for inducing private sector investment. A common concern is that while horizontal fragmentation of the distribution sector creates regulatory benefits – in that a larger number of companies facilitates “yardstick” regulation – it may also increase distribution costs and encourage inefficient investment decisions if economies of scale are ignored. For this reason, low levels of fragmentation are frequently prescribed in reform programs.

The hypothesized relationship between geographic fragmentation and distribution costs and investment is questionable, however, on several grounds. First, economies of scale in distribution are driven by the *density* of customers, implying that optimal geographic footprints can be very small, and that the degree of fragmentation can be quite large. Thus, in Norway, distribution activities are divided among more than 240 firms and in New Zealand among more than 40. Secondly, the ability to induce efficient levels of distribution investment depends on private sector expectations about future regulated rates of return and the possibility that once assets have been put in place attempts will be made by political actions to expropriate their rent streams.

Sequencing strategies

One of the first questions to address is whether there is a logical sequence of reforms, and whether it is costly to undertake reforms in the wrong order. It is a good principle that any reform addresses the most important problems first, and that the early reforms should if possible create a momentum for future desirable reforms, while minimizing the risks of failure and policy reversal. Reversible and less risky reforms can be undertaken more readily than irreversible (or costly to reverse) and more risky reforms. Some irreversible reforms may be necessary to commit the country to future desirable changes, and privatization is often argued to be one such reform. Nevertheless, the principle that irreversible reforms require more careful design and assessment than reversible reforms holds good.

There is growing evidence on what constitute robust, self-sustaining and desirable reform strategies, and what strategies are risky and may lead to undesirable outcomes. Privatization itself is only reversible at high external cost (loss of reputation for foreign investment). Imperfectly designed privatization can complicate subsequent reforms. Similarly, it is often hard or costly to reverse structural choices, such as the degree of vertical and horizontal integration.

VI. Recent Electricity Reforms in South Africa

The electricity sector in South Africa has undergone a number of important policy reforms in recent years. There are several factors that contributed to these policy changes. Before 1994, the main goal of public policy in the sector was to secure adequate and low-priced electricity supply for the industrial, mining, agricultural, transportation, and commercial sectors, as well as for mid- and high-income households. Energy policy was based on the principle of “separate development” and was fundamentally oriented to providing services on the basis of race. No national policy existed to promote wider electricity access despite the extensive over-investment in generating capacity. The government that came to power after the first democratic elections in 1994 was determined to redress the injustices of apartheid and to substantially expand access to electricity services by poor black urban and rural households. An indispensable precondition to the government’s accelerated electrification program was the reorganization of the highly fragmented local government structure that was part of apartheid’s legacy. Most of these local governments suffered from severe financing problems that greatly limited their ability to maintain and expand services. As a result there was a huge backlog in electricity connections to households in black areas.¹⁰¹

While important political changes were taking place in South Africa in the early- and mid-1990s, abundant evidence was emerging at the same time from many developing countries that the state-owned enterprises in core sectors of their economies, like infrastructure, were suffering from serious performance problems¹⁰². An important element of the new government’s economic agenda was the adoption of policies that sought to reorganize and reform the country’s state-owned enterprises in order to improve their efficiency and performance. It was widely accepted that Eskom was better managed and exhibited superior performance in comparison to other state-owned enterprises. Still, the government’s broad efforts aimed at reforming the state-owned enterprises provided the needed impetus for power sector reforms.

Another reform driver emerged from the government’s comprehensive reassessment of its energy policy during the mid- to late-1990s. The analysis that supported the formulation of the new energy policy highlighted the importance of avoiding Eskom’s past mistakes related to its excessive investment in generating capacity. This naturally focused attention on the potentially important relationship

¹⁰¹ ESMAP 2005. *Power Sector Reform in Africa: Assessing Impacts on Poor People*. Report 305/05. The World Bank.

¹⁰² State-owned entities were forced to pursue multiple, poorly-defined and conflicting objectives. They were frequently used as instruments of stabilization policy through price controls and investment targets. Their management was often appointed on the basis of political loyalty rather than professionalism and their employment and investment patterns reflected bureaucratic preferences rather than market demand and supply conditions. Scarce public investment funds allocated to the infrastructure sectors were in many cases squandered through policies reflecting political expediency and other short-run objectives rather than careful long-run planning in the public interest. Moreover, price controls were imposed in disregard of their performance implications, subjecting the operating entities to considerable financial distress and substantially impairing their ability to provide reliable service.

between market structure and investment efficiency and raised doubts as to whether Eskom should be entrusted with the planning and undertaking of all future generating capacity expansion.

The White Paper on Energy

The White Paper was written so as to clarify government policy regarding the supply and consumption of energy. The policy sought to strengthen existing energy systems in certain areas, called for the development of underdeveloped systems and demonstrated a resolve to bring about extensive change in a number of areas. It addressed international trade and co-operation, capacity building, and the collection of adequate information. The document was comprehensive, addressing all elements of the energy sector.

The process leading to the formulation of the White Paper entailed extensive and transparent consultations that consisted of the following steps:

- the release of an Energy Policy Discussion Document to interested parties for study and written comment;
- a workshop with the Parliamentary Portfolio Committee on Mineral and Energy Affairs;
- ad hoc briefing sessions for major stakeholder groups in the energy sector;
- an open workshop on the small-scale use of energy, mainly for households, where interested persons and representatives from local communities, both urban and rural, participated;
- a workshop on energy governance and the process of energy policy formulation, to which senior representatives of the energy industry, large and small energy consumer groups and government departments at national and provincial level, were invited;
- an open National Energy Policy Summit at which the various policy options were debated in detail.

The National Energy Policy Summit led to a consensus on energy sector goals. A draft paper was prepared in June 1996 but it became public only in July 1998 because of administrative and political reasons. After public hearings that were held under the auspices of the Parliamentary Portfolio Committee, the final paper was published at the end of 1998.

The policy options identified in the White Paper indicated the potential to move boldly from the status quo to a new, clear vision and policy framework for the energy sector in South Africa. Gone were the exclusive concerns of fuel security and self-sufficiency held by an apartheid government beleaguered with international sanctions. The advent of democratic government and the re-acceptance of South Africa by the international community offered the opportunity for a radical shift in energy policy. Energy policy was to align itself with the new social and economic policies of the Government of National Unity aimed at reconstruction and development. In addition it

was taking into account important international trends which were placing greater emphasis on competitiveness, efficiency and environmental sustainability.

The White Paper emphasized the following policy objectives:

- increasing access to affordable energy services;
- improving energy governance—clarification of the relative roles and functions of various energy institutions within the context of accountability, transparency and inclusive membership, particularly participation by the previously disadvantaged;
- stimulating economic development—encouragement of competition within energy markets;
- managing energy-related environmental and health effects—promotion of access to basic energy services for poor households while reducing negative health impacts arising from energy activities;
- securing supply through diversity—increased opportunities for energy trade, particularly within the Southern African region, and diversity of both supply sources and primary energy carriers.¹⁰³

Restructuring the Electricity Distribution System

The organizational architecture of the electricity distribution industry (EDI) was the subject of considerable debate for several years in numerous studies, a stakeholder forum, and government committees, including the National Electricity Forum (NELF), the Electricity Working Group (EWG), and the Electricity Restructuring Interdepartmental Committee (ERIC). The task for developing the government's position on the issue was given to ERIC which completed its report in 1996. On the basis of the ERIC Report, the Department of Minerals and Energy (DME) submitted a memorandum to the Cabinet in 1997 that recommended:

- the electricity distribution industry should be consolidated into the maximum number of financially viable and independent regional electricity distributors;
- cost-reflective tariffs, an electrification levy, and a capped tax for the funding of municipal service should be introduced.

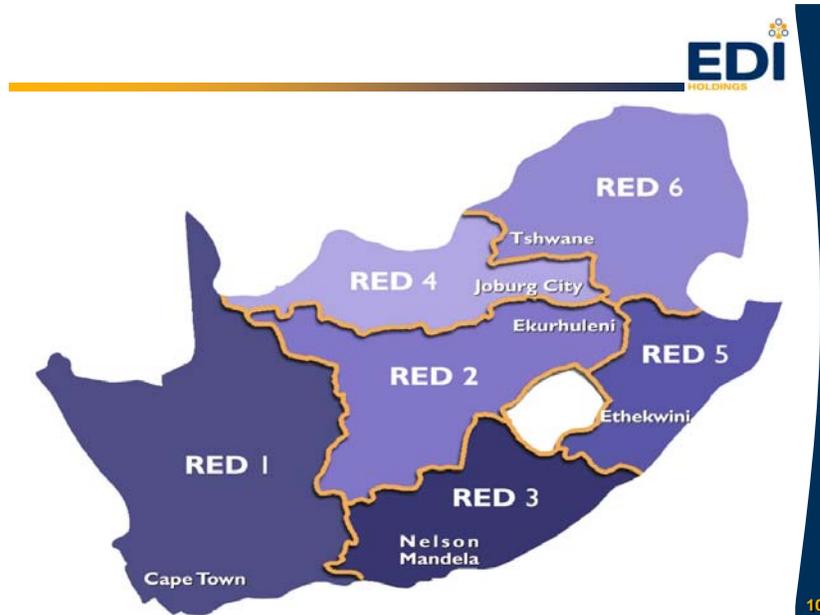
In June 1999 the cabinet agreed to rationalize the distribution businesses of municipalities and Eskom into six Regional Electricity Distributors (REDs--figure 32. The Cabinet also decreed the creation of the Electricity Distribution Industry Restructuring Committee (EDIRC) to oversee the transformation of EDI.¹⁰⁴ And it appointed Price WarehouseCoopers (PwC) as technical advisors. The Government made a serious effort to engage all key stakeholders in the process. For this, PwC organized several workshops. EDIRC produced a Blueprint for EDI Reform. In January 2001, the Cabinet adopted EDIRC's recommendation to rationalize the EDI into six REDs. In

¹⁰³ University of Cape Town (2004), *ibid*.

¹⁰⁴ EDIRC comprised of various relevant government departments, local government, Eskom, and the NER.

March 2003, EDI Holdings (Pty) Ltd was incorporated with a sole purpose of executing the government's strategic objectives of restructuring the EDI as per the recommendations of the Blueprint for EDI Reform (2001).

Figure 32 RED boundaries with anchor metros



A large number of municipalities have been deriving significant surplus income from their municipal electricity undertakings. Naturally, these local authorities have been ambivalent or outright hostile to the restructuring of EDI because it would imply the loss of an important source of their revenue. Similarly, the country's political forces have been divided on the issue. The country's political leadership has for a long time recognized the urgency and importance of resolving the problems of electricity distribution. However, those involved at the local government level have been less than enthusiastic about EDI restructuring because of they feared that it would diminish their influence.

As a result, progress towards transforming the fragmented electricity distribution businesses into six financially viable and sustainable REDs has been painfully slow. During the year 2004/5, the EDI restructuring process entered a qualitatively new and important stage when President Thabo Mbeki announced in his State of the Nation Address on 21st May 2004, that: "The first Regional Electricity Distributor will be ready to operate by June 2005 and the whole process of the establishment of these structures will be completed by January 2007." The President's statement signified the government's commitment to pursue the EDI restructuring process, and perhaps even

more importantly, to accelerate it such that it meets the government's socio-economic development imperatives as well as its program of action.¹⁰⁵

The first RED was indeed established in 2005, but only on paper. The restructuring of EDI is still very much work in progress.

The National Electricity Regulator (NER)

The NER was established on April 1, 1995 as the successor to the Electricity Control Board. It derived its statutory authority from the Electricity Act of 1987 as amended by the Electricity Amendment Acts of 1994 and 1995. The NER issued licenses and regulated all aspects of generation, transmission, distribution, and retail electricity activities in South Africa. Its key functions included:

- issuance of licenses for generation, transmission, distribution and retail of electricity;
- determination of electricity prices;
- settling disputes; advising the Minister of Minerals and Energy on matters pertaining to the electricity supply industry.

NER's consisted of a part-time Board whose membership included a chairperson, a Chief Executive Officer (CEO) and seven other members. Its board members were appointed by the Minister of Minerals and Energy but once appointed they were to act independently and report to Parliament.

The NER was recently succeeded by the National Energy Regulator (NERSA), the regulatory authority established in terms of the National Energy Regulator Act, 2004 (Act No. 40 of 2004) with the mandate to undertake the functions of the Gas Regulator as set out in the Gas Act of 2001, the Petroleum Pipelines Regulatory Authority as set out in the Petroleum Pipelines Act of 2003 and the National Electricity Regulator as set out in the Electricity Act of 1987 as amended.

¹⁰⁵ www.ediholdings.co.za

VII. An Agenda for Policy Action

A fundamental tenet of this report is that the role of government in relation to market behavior in the electricity industry should be explicitly based on the underlying economic characteristics of the industry, the technological conditions of its production, and the nature of market demands for the industry's products.

The Case for Radical Electricity Restructuring in South Africa Does Not Appear to Be Very Compelling...

In most developing countries the primary push for electricity (and more broadly infrastructure) privatization came from the debt and fiscal crises of the early 1980s. Another major impetus came from the extraordinarily weak performance of the electricity sector in these countries relative to the advanced industrial countries. Similar reasons motivated reforms in transition economies starting in the early 1990s. Heavy debt burdens forced many countries to make fiscal adjustments that hit public investment in infrastructure, including electricity, especially hard.

Privatization was also spurred by the intolerable damage caused by mismanagement of public electric utilities. Most such entities pursued multiple, poorly defined, conflicting objectives, with managers often appointed based on their political loyalty, not competence. Investment funds were frequently squandered on poor projects. Moreover, price controls were imposed without regard for their performance implications, subjecting enterprises to financial distress and impairing their ability to mobilize investments and provide reliable services. Electricity blackouts became one of the defining characteristics of developing countries.

In a globalized economy, poorly performing state-owned electricity systems were increasingly seen as constraining economic growth and undermining international competitiveness. Developing countries simply could not continue to absorb the fiscal burden of these systems. Around the world, it became evident to policymakers that the problems of public electricity systems could be solved only by implementing radical structural changes and realigning the roles of the government and the private sector.

The factors that prompted electricity restructuring and privatization reforms in developing countries are not nearly as powerful in the context of South Africa. Eskom is a well-functioning utility even by advanced industrial country standards. It has managed to fulfill its developmental obligations by delivering a highly successful electrification programs while at the same time charging some of the lowest tariffs in the world and maintaining very good operational and financial performance. Moreover, Eskom has been entirely self-financed through internal reserves and debt raised on the domestic and international capital markets without government guarantees. Thus, unlike many other state-owned utilities it has not been draining the state budget nor has it caused the diversion of scarce public resources from other social purposes. Finally, the South

African economy did not face the macroeconomic instability, external sovereign debt problems, and forced adjustments that provided the initial impetus for privatization in the developing countries.

However, even within South Africa's moderately well-run electricity system several problems have emerged which, if not addressed adequately, could pose a serious threat to the system's future viability and sustainability.

...Yet, Continuing Inefficiencies in the Distribution Segment Can Seriously Undermine System Security and Reliability

During the past decade, numerous studies [e.g. the analysis of boundaries, ownership, asset valuation, regulation, and human resources of the distribution industry undertaken by a consortium led by Price WaterhouseCoopers (PwC)] and consultations [e.g. the, and the Electricity Distribution Industry Restructuring Committee (EDRIC)] led to a growing consensus that the problems in the electricity distribution industry needed urgent attention. High levels of nonpayment for services, insufficient asset management strategies and levels of recapitalization, and a lack of appropriate technical resources at the municipal level have contributed to an alarming deterioration in the condition of distribution assets. A number of surveys conducted by the NER revealed a growing dissatisfaction of customers with their electricity service mainly due to a worsening reliability and availability of supply. There have also been growing complaints about the lack proper customer attention on the part of municipal distributors.

One of the key structural deficiencies of the distribution industry has been excessive fragmentation—there were too many small, non-viable, poorly-run municipal distributors. After several years of studies and consultations, the Cabinet finally approved in June 1999 a plan to merge the large number of municipal distributors and Eskom's distribution businesses into six Regional Distribution Companies (REDs). However, implementation has been painfully slow and convoluted. The first RED was established only in 2005 and only on paper.¹⁰⁶ Moreover, recent draft Cabinet memos and interventions by National Treasury officials have created some uncertainty and confusion about the consolidation model that will ultimately be implemented.

The continuing uncertainty regarding the status of the distribution industry is likely to exacerbate the problems of inadequate investment in and deterioration of system reliability.

The original consolidation plan, if successfully implemented, will correct the past failure of small municipal distributors to capture economies of scale, skill and specialization; and reduce the substantial differences in the financial status of municipal distributors and the wide disparity in the prices paid by geographically segmented customer groups. However, unfavorable microeconomic conditions were not the only

¹⁰⁶ Eberhard, A. 2005. "From State to Market and Back Again: South Africa's Power Sector Reforms". *Economic and Political Weekly*: 5309-17.

cause of municipal distributors' problems. Governance, nonpayment, and the municipalities' traditional dependence on electricity revenue to fund other municipal services were also important contributing factors. The merger and consolidation of municipal distributors is unlikely to adequately, if at all, address these governance problems. To the extent that governance problems at the municipal level and the performance of local economies were major factors, a more promising direction for restructuring and reform would be to remove distribution from direct municipal control.

International experience seems to indicate that an effective way to start and sustain revenue collection discipline, pricing and other related reforms critical to the viability of electricity distribution is to separate the distribution monopoly from the rest of the industry, privatize it, and subject it to price or revenue cap regulation. A careful assessment of the applicability of this experience would clearly require taking into account contextual country-specific differences in terms of national priorities and development plans, socioeconomic characteristics, historical perspectives that relate to the manner in which the electricity sectors evolved and currently operate, and the role of institutions and their networks. Still, it is the view of this report that the government's decision to retain the distribution industry under municipal ownership needs to be reexamined.

...And Eskom's Extreme Market Dominance Is Cause for Concern

Historically the electricity industry has had a monolithic structure, with a single entity owning generation and transmission capacity and performing all system operations and administrative functions. Due to technological and other fundamental economic changes, the conditions that generated this model no longer exist in most countries. Indeed, in the last few years, there has been an increasing recognition that the electricity industry is not monolithic industries but rather encompasses a number of distinct activities with entirely different economic characteristics. Electricity is a vertical industry characterized by transportation (a hierarchy of transmission links) and distribution networks linking upstream production with downstream consumption. These networks entail substantial fixed costs that are largely sunk because the assets are of minimal value for other purposes. The sunkness of transmission and distribution infrastructure mitigates against freedom of entry, especially since there are natural monopoly conditions as well due to massive fixed costs.

The monolithic, vertically-integrated and state-owned electricity option is largely a strawman from today's perspective—i.e. no one would deliberately choose it for the public interest.

The cost conditions relating to upstream generation and downstream supply activities are less inimical to competition. Although there are important economies of scale and inevitably some sunk costs associated with these activities, they are small in relation to those encountered in the transmission and distribution infrastructure.

Therefore, there is no question that substantial competition could emerge in many activities in the electricity sector if it was properly reorganized. As a result, governments throughout the world have taken substantive steps to restructure and deregulate their electricity industries to the fullest extent that is consistent with technological opportunities and other elements of efficiency. The objectives for such restructuring and regulatory reform programs have properly included injection of more innovative and efficient management, cost-reducing competition and increased efficiency with which the sector meets users' demands, and more responsiveness to the needs of consumers and national enterprises.

In view of the sector's substantial investment requirements, it is imperative that the South African authorities reassess their historic policies toward competition and market structure in the electricity industry. Especially because of the tightening demand/supply balance and the inadequacy of investment for the maintenance of distribution networks (with consequent security and reliability of supply problems) there is an urgent need consider rebalancing the roles of the private and public sectors in this vital industry of the South African economy. Private sector participation could have a beneficial impact in several areas. It could: provide superior financial, technical and managerial resources; bring greater clarity and transparency to the industry; force the de-politicization of tariffs; and encourage a procurement environment based on competition and cost-effectiveness.

Eskom's extreme vertical and horizontal market dominance, and especially its control of the industry's bottleneck facilities, is a primary impediment to the future competitive developments in the sector. The integrated utility will have strong incentives and ability to make it very difficult for other entities to participate in South Africa's electricity business. Private entities will simply be reluctant to enter into the electricity industry and make substantial sunk investments if the industry's essential facilities are controlled by Eskom—a likely competitor in the downstream provision of electricity services to final users.

Eskom's continued vertical and horizontal market dominance may also inhibit the integration of electricity markets in SADC. The other countries of the region may consider Eskom's large size as posing too serious of a threat to the survival of their smaller national utilities. Thus, integration may be viewed as likely to facilitate Eskom's dominance and monopolization of the region's electricity markets. Also, as a vertically-integrated utility, Eskom will generally have strong incentives for self-dealing and self-preference (e.g. for its own generating stations) and thus could hinder the interchange of power and the extent of cross-border competition that could emerge.

Effective Regulation Is Likely to Prove Challenging

Initially NER faced the typical problems confronting newly established regulatory agencies in developing and transition economies that had no prior experience with regulation. These problems included technical capacity and resource constraints; accountability and transparency; methodological challenges in areas of substantive regulatory determinations, such as the setting of tariffs. However, NER's legal mandate

was fairly clear and over time it managed to achieve a reasonable degree of autonomy and independence, and develop good technical capacity. Thus, it ultimately became one of the most capable independent regulatory institutions in Africa.

The new Electricity Regulation Bill that was introduced into Parliament in August 2005 could undermine the coherence and independence of the sector's regulatory structure. Chapter IV of the Bill, if enacted, will take away the statutory authority to regulate prices from the National Energy Regulator (NER) and place it in the hands of the municipalities which would exercise that authority under the guidance of the Minister of Minerals and Energy. Regulatory responsibilities that must be coherently and delicately harmonized should be kept within a single agency and not be counterproductively splintered. The Bill's proposed demarcation of responsibilities between the Ministry of Minerals and Energy, the municipalities, and NER (which would be charged with monitoring and regulating the performance and compliance of the municipalities to the requirements of the Act), is confusing and will likely undermine regulatory clarity—the provisions for NER's monitoring function are too complex. Moreover, to ensure regulatory stability, an indispensable precondition for attracting private investment, it is imperative to mitigate political intrusion on the sector's tariff policies. In the face of the sector's substantial requirements for new generating capacity, any rational tariff policy will have to be increasingly based on forward looking economic costs—i.e. the reliance on historical book values of generating and other assets which facilitated the low prices of the last two decades will inevitably come to end. Thus, the realignment of prices with underlying long-term costs (that are based on forward looking incremental costs and not just historical book values) is rapidly becoming necessary—both for the financial viability of the sector and for the public interest. Effective regulation requires independence of the regulators from political influences--the posture of the regulatory agency must be one of an impartial, objective, non-political enforcer of policies set forth in the controlling statutes, free of transitory political influences. Thus, the proposed role of the Ministry of Minerals and Energy in the regulatory arena will inevitably increase regulatory risk, especially as perceived by potential private investors. And the combination of regulatory and operational functions on the part of the municipalities will clearly conflict with the creation of a "level playing field" in the sector. Also, some of the municipalities might lack the technical expertise to carry out their regulatory functions. Thus the Bill's proposed statutory framework will lead to capacity problems.

South Africa Must Choose among Imperfect Options

It is the view of this report that there is no universally appropriate model for restructuring the electricity sector. And the fact that state ownership is flawed does not mean that privatization is appropriate for all countries and all activities within the electricity sector. Before state ownership is supplanted by another institutional setup in South Africa, it is essential to assess the properties and requirements of the proposed alternative—taking into account the sector's features (its underlying economic attributes and the technological conditions of its production) and the country's economic, institutional, social, and political characteristics.

In electricity, wholesale competition has worked well in industrial countries because of excess capacity, moderate demand growth, and the availability of natural gas (which enabled the entry of gas-fired plants at modest scale and relatively low cost). In contrast, the South African electricity market is beginning to face a very tight demand/supply balance, and periodic blackouts. Thus electricity restructuring and privatization are likely to prove more challenging and dependent on administrative ability. California's experience has shown that market liberalization under conditions of tight demand (reserve margins below 10 percent) can lead to high and volatile prices that would be politically unacceptable and would likely derail attempts at radical reform. Unbundling introduces price risks between generators and suppliers that require contracts and hedging instruments to guard against unanticipated events that dramatically affect spot prices. And in interconnected systems operating under a variety of jurisdictions, spare capacity is a public good that may not be adequately supplied unless pricing policies are put in place to ensure its adequate remuneration.

Given the unique economic characteristics of the electricity industry—especially the need for coordination between generation and transmission, and the difficulty of replicating vertical relationships with market mechanisms—Eskom's vertically integrated structure has some appeal. In theory the integrated company could minimize the cost of meeting demand at each point in time through optimal dispatch of its power stations, taking into account system-wide transmission constraints and losses. In the long run it could exploit the investment relationships between generation and transmission and undertake investments based on system-wide planning.

But these benefits will likely be small relative to those that come from promoting competition in generation: lower construction and operating costs, incentives to close inefficient plants, and better pricing. Recent technological advances have dramatically altered the cost structure of electricity generation that ultimately rendered this segment of the industry structurally competitive or contestable. Moreover, the size of the electricity market in South Africa is sufficiently large to permit many generation companies to function, and to provide both active and potential competition to each other.