# MIR

Management Programme in Infrastructure Reform & Regulation

# South Africa's Electrification Programme
## an overview and assessment

Andrew Marquard, Bernard Bekker, Anton Eberhard, and Trevor Gaunt

Working paper
December 2007

Graduate School of Business
University of Cape Town
Breakwater Campus
Private Bag
Rondebosch 7701
Cape Town
South Africa
www.gsb.uct.ac.za/mir

## DEDICATION

This paper is dedicated to the memory of Charles Dingley who died on Christmas Day 2004. Charles was an academic at the University of Cape Town and played a seminal role in the birth of the South African electricity programme that has brought light and power to so many poor urban and rural households. In 1987 he presented a provocative paper to the annual conference of the South African Institute of Electrical Engineers highlighting the need to electrify underdeveloped areas of South Africa. And in 1990 he published his visionary paper: "Electricity for all in South Africa: the need and the means", demonstrating that a massive national electrification effort was imperative and possible. His work was influential in shaping the policy proposals developed for the ANC by researchers at the Energy and Development Research Centre which led to the setting of ambitious targets for the Reconstruction and Development Programme, probably the most successful of all the new government's social and infrastructure delivery programmes. Charles's work did much to shift paradigms and policy and planning perspectives, heralding a most rapid and impressive electrification effort.

## AUTHOR BIOGRAPHIES

*Andrew Marquard*
Energy Research Centre
University of Cape Town
Tel: + 27 21 650 3230
Email: Andrew.Marquard@uct.ac.za
Andrew Marquard has recently completed a PhD on the History of Energy Policy in South Africa and a Post Doctoral Fellowship at the Management Programme in Infrastructure Reform and Regulation at the Graduate School of Business at the University of Cape Town. He is currently a researcher at the Energy Research Centre.

*Anton Eberhard*
Director Management Programme in Infrastructure Reform and Regulation
Graduate School of Business
University of Cape Town
Tel: + 27 21 406 1361
Fax: + 27 21 406 1070
Email: eberhard@gsb.uct.ac.za
Professor Anton Eberhard directs the Management Programme in Infrastructure Reform and Regulation at the University of Cape Town's Graduate School of Business. He is a former Board Member of the National Electricity Regulator of South Africa. His research

and teaching focuses on the restructuring and regulation of the electricity sector and linkages to sustainable development issues such as widened access to services, and investments in renewable energy and energy efficiency. He has worked in the energy sector for more than 20 years and was the founding Director of the Energy and Development Research Centre. Professor Eberhard has a PhD from the University of Edinburgh.

*Trevor Gaunt*
Department of Electrical Engineering
University of Cape Town
Tel: +27-21-6502810
Email: ct.gaunt@uct.ac.za
Trevor Gaunt is a Professor at the University of Cape Town. He is an electrical engineer with over 30 years of experience with an equipment manufacturer, electricity utility, consulting engineer, and now in teaching and research. He specialises in power delivery system planning and design, including technology, and development and organisation planning.

*Bernard Bekker*
Department of Electrical Engineering
University of Cape Town
Tel: +27-21-6502810
Email: bbekker@mail.com
Bernard Bekker completed a M.Sc.Eng in electrical engineering in 2004 at the University of Stellenbosch. He is a doctoral candidate at the University of Cape Town, researching decision-making within the context of renewable energy-based rural electrification projects in Southern Africa.

# Table of Contents

# List of Acronyms

| | |
|---|---|
| **ANC** | African National Congress |
| **ABC** | Arial Bundled Conductors |
| **BEE** | Black Economic Empowerment |
| **BLAs** | Black Local Authorities |
| **BWO** | Black Women Organisations |
| **DME** | Department of Minerals and Energy |
| **DMEA** | Department of Minerals and Energy Affairs |
| **DPLG** | Department of Provincial and Local Government |
| **EDRC** | Energy and Development Research Centre |
| **ERC** | Energy Research Centre |
| **Escom** | Electricity Supply Commission |
| **ESI** | electricity supply industry |
| **GHS** | July General Household Survey |
| **GIS** | Geographical Information System |
| **HDI** | UNDP's Human Development Index |
| **IDPs** | Integrated Development Plans |
| **INEP** | Integrated National Electrification Programme |
| **IT** | Information technology |
| **MTEF** | Medium Term Expenditure Framework |
| **MU** | National Electrification Programme Management Unit |
| **NEAC** | National Electrification Advisory Council |
| **NEC** | National Energy Council |

| | |
|---|---|
| **NECC** | National Electrification Co-ordinating Committee |
| **NEF** | National Electrification Fund |
| **NELF** | National Electrification Forum |
| **NEP** | National Electrification Programme |
| **NER** | National Electricity Regulator |
| **OHS** | October Household Survey |
| **PPI** | Producer Price Index |
| **RDP** | Restructuring and Development Programme |
| **REDs** | Regional Electricity Distributors |
| **SHS** | Solar Home System |
| **SMME** | Small and medium enterprises |
| **Stats SA** | Statistics South Africa |
| **SWER** | Single Wire Earth Return |
| **UAP** | Universal Access Plan |

# 1 Introduction

South Africa's electrification programme is remarkable by most measures. Prior to 1990, less than a third of the population had access to electricity. By the end of the decade that proportion had doubled. This paper documents the programme, which had its roots in the late 1980s, was in full swing by 1994, and continues currently with the stated aim of achieving access for all households to electricity by 2012[1]. In addition, the paper will reflect critically on key aspects of the programme, including planning, financing and technical innovation as well as social and economic impacts.

## 1.1 A brief overview of the electrification programme

The watershed event, which provided the impetus for all the policy and institutional shifts underpinning the electrification programme, was the demise of apartheid and the election of a post-apartheid government in 1994. Apartheid policies left two key legacies: first, a history of racially determined differentiation in infrastructure provision, and second, a stark contrast between rich and poor, which was largely racially defined. The UNDP's Human Development Index (HDI) for South Africa in 1988 indicated that South Africa had a considerably lower HDI than similar-income countries, and the index disaggregated for race indicated that while white South Africans ranked above average by comparison to industrialised countries, black South Africans ranked with low-income developing countries [Stats SA 2000:101]; the poorest 20% of the South African population between 1987-1994 ranked 33% lower than the developing country average, and markedly lower than the same segment in middle-income developing countries with similar average incomes to South Africa [Stats SA 2000:103].

This significant disparity in income was matched by disparities in access to basic services and infrastructure: the 1996 census, the first census in South Africa which surveyed the whole population, indicated only 58% of the country's population lived in formal housing, around 60% had access to piped drinking water, 58% had access to electricity, and only one in four non-urban black South African households was electrified, as opposed to 97% of non-urban white households [Stats SA 2000:90]. At the beginning of the electrification programme, the situation was much worse: by comparison to countries with similar income levels (Argentina – 88%, Venezuela – 86%, Costa Rica – 85%, Thailand – 75%, Brazil – 65%), the estimated proportion of households with access to electricity 1990 in South Africa was a very low 35% [Eberhard & Van Horen 1995:48]. In 1990 South Africa possessed an extremely energy-intensive economy, a world-class electricity supply industry in the form of the state utility Eskom, and a 55% reserve

[1] This aim is referred to as 'Universal Access', and was stated as a policy goal for 2012 by President Mbeki in 2004 in his State of the Nation address; however, what exactly 'Universal Access' implies varies between stakeholders.

margin[2] due to overbuilding in the 1980s; moreover the same utility had been involved (albeit on a small scale) in a programme to electrify rural white farmhouses since the 1940s.

Thus, the electricity sector faced few of the usual barriers to electrification in developing countries: lack of access to capital, lack of skills and lack of supply infrastructure. In addition, much of the initial demand was for urban electrification, devoid of the challenges encountered in rural electrification projects.

The main barriers to widened access to electricity in the late 1980s were institutional and political: both were swept away by the democratic transition in the early 1990s, which provided not only a fundamental shift in the political landscape, but also an unusual institutional environment for policymaking. During the initial negotiation process much policymaking moved from the state to stakeholder forums. This was an uneven process, since the entry into the policy process of anti-apartheid political grouping also changed the content and scope of the policy agenda significantly.

The African National Congress (ANC) won the 1994 elections by a large margin, and consolidated their majority in the next two elections in 1999 and 2004, thus providing a high degree of political continuity in the immediate post-apartheid era.

From a policy and an institutional point of view, the period from 1994-1999 can be regarded as a transitional period, during which apartheid frameworks and policies were dismantled or reformed, a new constitution was adopted, new government institutions were created at national, regional and local level, and other institutional reforms were carried out in many areas of government. From 2000 onwards, these institutions began to function effectively (in most cases), and policymaking and governance returned to 'business-as-usual'. The electrification programme followed a similar pattern.

## 1.2 The problem of electrification

Electrification in the broad sense became a primary symbol of modernisation worldwide in the 20th century[3]. A number of factors necessitate state interest in electricity systems, even privately owned ones, and the outcome of early electricity policies in most states was the establishment of institutions to regulate and facilitate the orderly expansion of electricity systems. This can be referred to as the 'first wave' of electrification policy, usually involving the electrification of the economy as a whole. After the triumph of electricity as the modern energy carrier of choice, a 'second wave' of electrification policies can be identified, generally leading to various forms of institutional innovation,

[2] Calculated as ((total sent-out rating of Eskom generation plant)/(peak demand on Eskom system)-1)*100 [Eskom 1990].

[3] As encapsulated by Lenin in his famous definition of communism as 'soviets plus electrification'.

which responded to the problem of including areas of national economies that did not meet criteria for electrification under existing institutional arrangements (most often expressed as financial criteria). This included first the electrification of rural areas in developed countries from the 1930s, with a similar emphasis on rural areas in developing countries many decades later.

One of the primary motivations for second-wave electrification is developmental, on two counts: a) because of the potential for electricity to promote local economic development, and b) to resolve problems of 'energy poverty' – economic penalties paid by low-income households for using low-quality energy carriers. These include labour (for wood collection), negative heath effects (smoke/particulate inhalation, paraffin ingestion and unsafe paraffin appliances), and expense (inefficient appliances/conversion processes, expensive energy carriers). However, electricity is not merely a cleaner, safer and often cheaper way of providing energy services required by poor households, but is the only carrier for electronic appliances, including radios, TVs, telecommunications and information technology (IT) equipment. Thus, access to electricity is an essential component of modernisation, since the core features of modern social and economic organisation are not accessible to citizens without access to it. While electricity is usually one of a number of conditions for economic and social development, lack of electricity is an insurmountable barrier to all the more sophisticated forms of modernity, from vaccines to IT.

From a policy perspective, the development of second-wave electrification policies requires the establishment of electrification as a public problem[4], which in turn, as alluded to above, depends on the portrayal of existing institutional arrangements as inadequate in relation to national goals. In most instances in developing countries, this is brought about by the disparity between narrow economic criteria within the electricity system and broader development goals[5].

In the South African context, apartheid kept an interest in energy poverty off the policy agenda through its exclusion of most of the population, including almost all the poor, from electoral politics. Interest in energy-poverty problems in state agencies began to emerge in the 1980s, but was marginalised in key decision-making structures. Energy for the poor was not regarded as an energy policy issue, and service provision for black South Africans formed a highly charged policy arena dominated by the security establishment. In addition, within the state system there was not even basic demographic data on most

[4] See Kingdon [1995] for a fuller analysis of policy agenda-setting.

[5] Gaunt [2005] made the distinction between economic, socio-economic, and social electrification. The former represents 'business as usual'.

black communities until the 1990s; thus, the struggle against apartheid was largely literally a struggle by candlelight.

The first significant attempts to quantify energy use in low-income households were documented by Eberhard [1984, 1986]; this work was influential in the work of Dingley[6] [1987, 1990], who proposed the idea of a national electrification programme. The crisis faced by the apartheid state at the end of the 1980s, coupled with the dramatic political changes occurring with the beginning of the negotiation process, resulted in the rapid formulation of electrification as a definable problem in the beginning of the 1990s. Political attention was focused on apartheid-era institutional arrangements in the electricity sector, which had not been subject to policy scrutiny before: in the light of the transition they appeared unjust, inefficient and inadequate, and the lack of electrification appeared, to quote a former Eskom CEO, "downright shocking"[7]. Lack of electrification in large parts of the country, explained in 'economic' and other more esoteric terms[8], was now obviously almost entirely a direct outcome of apartheid.

The electrification problem existed in two different frames, which would later compete for institutional and policy dominance (explored later in more detail). The first frame, pioneered by the work of the Energy and Development Research Centre (EDRC) - and by proxy the National Energy Council (NEC) and the Department of Minerals and Energy (DME) - and other socially-oriented policy analysts in the late 1980s and early 1990s, was based on an analysis of low-income household energy use: electrification was seen as one (and probably the most important) of a range of co-ordinated interventions to ameliorate energy poverty [Eberhard & Van Horen, 1995], and thus electrification policy was a subset of energy policy, and should be integrated into a complete energy policy framework.

The second frame, inherent in the approach of Eskom, local authorities[9] and to a certain extent, the ANC's Restructuring and Development Programme (RDP), was based on the understanding of electrification as infrastructure development; it should thus be integrated with other service-oriented infrastructure development processes, and located institutionally in the same place as other forms of infrastructure development. The tension between these two approaches will be further explored below.

---

[6] Dingley was both an electrical engineer as well as a committed ANC member.

[7] Interview with Alan Morgan, previous Eskom CEO

[8] 'Economic' criteria cited for non-electrification of urban areas were obviously highly-skewed by apartheid spatial arrangements – See Horwitz [1994].

[9] For simplicity local authorities are included in this second frame, although their contribution can easily be defined as a third frame, based on an understanding of electrification as service provision.

# 2 Planning, policy and institutions

## 2.1 Policy and institutional phases

Policy and institutional development within the context of the electrification programme can be described in three phases as shown in Figure 2.1: phase 1 from initial scattered efforts to the strong appearance of the programme on the policy agenda with associated firm political backing; phase 2, from 1994, when the programme became part of the RDP and targeted much higher connection rates, and phase 3, from around 2000, when rates dropped to lower levels and the programme was formally institutionalised in government. In delineating the key policy and institutional events and decision moments of the programme, the most coherent approach follows these three phases.

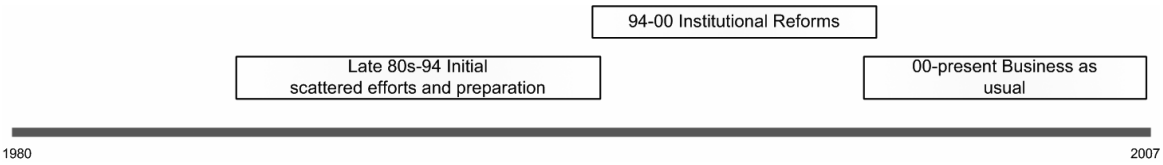


**Figure 2.1:** Policy and institutional phases

One of the first significant events that occurred during the 'initial scattered efforts' phase of the electrification programme was Eskom's adoption of the 'Electricity for All' slogan in 1987 [Eskom 1987]. A coherent national programme however only emerged in 1992 in parallel to the political negotiation process of the early 1990s, when Eskom's CEO committed to bringing electricity to at least an additional 5 million people by 1997 [Eskom 1992:16]. Eskom's monthly connection rates, which began in January 1991 below 1000, rose to only around 5000 in that year, but rose dramatically to 30000 connections by December 1992.

The key event of this first phase, however, was the organisation of a National Electrification Conference[10] in 1992, which led directly to the establishment of a National Electrification Forum (NELF), a broad-based stakeholder body with participants from Eskom, municipalities, the DME, unions and others. Work in NELF was done by a number of technical committees which assessed the various constraints, and elaborated a vision for an 'accelerated national electrification programme'. Informed by these studies, a target was agreed between Eskom and the ANC, which was incorporated into the ANC's RDP in 1994, for 2.5 million new connections between 1994 and 1999, divided between Eskom and local authorities, but funded by a cross-subsidy from Eskom's electricity sales, as well as from grants and loans. The RDP targets provided the

[10] The conference was organised and hosted by the Energy and Development Research Centre under the auspices of the ANC at the University of Cape Town.

necessary combination of technical and financial capacity and political imperatives (in the new government) to entrench the programme on a large scale.

In the second phase, the new government converted the 'Electricity for All' programme into the National Electrification Programme (NEP) and connection rates were stepped up considerably. In a process described more fully below, Eskom and many municipalities gained access to distribution areas by taking over defunct apartheid-era distributors. Eskom, due to the fact that rural[11] areas were part of its licensed area of supply and had the largest backlog of electrification, took on the majority of the RDP targets. This had the significant outcome that a higher proportion of rural connections were made during the initial stages of the programme that might have been the case in a 'unitary' programme, as evident from Figure 2.2. During the period 1994-1999, the emphasis was almost solely on achieving high connection rates, and creative ways were found to lower costs dramatically and overcome institutional barriers to achieve this. Funding for the programme was largely derived from Eskom through an implicit levy on electricity sales to existing cutomers, which was partly disbursed to local authorities via the NER from 1996 [NER 1998:11].

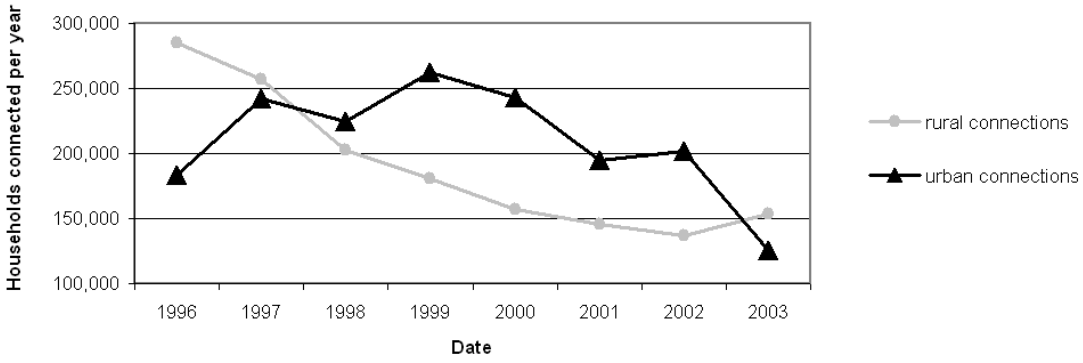


**Figure 2.2**: Annual number of urban and rural connections [NER 2003]

While there were a high number of rural connections in the mid-1990s, the programme was dominated by urban electrification until 2002, when the programme shifted to a mainly rural focus[12], which increased average costs and necessitated the funding of bulk infrastructure to strengthen and extend transmission networks and transformers. Phase 3, therefore, was characterised by a slowing in the connection rate, the formalisation of electrification policy and institutions, and the integration of the programme with other policies and development processes. Due to a number of factors, including the commercialisation of Eskom (see below), the state opted to shift the programme into the DME, a process that began with the establishment of the National Electrification Co-

[11] The distinction between 'urban' and 'rural' areas in South Africa was largely institutionally defined, and often vague; after municipalities were reorganised in 2000, the institutional distinction fell away. For more details refer to [Stats SA 2003].

[12] Current estimates are that most of the existing backlog remains in rural areas.

ordinating Committee (NECC) in April 1999. A unit within the DME was set up to house the programme (the Integrated National Electrification Programme (INEP) from 2002), which took over administration of the programme, including planning and funding, which was derived from the fiscus. The programme shifted from a fairly narrow focus on connection targets to a broader set of development criteria. Another two significant developments in phase 3 were the implementation of an off-grid photovoltaic programme for remote rural areas, and the introduction of free basic electricity for poor households (i.e. the first 50 units consumed each month are free). Current policy is aimed at achieving universal access to electricity by 2012, a goal announced by President Mbeki in 2004.

## 2.2 Phase 1: initial scattered efforts and preparation

The key decision-making processes that underpinned the electrification programme in the 1990s took place between 1992 and 1994 in NELF. The context for these processes, their structure, and the range of available outcomes were linked strongly to the structure and scope of apartheid-era institutions in the electricity sector and elsewhere, which provided both opportunities and obstacles to the emerging programme. Policy-making during this first phase set the basic parameters for electrification policy, as well as setting in motion processes of institutional reform that culminated in the changes at the end of the century.

### 2.2.1 Institutional structure in the late 1980s

One of the key factors determining the form of the programme, as well as its ultimate outcome, was the institutional structure of the electricity industry in the late 1980s. Historically, the industry had been divided into two spheres of influence: the state electricity utility Eskom[13], and local authorities. While local authorities had in many instances developed their electricity systems autonomously, by the late 1980s several factors, including the connecting up of a national transmission grid in the 1960s, Eskom's low cost of generation, and, most significantly, the Provincial Administrators' restrictions on municipalities building new generation stations, had established a policy of dividing the electricity system between generation and transmission (Eskom) and distribution (Eskom and local authorities). By the mid-1980s, most of Eskom's small distribution customers were in rural areas. [14]

[13] The utility was initially established as the Electricity Supply Commission and known as Escom or Evkom, but was restructured and named Eskom in 1987. 'Escom' is the designation used by authors for all references to the utility before 1987, and 'Eskom' for all references thereafter.

[14] Noticeable exceptions being the Northern suburbs of Cape Town and Midrand and Sandton in Johannesburg.

However, because of the local and regional government institutions of the apartheid era, development of electricity distribution infrastructure was highly uneven. Under the 'grand apartheid' policies of the 1960s and 1970s, a significant proportion of the rural population were hived off into 'independent' or 'self-governing' territories, and independent electricity distribution authorities were set up. At the time these were some of the most economically marginalised areas of the country, and almost no infrastructure development took place, among other reasons due to poor load profiles, financial mismanagement and lack of industrial customers [Davis 1997]. Urban areas were segregated and placed under a succession of unsuccessful governance structures, culminating in 'Black Local Authorities' (BLAs) in 1982, which suffered from similar problems: a lack of political legitimacy, maladministration, and a very poor potential customer base – whereas 'white' areas included central business districts (CBD) and most industrial areas of major towns, the potential customer base of BLAs consisted largely of low-income households. In addition to this, BLAs faced open revolt from their citizens by the late 1980s, which included a boycott of services payments, which further threatened their financial viability. As a result, by the end of the 1980s, whereas areas under the jurisdiction of 'white' authorities had reasonably sound distribution infrastructure, some other areas had little (with low reliability) or none.

Another key development preceding the electrification programme was the crisis culminating in the De Villiers Commission in the mid-80s. Both the origins and the aftermath of the crisis were significant. The crisis was prompted by the impact of steep Escom's tariff increases on the cost structure and competitiveness of the South African economy [De Villiers 1984:1]. The commission identified a number of reasons for the tariff increases, including large investment by Escom into generation capacity expansion projects. The commission found that these expansion projects were based on over-optimistic electricity consumption forecasts, and recommended delaying the commissioning of new plants.

The post De Villiers period saw a number of important developments: first, Eskom slowed down its capacity expansion programme. It had accumulated significant surplus capacity. Over time these investments were amortised so that by the late 1980s and early 1990s Eskom was in a good position, both in terms of capacity and a healthy balance sheet, to launch an ambitious electrification programme. Second, Eskom was freed from its previous prohibition on making a profit or a loss[15], which allowed it crucial leeway in determining the viability threshold for electrification projects. Third, there was a

[15] This provision, in terms of the legislation applied to each 'undertaking' separately, effectively prohibited cross-subsidisation between 'undertakings', and was a significant obstacle to subsidising the electrification of white farmhouses before the 1980s (which eventually required a parliamentary amendment).

political opportunity for Eskom to establish itself as a national champion in the eyes of the new government[16].

The final significant institutional factor was the evolution of energy policy institutions in the country in the 1970s and 1980s. Energy policy as a formal government activity was a latecomer to South Africa, only making an appearance in the early 1970s. Most of the institutional capacity built in the government's complex of energy agencies in the 1970s and 1980s concerned the nexus between coal, liquid fuels and energy security, and the electricity sector remained almost entirely autonomous[17]. Whereas there was a nascent strategic concern with electricity supply during this period, electricity distribution (and electrification) was regarded as the sole sphere of local authorities, which also reflected the supply-side emphasis of energy policy during this period. While in the 1980s NEC developed an interest in 'energy and development' (energy for low-income rural households), a policy of mass electrification was not something that the NEC could contemplate or pursue, for jurisdictional and political reasons. It was only with the collapse of the authority of the apartheid state's state agencies in the late 1980s that a policy vacuum was created, which could be easily filled during the transition.

### 2.2.2 Setting electrification targets in an unusual policy space

In common with other policy processes during the negotiation process leading up to the 1994 elections, electrification policy, and other policy spheres linked to it (notably energy policy), moved out of a formal government context and into a less formally structured negotiation process. Some of the primary actors in defining electrification policy in the years leading up to the elections were Eskom, institutions like Nedcor and Old Mutual which launched an influential economic scenario exercise in the transition period including recommendations on an accelerated electrification programme[18], and a group of 'energy policy activists' aligned with the ANC. These consisted primarily of a group of policy analysts associated with the EDRC at the University of Cape Town, who were also active in several ANC policy development groups, and lobbied successfully within the ANC for the formulation of a position within the party on electrification and energy policy,

---

[16] Much of Eskom's strategic behaviour after 1985 was structured by efforts to ward off further government intervention, or as the CEO at the time famously put it, "to keep government out of the engine room" [McRae 2006], which involved a range of measures including improving financial performance, reducing real prices, international benchmarking, and aligning itself strongly with the new government's social goals.

[17] There were two underlying reasons for this: 1) the national status of Escom, and its sheer size, and 2) the dominance of coal-fired power, which decoupled the electricity system from the direct effects of the 1970s oil crises; South African electricity prices did not, and still do not, react to international oil (or gas) price movements.

[18] Nedcor / Old Mutual's 'Change of gears' recommendations on electrification, low-cost housing and social investment are explored in more detail in Segal [2007]. Charles Dingley, based at UCT's Electrical Engineering Department, contributed to these scenarios, which were influential in shaping some of the thinking in the ANC's Reconstruction and Development Programme that sought to stimulate economic activity through redistributive investments such as electrification. The Chairman of Nedcor at the time was Johan Maree who was also Chairman of Eskom – and so these scenarios also reinforced Eskom's commitment to accelerate their electrification programme.

as well as being involved in the drafting of electrification policy provisions in key party policy documents. Other actors, such as the trade unions and local authorities, played a secondary role, and the line department, the Department of Minerals and Energy Affairs (DMEA), was marginalised.

Eskom's increased role in low-income electrification began in the late 1980s with a few small projects undertaken with local partners. At the same time, Eskom's leadership, in view of the changing political environment, began to see involvement in electrification as an essential strategy to maintain organisational autonomy[19]. To this end, Eskom adopted the slogan 'Electricity for All' in 1987. Given that Eskom had limited access to non-electrified households in urban areas, a key development in the late 1980s was the takeover of several areas of supply from crisis-ridden BLAs – Eskom's leverage for this was that most bankrupt BLAs could not pay Eskom for their bulk supply, which was written off against the value of existing distribution assets acquired by Eskom [Conradie & Messerschmidt 2000]. While Eskom met resistance from some quarters of the state initially, as the negotiation process took off, this was seen as a pragmatic solution by some stakeholders and, by 1994, Eskom (with the endorsement of NELF) had taken over rights of supply (and the limited infrastructure in) 130 townships [Conradie & Messerschmidt 2000:280], as well as the mostly bankrupt distribution authorities of the 'independent states' and 'self-governing territories', which were re-incorporated into South Africa in the run-up to the 1994 elections. Thus, whereas in 1991 Eskom had only 142 746 domestic and street lighting customers [Eskom 1991], by 1994 Eskom had 1 053 725 of this category of customers [Eskom 1994].

Eskom began electrification at a relatively low level from 1990, but the watershed event was the National Electrification Conference in 1992, which was attended by a wide range of stakeholders including local authorities, but excluding any government representatives (who were banned from attending by ministerial directive[20]). Eskom, inhibited by its status as a state agency, attended informally.

The conference led to the establishment of a National Electrification Forum later in the same year. The core of NELF was a management committee consisting of representatives of the Association of Municipal Electricity Undertakings, the ANC, the Chamber of Mines, the DMEA, Eskom, trade unions, the South Africa Agricultural Union

---

[19] Much of Eskom's commitment was also associated with the personal moral vision of its late-1980s management (who later described this period as "the years when Eskom found its moral purpose" [interview with Alan Morgan, ex CEO of Eskom]) but this strategic view was certainly the way in which its early commitment was rationalised within the organisation.

[20] The justification was that Government officials were not allowed to participate in party political events. This needs to be viewed in the context of other public policies, such as political parties not being involved in local government, which was changing in many ways during the period of the 1980s and 1990s.

and local authorities via the United Municipal Executive. The concrete work in NELF was done by eight working groups focusing on regulatory structure and policy; human resources; supply technology and standards; data on electrification levels and needs; finance and tariffs; transitional issues; end-use and environment, including appliances and environmental issues; and a management working group to integrate the other processes [NELF 1993:3].

There were several key outcomes from NELF that set the pattern for electrification policy until the late 1990s. The first was a significant degree of technical work on the feasibility of electrification, which established the viability of, and built a consensus around, a much faster programme; the second was the establishment of a National Electricity Regulator (NER), which became the institutional focus of the programme until 2002. The final outcome was the adoption of the proposals for restructuring the electricity industry. The key motivation for this was that the fragmented nature of the distribution industry was seen as an obstacle to electrification, since many local authorities were perceived as lacking capacity to carry out electrification projects.

The discussions in NELF culminated in an agreement between Eskom and the ANC to electrify 2.5 million houses between 1994 and 1999, which was codified both in the ANC's RDP[21], the party's blueprint for social and economic policy during the transition, and in a 'compact' between Eskom and government[22], which contained commitments on price and employment equity. Thus the policy outcomes of phase 1 established the principal aim of addressing the electrification backlog, and allocating significant societal resources to this end, as well as placing Eskom in a central role in the unfolding programme.

## 2.3 Phase 2: Institutional reforms

The main purpose of the 1994-1999 NEP was to achieve the connection targets outlined in the RDP. Eskom assumed 66% of the target (300 000 new connections per year) and the local authorities assumed the rest. Since Eskom's electrification programme was effectively funded from a non-transparent, internal levy on electricity sales (which included bulk sales to local authorities), local authorities lobbied to receive a grant from Eskom to subsidise their electrification programmes. Eskom agreed in 1996 to provide an amount of R300 million annually for a period of five years, escalated annually by the average annual tariff increase, which would be distributed to local authorities via a NER Electrification Fund [NER 1998:11]. The Board of the NER determined principles for the

[21] Researchers at the Energy and Development Research Centre at the University of Cape Town undertook much of the modelling that underpinned these targets.

[22] In 1991 Eskom undertook to reduce the real price of electricity by 20% over a 5-year period effective from 1992 [Eskom 1992].

allocation of the fund. The NER continued to administer the Electrification Fund until it was exhausted around 2003. The NER also played a major role in monitoring the programme, from three perspectives. First, legislation establishing the Regulator[23] required it to license all distributors. Secondly, part of this function was to collect accurate statistics on electricity infrastructure and publish it annually. Thirdly, the NER was required to audit the electrification activity of local authorities.

Given that ex-Eskom personnel ran the regulator for its first few years[24], it is fair to conclude that the electrification programme was co-ordinated during this phase by an NER-Eskom nexus. The NER provided an overall reporting framework for the programme including setting up a basic model to track electrification progress in the country as a whole[25], and a report on the programme was published by the NER from 1995 to 2003[26]. National electrification planning functions during this period were located within Eskom.

Two other developments of note occurred during this period. In the first, due to the withdrawal of the National Party from the Government of National Unity in June 1996[27], an ANC Minister of Minerals and Energy was appointed, which led to the replacement of the old-guard leadership within the Department over several years and internal reorganisation, resulting in less capacity being devoted specifically to household energy problems and more being allocated to supply-side policy issues. Second, a post-apartheid energy policy framework was drafted, a process which began in 1995 with work commissioned from UCT and culminated in December 1998 with the White Paper on Energy Policy. The White Paper placed significant emphasis on an integrated approach to household energy problems, while emphasising the imperative of electrification: *"Government recognises that household access to adequate energy services for cooking, heating, lighting and communication is a basic need. Whilst these needs can be met by various fuel-appliance combinations, government recognises that*

---

[23] The NER was established by amending the Electricity Act (Electricity Amendment Act 46/1994), which a) changed the name of the regulatory authority which had existed previously (the Electricity Control Board), b) expanded the authority from a board of 5 and 1.5 personnel to an organisation which currently has over 100 personnel, c) imposed a dedicated levy on electricity sales to fund the NER, and most importantly, d) placed *all* electricity undertakings under the regulatory authority of the NER. Previously, local authorities within their municipal areas, and Eskom (between 1987 and 1994), had not been subject to licensing or price controls by any regulatory authority. The Electricity Amendment Act in 1987 exempted Eskom from ECB regulation. This was changed in the 1994 Act.

[24] Aside from a large movement of staff from Eskom to the new Regulator, Ian McRae, CEO of Eskom from 1985 to 1994, who was a strong supporter of electrification, and had been instrumental in steering Eskom into the programme, headed the NER for its initial years.

[25] This was pretty much abandoned later for greater emphasis on other indicators.

[26] See Lighting Up South Africa, published by the NER in most years from 1995 to 2003.

[27] In terms of the interim constitution in force when the 1994 elections were held, although the majority party/coalition formed the government, minority parties were offered Cabinet seats in proportion to their share of the vote – under this arrangement, the Minerals and Energy portfolio was allocated by the ANC to the National Party, the governing party that had implemented apartheid. Pik Botha, the ex Foreign Minister in the apartheid government, became the first Minister of Minerals and Energy Affairs in Mandela's cabinet in the period 1994-96.

*without access to electricity, a clean, convenient and desirable fuel, human development potential is ultimately constrained."* [DME 1998]

To this end the White Paper proposed the integration of another nascent programme in the DME: the installation of photovoltaic systems in households too remote to be electrified. The rest of the policy principles spelled out in the electricity section of the White Paper related to the government's requirement to formalise the management of the programme in order to correct some of the problems of the ad hoc arrangements of the RDP programme, including an over-allocation of resources to rural areas, non-transparent funding arrangements (via Eskom), and the electrification of areas better served by off-grid systems.

An electrification programme funding requirement of R2 billion per annum was foreseen for the medium term, and the long-term aim of the programme was to provide universal access to electricity (a mix of grid and off-grid supply). The White Paper outlined a funding policy, which involved a partial subsidy of the capital cost of connection, to be derived from a levy on electricity sales and routed via the fiscus, subject to resolving the question of the corporatisation of Eskom, which would require the utility to pay taxes and dividends to the state, which it had not done up to then. An additional complication emerged with the imminent expiry of the Compact between the state and the utility, which would expose Eskom to price regulation by the NER and thus make it more difficult to cross-subsidise the programme without an explicit policy by the state and/or ruling by the regulator. The main challenge facing government after the White Paper in terms of electrification was how to set up appropriate institutional arrangements to plan and manage the electrification programme within government.

## 2.4 Phase 3: business as usual

The period 2000 to 2001 saw the confluence of a number of different developments that resulted in policy shifts that significantly changed the institutional basis of the electrification programme. This involved the post-transition development of policy frameworks in a number of spheres, including energy policy (see above), public enterprises (key policy framework published in 2000), local government (restructured in 2000), and spatial development (the Integral Sustainable Rural Development Programme and Urban Renewal Programme were announced in 2001, and the Integrated Development Plan (IDP) framework implemented in 2001). Additional factors included the electricity sector restructuring process and internal organisational developments within the DME. The outcome was that funding and co-ordination of the electrification programme was shifted to the DME; from inception to the assumption of effective operational control took around three to four years. These factors will be discussed individually below.

Towards the end of the 1990s, in addition to considering the restructuring of the electricity distribution industry, policy discussions were focused on introducing competition into the electricity supply industry (ESI). The model for the electricity industry as a whole, as anticipated in the Energy Policy White Paper, would include a number of independent regional distributors, an independent transmission company and system operator, and a number of independent (and eventually privatised) generation companies. As a preparatory step, Eskom was converted into a corporation in 2001 (via the Eskom Conversion Act), which in operational terms meant that it would adopt the same institutional structure as a private company, with a board of directors (replacing the stakeholder-based Electricity Council), and a sole shareholder (the state, via the Department of Public Enterprises), and would henceforth pay tax. Between 2001 and 2004 serious work was done on designing a competitive electricity market along the lines of Nordpool: i.e. generators would be able to bid into a power exchange and could also enter into long term contracts directly with distribution companies or large customers. However these plans were abandoned at the end of 2004. Currently there are no plans to unbundle Eskom or to sell off some its generators. While IPPs are being permitted on the margin, Eskom continues its dominant market position and has been assigned primary responsibility for new generation capacity and transmission networks as well as continuing its distribution business.

Eskom's relationship with the electrification programme on an ideological level follows this advance and recession of the threat of restructuring closely: its major national role in pioneering electrification in the 1990s was called into question by its corporatisation, for two reasons. First, it obviously could not play a central role in its restructured form, and secondly, it could not continue to plausibly support electrification financially. While the high level of capital funding that Eskom provided in the first stage of the programme was effectively a cross-subsidy from other electricity users, Eskom was not willing to continue funding the programme after its corporatisation (especially since it would now be obliged to pay taxes and dividends to the state); at the same time its 'price compact' with government expired, which coincided with the introduction of a more transparent wholesale pricing regime by the NER. The state decided to fund electrification directly from the fiscus, and to subsidise the entire capital cost of connection, from 2001.

The obvious dilemma which government faced, given the restructuring plans and its desire to implement a less autonomous and more policy-driven programme, was where to situate the programme, and what form it would take after the initial targets had been met. To this end, the NECC was set up by ministerial directive in April 1999, consisting of representatives of Eskom, the DME, the NER and other, to resolve a number of policy questions, including those related to a) the integration of the programme with other

development processes, and b) the most suitable institutional form which the programme ought to take. The NECC did most of its work through four working groups, which reported after about a year that the DME would be the most suitable institutional home for the programme, and that a National Electrification Programme Management Unit (MU) should be set up under the auspices of the DME, supported by a stakeholder-based National Electrification Advisory Council, which in practice was a continuation of the NECC. The MU would have a national perspective on planning and approving electrification projects, and control and disburse funds and local agencies.

At the time (the late 1990s), the siting of the MU in the DME was more or less a foregone conclusion, since electrification had been placed firmly in the realm of energy policy by the 1998 White Paper, which contained many basic policy premises on which the NECC based its deliberations. Moreover, the White Paper placed great emphasis[28] on integrated energy solutions to household energy problems, which ideally would be institutionally and procedurally integrated. In addition, there was a growing parallel strand of policy deliberation within the DME on how to solve the problem of remote rural households that were, according to the extant financial criteria of the programme, too expensive to connect to the grid.

Work done on off-grid electrification in the early 1990s had converged on PV systems as the most feasible technology. After a number of institutional dead-ends[29], a policy was arrived at in the DME of allocating a number of concession areas to private companies, which would in theory also provide thermal fuels such as paraffin and LPG. The first implementation of this concession policy involved a joint venture between Eskom and Shell International Renewables, announced in October 1998, with the stated target of electrifying some 50 000 rural households using Solar Home Systems (SHS) over the following 5 years [DME 2001]. The DME invited submissions in 1999 for additional off-grid service providers, based on which four additional consortiums were selected to participate in the first phase of the off-grid electrification programme. In order to ensure the full complementary implementation of both grid and off-grid technologies in the same area, the NECC recommended that the licensed grid utilities in the selected rural areas take on the responsibility as concedantes by engaging the selected consortia under condedante/concessionaire agreements, with the NER providing the licensing and regulatory framework.

---

[28] As it turned out, more than the DME did.

[29] Notably Renewable Energy Fund for South Africa (REFSA), a subsidiary of the Central Energy Fund set up by the DME in 1996 to implement off-grid electrification and other renewable energy projects – before it had achieved anything significant, it was reincorporated into the DME.

In an institutional shift that signalled the end of the DME's nascent integrated approach to household energy, both the off-grid and grid-based electrification programmes were placed in the electricity supply section of the DME.

The implementation of a new local development framework from 2000 onwards however created a set of institutional arrangements in which the DME's oversight of electrification was contested, which delayed the establishment of the new Integrated National Electrification Programme (INEP) in the DME for several years. The two most significant developments in this regard were the major reorganisation of local government in 2000, and the promulgation of new spatial development frameworks. This was the focus of the Mbeki Presidency's new emphasis on 'service delivery' to low-income households, and electrification was a key deliverable, along with housing, water and sanitation and other less tangible goods such as education and safety. The reorganisation of local government imposed permanent local government boundaries in place of the interim boundaries imposed during the 1990s to deal with the crises in local government engendered by apartheid-era fragmentation and uneven development: as a result, the interim local authorities, numbering around 800, were restructured into around 280. Another innovation was the inclusion of surrounding rural areas in urban councils' areas of jurisdiction – the previous system had limited local authorities to urban boundaries; as a result, with the exception of a few extremely sparsely-populated areas of the country, every part of the country came under the jurisdiction of a local authority after 2000. This completed the spatial-political coverage of the post-apartheid three tiers of government, and rendered local authorities as the most rational site for service delivery. This was formalised through the formulation of urban and rural development strategies in 2001, and the promulgation of the Integrated Development Planning process in the same year, in terms of which all local authorities were obliged to submit IDPs for evaluating and implementing all government-based development funding and projects. This process is co-ordinated through the Department of Provincial and Local Government (DPLG), which after 2000 became the primary locus for the delivery of basic services to low-income households.

The implication for the electrification programme was that in 2002 government decided to limit the DME's role and shift planning functions entirely to the local level. This was not successful, and these were brought back into the DME in 2003. During this period, the DME had a small staff (about 5 people) under the Electricity Chief Directorate, who dealt with electrification as part of electricity policy. A separate unit was set up in the DME in 2003 on a temporary basis with a relatively high staff component (by DME standards) specifically for the management of the electrification programme (2 senior managers and 14 managers). In the same year, Cabinet decided to funnel funding for infrastructure

projects through a central fund, the Municipal Infrastructure Grant (MIG), which would be administered by the DPLG. Since the electrification programme was classified as an infrastructure project, the DPLG wrote to the DME in 2004, expressing its intention to run the programme through the MIG.

The DME argued successfully against moving it to the DPLG, on grounds that included a critique of the problem of planning electrification at a local level, including the problem of co-ordinating the development of bulk infrastructure. Ultimately, the DME's favoured institutional model will be for the DME to plan electrification nationally and allocate funding, for the (as yet theoretical) Regional Electricity Distributors (REDs) to implement it, and for local authorities to conclude service agreements with the REDs. Having resolved the problem of the location of the programme, the INEP was established in the DME on a permanent basis in March 2005; the number of INEP personnel has expanded considerably from around 14 people to just below 50, including two representatives in each province. The unit consists of two sections: the first deals with planning, and the second with capital allocation and monitoring of programme implementation, which is usually done by independent auditors. In addition to this, there is a small electrification policy section (at directorate level) consisting of several senior officials; thus the number of DME staff dedicated to electrification is larger than any other section of the DME's energy branch.

There are several key shifts that have occurred in the execution of the programme between the 1990s and INEP. The first of these has been the form of the planning process. Whereas during the RDP programme, electrification projects, particularly those in Eskom, occurred without reference to other local developments, under the INEP framework all implementers, including Eskom, are required to situate electrification projects within the applicable IDP. This process seems to result in slower and less efficient implementation, but on a more sustainable basis. There was a division in responses to the new framework between technocrats and planners: the former were critical of the new system because it was slower, more bureaucratic, and undermined potential economies of scale[30], whereas the latter criticised many of the 1990s projects as unsustainable[31]. The second has been a shift from a programme with a significant urban component to a primarily rural programme, which raised the problem of bulk infrastructure. While the electrification programme did not previously deal with the lack of bulk infrastructure (it was assumed that implementing authorities would bear the

[30] For instance, some Eskom project managers complained that the new planning system prevented them from allocating resources from one project to another, which often overcame bottlenecks in the 1990s.

[31] These criticisms were mainly aimed at Eskom, for a) not consulting local communities, b) electrifying 'unproclaimed' areas (where particularly urban residents were settled illegally, and sometime moved shortly afterwards), and c) 'cherry-picking' by avoiding or abandoning 'complicated' projects (where there were challenging local physical, social or political conditions, or severe limitations on the network).

associated costs), the DME determined in 2004 that lack of bulk infrastructure was becoming a major obstacle to electrification, and began to fund the development of infrastructure in cases where at least 70% of the load could be attributed to newly-electrified houses, and have allocated between 10 and 15% of the annual electrification budget to bulk infrastructure projects. The DME also embarked on a separate project to strengthen the distribution grid where required.

The final policy shift in the electrification programme occurred from 2004, and focused on the date 2012. During the 1990s the dominant planning assumption was that 80% of households would be electrified by 2012; however in his 2004 State of the Nation Address, President Mbeki stated that *"...with a strengthened local government working with our state enterprise, Eskom, we will, within the next eight years, ensure than each household has access to electricity"* [Mbeki 2004]. The implications of this policy shift are discussed in more detail later.

In order to gain a better understanding of the context of significant institutional and policy events over time, these events are illustrated in figure 2.2 on a timeline from 1980 to 2007.

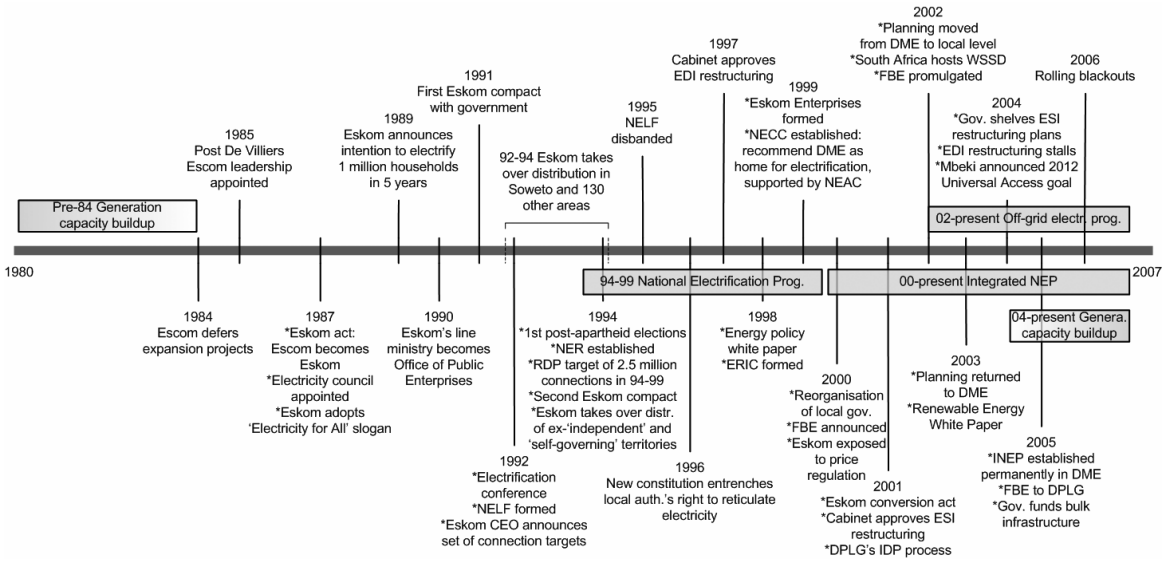


**Figure 2.2:** Significant institutional and policy events

# 3 Financing

The costs of electrification can initially be understood through two components: a capital and an operational cost; however these can be assessed in a number of different ways [Gaunt 2003:149]. Capital costs of electrification are incurred for the electricity system as a whole as a result of extra transmission, sub-transmission and generation capacity, depending on the load profile of the user. Within a transparent pricing system, these costs should be factored into the price of power.

Operational costs consist of two parts – a fixed cost (line maintenance and other operational expenses not related to the amount of electricity used) and a variable cost (the actual cost of energy, losses, etc). Thus, full financial cost recovery for a new grid connection might involve payment by the customer of the initial capital cost, and a two-part tariff for operations (fixed and variable costs). However, economic costs and benefits of electrification can be different from financial costs[32] [Davis 1997]. In addition, tariff structures are vital in determining the uptake of electricity once the investment has been made.

Key policy challenges for the electrification programme in South Africa were to a) resolve the problem of funding the costs, and b) design affordable tariff structures. This dilemma resulted in a gradual process of introducing, raising and making more transparent subsidies from the late 1980s to the present, coupled with a simultaneous process of technical and procedural innovation, which reduced costs per connection significantly, until these began to rise as the programme began to electrify more remote areas from 2003.

## 3.1 Financing phases

Three phases can be identified in the evolution of the financing of the electrification programme: self-funded, funded by Eskom and funded by government. These phases correspond closely to changes in the motivation for electrification from economic in the 1980s to social at present [Gaunt 2003], as shown in Figure 3.1.

In the first phase, from the late 1980s to the mid-1990s, there was an influential but diminishing belief that electrification could be self-funding. Although there was increasingly strong evidence that this was not the case, initial forays into electrification by Eskom were partly based on the assumption that consumption by electrified households would rise to an average level where operational and capital costs could be recovered, and that this would create a new market for Eskom's overbuilt generation sector. Although it became apparent that this was not true, it was almost certainly politically important at the time for those within Eskom (including the CEO) who needed to persuade the more economically and politically conservative leadership to involve the organisation in electrification. Since in most cases only a nominal connection charge was paid, the capital cost was theoretically to be recovered through energy charges. In addition, prepayment metering was introduced, usually coupled with a simple tariff based only on energy consumption (no fixed charge). A further challenge began to surface:

[32] As a result of various non-trivial negative externalities arising from non-electric energy carriers in low-income households, as well as positive externalities associated with the broader economic and social benefits of electrification.

'non-technical losses' (electricity theft through illegal connections and/or bypassing the meter).

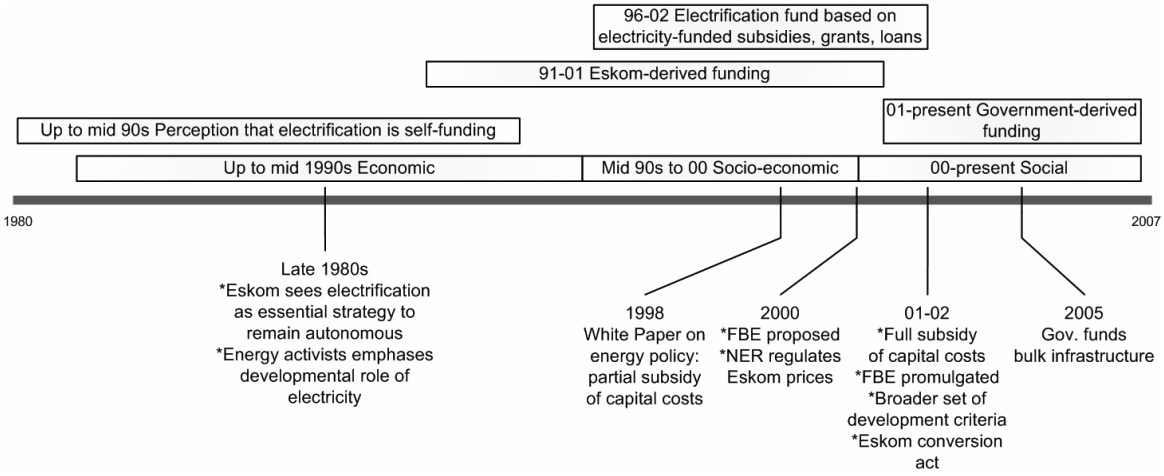


**Figure 3.1**: Financing phases during the electrification programme, and the corresponding changes in motivation for electrification. Significant events are also shown.

By the mid-1990s, it became unavoidably apparent that electrification was not going to be self-funding. Davis identified five factors crucial to Eskom's rate of return on electrification investment: cost per connection, support costs, consumption, revenue losses and tariff levels. Given current tariff levels and capital costs, consumption levels of 350 kWh per month were required, whereas average consumption in newly electrified households was only around 100 kWh/month [Davis 1995].

This realisation that electrification might not be self-funding introduced a second phase of programme financing, from 1995 to around 2000, when electrification had become a political priority and broader socio-economic criteria were introduced. During this period Eskom played the lead role in financing the programme. Finance was accessed from various sources. These included 'electrification bonds', called Electrification Participatory Notes, raised from private capital markets in the early days of the programme, the returns on which were linked to consumption growth. Most funding, however, was in the form of a cross-subsidy from industrial users, bulk sales to municipalities, as well as various (relatively small) hidden cross-subsidies in the form of various organisational capacities (secondment of staff to the DME, etc).

In the late 1990s the state took the decision to fund the capital cost of the programme entirely from the fiscus, through the National Electrification Fund [Eskom 2001]. This was the time when Eskom was corporatised and had to pay tax and dividends for the first time. The effect of these changes was to make electrification funding more transparent. At the same time (final decision taken in 2002), the state decided to introduce Free Basic Electricity (FBE), also to be funded from the fiscus, and targeted at low-income

households. This programme was however only effectively launched in September 2004 [DME 2005:2].

The state's FBE policy was announced in 2000, and promulgated in 2002, and specified the provision of a 'self-targeted' subsidy consisting of 50kWh per month of free electricity to poor households, identified either by the willingness of these households to accept a limited supply capacity of 10A (households have to apply), or by a very low consumption level (in which case the subsidy is automatically allocated) [SA Government 2002]. The subsidy was estimated to cost around R600 million per annum, increasing by R80 million per year, depending on progress with electrification, with an upfront capital cost of around R600 million (to install/replace metering equipment etc). The policy was drafted by the DME's electricity policy section, but was transferred to the DPLG, where it is implemented along with a basket of other free basic services. National implementation has been slow and uneven, because of a) lack of capacity in local authorities, b) the right of local authorities to implement FBE differently from the guidelines, and c) the requirement that local authorities conclude 'service-level agreements' with Eskom if it (Eskom) was operating in their area jurisdiction [DME 2004, 2005, 2006].

By 2005, the state was also funding bulk infrastructure development. In addition it was announced that, from 2006/7, funds allocated to the INEP would flow through the DPLG [DME 2005:37]

## 3.2 Electrification capital expenditure

While connection rates remained high (until these began to decline in 2001), total programme expenditure declined over this period due to reductions in connection costs. Most innovation took place in the 1990s; after this, costs began to rise again in the early 2000s because of two factors: firstly, the programme had by then become focused largely on more sparsely-populated rural areas (some of which required significant additional infrastructure), and secondly, the prices of basic commodities required by the programme (steel, copper, aluminium) began to increase in price significantly above the PPI. While the DME estimates the average cost per connection will rise (in nominal terms) to around R6500 in 2013 [DME 2007c], excluding bulk infrastructure costs, Eskom officials estimate that these will rise to around R10 000 by the same year[33].

[33] The DME's nominal R6'500 is around R3'400 in 2000 Rands, roughly equal to current costs; Eskom's R10'000 is around R5'300 in 2000 Rands, 35% higher than current costs (assuming March 2013 PPI of 190%, or 6.9% p.a.).

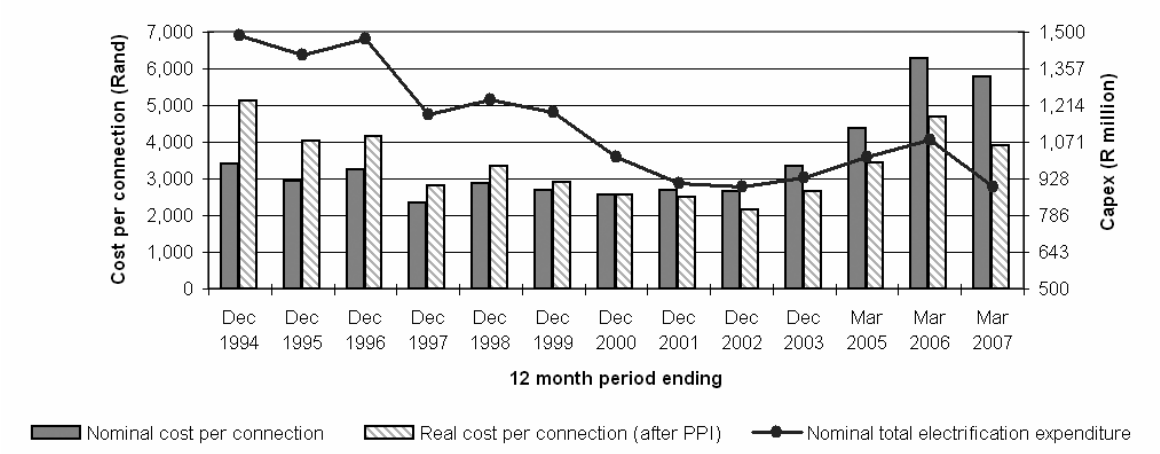


**Figure 3.2**: Average annual cost per connection and total electrification capital expenditure, from table 4.2.

# 4 The problem of electrification data

Accurate knowledge on the state of electrification in South Africa is an essential requirement for the realization of the goal of Universal Access by 2012, in terms of setting connection targets and preparing implementation capacity and budgets.

Published data on the state of electrification data however varies widely depending on the source, with reported proportions of households electrified in 2005 varying from 57% to 80%, and apparent discrepancies of tens of thousands between annual connections rates reported in different publications by the DME, responsible for electrification data collection since 2002.

This section explores the apparent inconsistencies in the electrification data by briefly sketching a background to electrification data collection and publishing in South Africa and then examining the current state of this data.

## 4.1 Data collection and publishing

Various policy and institutional changes resulted in the DME taking over from the NER in April 2002 as coordinator of the electrification programme [DME 2004:37], and as the official source of electrification data.

For most years from December 1995 until December 2003 the NER published the 'Lighting Up South Africa' report (e.g. [NER 2003]), which gave a mostly consistent and complete overview from 1991 to 2003 of the annual number of new connections, including the connections by Eskom and Local Authorities, the urban, rural, offgrid, school and clinic connections, and the total annual capital expenditure and cost per connection. In most years up to 2004, the NER also published another source of electrification data in the 'Electricity Supply Statistics' report (e.g. [NER 2005]), which identified the number of domestic electricity customers in South Africa.

After 31 December 2003 (when the last 'Lighting Up South Africa' reporting period ends) up to the present, the DME's annual reports are the primary public source of electrification data. The DME bases the electrification data in these reports on data submitted to it on a monthly basis, in a format prescribed by the Division of Revenue Act (DoRA), by Eskom, municipalities and non-grid service providers licensed to distribute electricity.

Eskom's annual reports also publish electrification data, but these relate only to connections by Eskom, not by the municipalities or off-grid service providers, and therefore cannot reflect the state of electrification in South Africa as a whole.

A statistically derived indication of the proportion of households electrified is published in Stats SA's annual household surveys and national censuses, which report the number of households in South Africa that use electricity for lighting. As lighting is typically the most basic application of electricity in a household, statistics on its utilisation are taken as an indication of the households electrified.

## 4.2 Inconsistencies in DME publications

Since 2003, the DME publications are the main public source of detailed electrification data for the whole of South Africa. However a number of data inconsistencies are apparent, as discussed below.

### 4.2.1 Annual connections

The NER reported 278'762 connections for the January 2003 to December 2003 period [NER 2003]. The DME annual report for the period April 2003 to March 2004 shows 230'967 grid and off-grid connections for the year [DME 2004:37], inconsistent with the DME's 2004 strategic report, which shows 258'000 total connections (see table 4.1) for the same 03/04 financial year [DME 2004b:32]. Neither DME report supplies information on the number of connections in the January to March quarter of either the 2003 or 2004 years, which might have explained the substantial difference between its data and that of the NER.

The DME's 04/05 annual report contains inconsistent connection data. The Minister's report states that INEP delivered 232'287 total household connections [DME 2005:6], while 217'287 total household connections are reported on page 26, which is the same number given as the total of municipal connections on page 27.

Due to the difference between the reporting periods of the DME and the NER, the lack of information on what happened during the overlap of the two periods, and the inconsistency of the DME's published data, the cumulative total of new connections since 1991 has to be estimated after December 2003. For the purpose of this paper, it is

assumed that 64'500 new connections were made in total for the quarter January to March 2004, based on the DME's reported annual connections of 258'000 for the 03/04 financial year, as shown in table 4.1.

Although it is clear from figure 4.1 that connection numbers have been steadily decreasing since 2003, non-reporting of connections might play a role, especially in the decline of municipal connections [DME 2004:40].

| | Eskom connections [NER 03, Eskom 05-07] | Local government connections [NER 03, DME 03-07] | Off-grid connections [NER 03, DME 03-07] | Farm workers connected [NER 03, Eskom 03-07] | Total household connections for period, incl. farmworkers and off-grid [NER 03, DME 03-07] | Calculated cumulative household connections, including farmworkers and off-grid |
|---|---|---|---|---|---|---|
| 1 Jan 1990 | --- | --- | --- | --- | --- | 2'998'897[1] |
| Jan91 - Dec91 | 31'035 | 51'435 | 0 | 0 | 82'470 | 3'081'367 |
| Jan92 - Dec92 | 145'522 | 74'335 | 0 | 12'689 | 232'555 | 3'313'922 |
| Jan93 - Dec93 | 208'801 | 107'034 | 0 | 16'074 | 331'909 | 3'645'831 |
| Jan94 - Dec94 | 254'385 | 164'635 | 0 | 16'838 | 435'858 | 4'081'689 |
| Jan95 - Dec95 | 313'179 | 150'454 | 0 | 15'134 | 478'767 | 4'560'456 |
| Jan96 - Dec96 | 307'047 | 137'534 | 0 | 9'414 | 453'995 | 5'014'451 |
| Jan97 - Dec97 | 274'345 | 213'768 | 0 | 11'198 | 499'311 | 5'513'762 |
| Jan98 - Dec98 | 280'977 | 136'074 | 0 | 10'375 | 427'426 | 5'941'188 |
| Jan99 - Dec99 | 293'006 | 144'043 | 0 | 6'241 | 443'290 | 6'384'478 |
| Jan00 - Dec00 | 250'801 | 139'780 | 0 | 6'438 | 397'019 | 6'781'497 |
| Jan01 - Dec01 | 206'103 | 127'255 | 0 | 3'560 | 336'918 | 7'118'415 |
| Jan02 - Dec02 | 209'056 | 124'961 | 1'736 | 2'819 | 338'572 | 7'456'987 |
| Jan03 - Dec03 | 173'094 | 88'149 | 15'156 | 2'363 | 278'762 | 7'735'749 |
| Apr03 - Mar04 | --- | 56'799[#] | 18'092[#] | --- | 258'000 or 230'967[# 2] | 7'800'249[*] (Estimated 64'500 new connections 1 Jan to 31 Mar 2004) |
| Jan04 - Mar05 | 219'885[#] | --- | --- | 2'429[#] | --- | --- |
| Apr04 - Mar05 | --- | 217'287[# 3] | 6'146 | --- | 232'287 or 217'287 [# 4] | 8'032,536[*] |
| Apr05 - Mar06 | 135'903 | --- | 20'842 | 1'105 | 172'139 | 8'204'675[*] |
| Apr06 - Mar07 | 151'088 | --- | --- | 1'037 | 155'476[5] | 8'360'151[*] |

**Table 4.1**: Reported households connected by the South African electrification programme, with calculated cumulative total. Grey text indicates overlapping periods. [*] Based on estimates. [#] Not referred to elsewhere in this paper, to avoid confusion. [1] Derived from [NER 2003:10]. [2] [DME 2004b:32] versus [DME 2004:37]. [3] [DME 2005:27]. [4] [DME 2005:6] versus [DME 2005:26]. [5] Does not include numbers for March 2007.

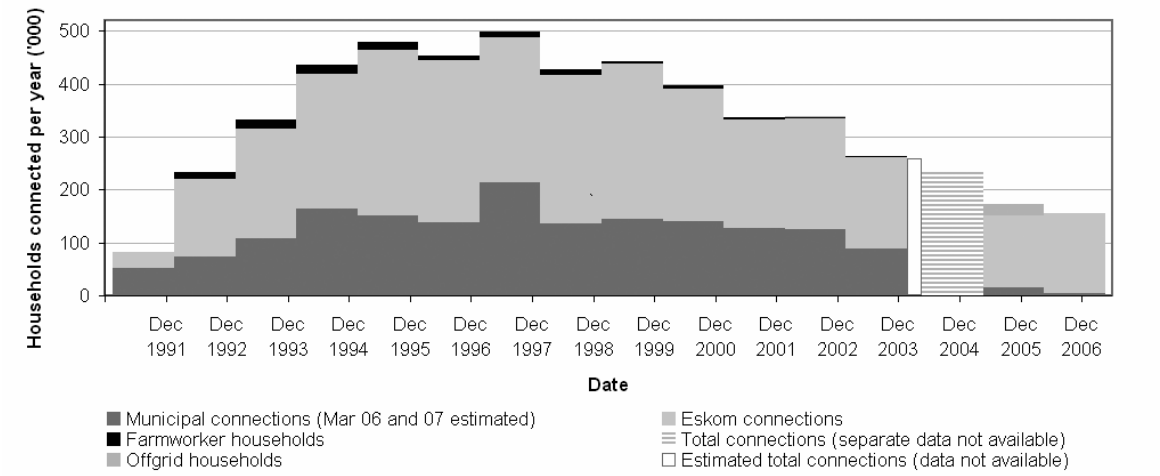


**Figure 4.1**: Annual new household electricity connections in South Africa (from Table 4.1)

### 4.2.2 Capital expenditure and cost per connection

The annual total capital expenditure of the electrification programme and the associated costs per connection were clearly reported in the NER's 'Lighting Up South Africa' reports, but these figures are less apparent in the DME's annual reports since 2003.

The 06/07 DME annual report declares the total expenditure on electrification as R897.235 million or R897.232 million [DME 2007:64,65]. However it also reports that total transfers of R1'365.922 million were made to municipalities, Eskom and off-grid service providers for electrification and an amount of R282 million towards bulk infrastructure [DME 2007:65,7].

In the years preceding 06/07 the total electrification expenditure is not reported, only the amount allocated to the INEP, and the amount transferred. Whether some connection funds had to be reallocated towards bulk infrastructure is not clear from the reports. Under- and over-spending and rollovers from previous years introduce further uncertainty.

This paper takes the yearly INEP capital expenditure to be the amount transferred as reported in the relevant DME annual report. For 05/06, this was R1'080.949 million [DME 2006:17] and for 04/05, R1'015.277 million [DME 2005:58].

The cost per connection may easily be calculated from this, as shown in table 4.2 and figure 3.2. The PPI is used to compensate for inflation, as described in section 3.

| | Total capital expenditure (R'million) | Total new connections | Cost per connection | Average PPI [Stats SA] | Cost per connection after PPI |
|---|---|---|---|---|---|
| Jan94 - Dec94 | R 1'488 | 435'858 | R 3'413 | 66.7 | R 5'117 |
| Jan95 - Dec95 | R 1'412 | 478'767 | R 2'949 | 73 | R 4'040 |
| Jan96 - Dec96 | R 1'473 | 453'995 | R 3'245 | 78.1 | R 4'155 |
| Jan97 - Dec97 | R 1'176 | 499'311 | R 2'356 | 83.6 | R 2'818 |
| Jan98 - Dec98 | R 1'235 | 427'426 | R 2'889 | 86.6 | R 3'336 |
| Jan99 - Dec99 | R 1'186 | 443'290 | R 2'676 | 91.6 | R 2'921 |
| Jan00 - Dec00 | R 1'011 | 397'019 | R 2'548 | 100 | R 2'548 |

| | | | | | |
|---|---|---|---|---|---|
| Jan01 - Dec01 | R 909 | 336'918 | R 2'699 | 108.4 | R 2'490 |
| Jan02 - Dec02 | R 899 | 338'572 | R 2'655 | 123.8 | R 2'145 |
| Jan03 - Dec03 | R 931 | 278'762 | R 3'341 | 125.9 | R 2'654 |
| Apr04 - Mar05 | R 1'015[1] | 232'287[2] | R 4'371 | 127.4 | R 3'431 |
| Apr05 - Mar06 | R 1'081[3] | 172'139 | R 6'280 | 134.3 | R 4'676 |
| Apr06 - Mar07 | R 897 | 155'476[4] | R 5'771 | 148.2 | R 3'894 |

**Table 4.2**: Electrification programme total capital expenditure and cost per connection. [1,3] Amount transferred [2] Estimate – refer to table 4.1 [4] Does not include numbers for March 2007.

## 4.3 Total households in South Africa

Population growth and associated household growth are a significant and little discussed aspects of the electrification programme. The number of households in South Africa, shown in figure 4.2, has been estimated each year by Stats SA, based on data extrapolated from two censuses, held in 1996 and 2001[34].

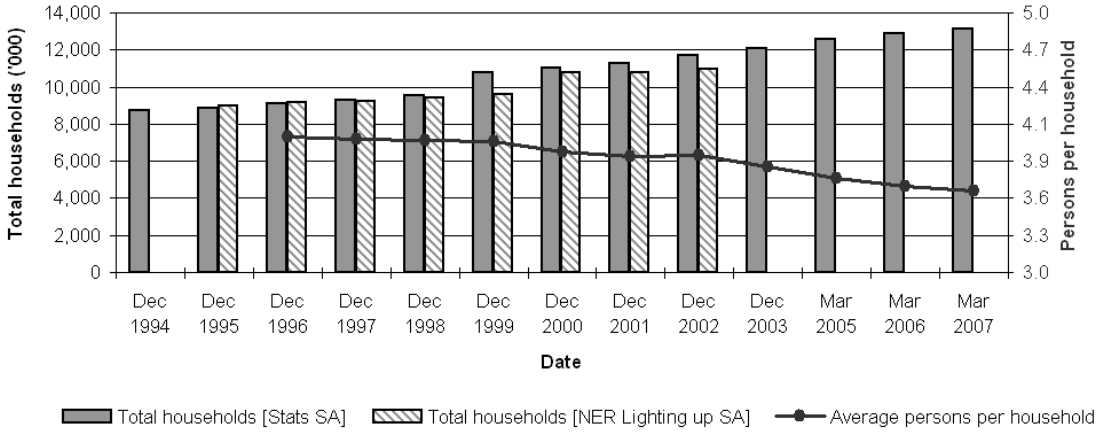


**Figure 4.2**: Total households in South Africa as reported by Stats SA in OHS, GHS and census publications, compared to data used in NER's Lighting Up SA reports. Persons per household obtained from Stats SA [2005:133] and the GHS (1997 and 1998 data extrapolated)

Population growth and household growth are however taking place at different rates, evident from the decline in average household size in figure 4.2 (from 4 people in 1996 to 3.8 in 2001 [Stats SA 2005:133]). This decline is due to a number of factors that are still poorly understood, but which include housing programmes (the housing programme's website reports that 2.3 million houses have been built by the programme in the 10 years since 1997), urbanisation, a decline in fertility and HIV/AIDS.

While household size has been declining, the population is estimated to have increased from around 40 million in 1994 to 47 million in 2006 (18%), with an increase in the number of households from around 8.6 million to around 13 million over the same period (48%) [Stats SA 1994, 2006]. This increase in the number of households has significant

[34] Data from pre-1996 censuses is problematic due to several fundamental factors: 1) the censuses focused on the white population, where the most resources were expended on accurate counting – other population groups were often surveyed by less accurate methods such as aerial photography; 2) some South Africans were counted separately – those that lived in so-called 'independent territories' were not regarded as South Africans; and 3) others were not regarded as legally resident in South Africa or parts of South Africa, and either were not counted or resisted/evaded counting, since encounters with any type of apartheid-era officialdom could result in deportation or prosecution.

implications for the electrification backlog, as depicted in figure 4.3. Whereas the electrification programme significantly outstripped household formation from 1995 to 1998 (and thus addressed the backlog), it has fallen behind annually since 2003. Note that Stats SA appears to have adjusted the total households figure between 1998 and 1999, leading to the inconsistent values shown between 1998 and 1999 in figure 4.3.

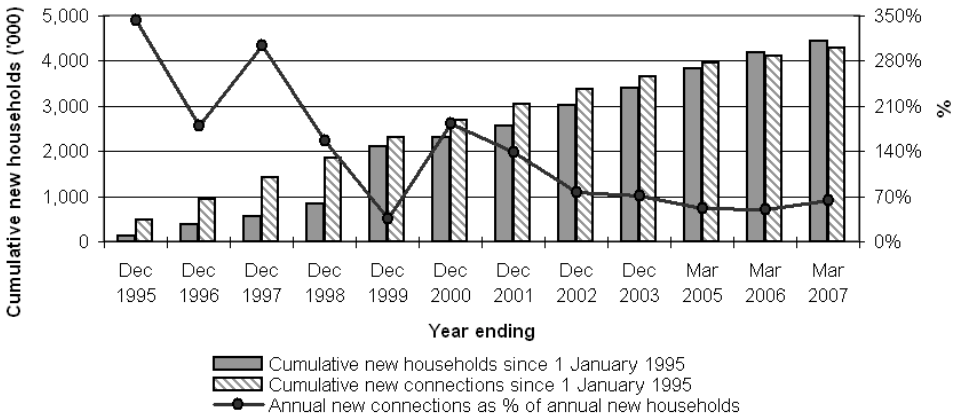


**Figure 4.3**: Cumulative new South African households versus cumulative new electricity connections since 1 January 1995. The annual new connections as a percentage of annual new households are also shown.

## 4.4 Estimating the percentage of households electrified

The most useful electrification indicator and arguably also the most politically significant, the proportion of households electrified, is subject to a large amount of uncertainty. Early estimates (for 1990) were based on limited samples, and probably had a very large margin of error of 30-40% [Dingley 1987, 1990; Eberhard & Van Horen 1995]. The first systematic effort to estimate the degree of electrification was undertaken by Eskom and the NER from 1994 to 1995 as part of the NER's process of licensing local authorities. The NER concluded that at the end of 1995 50.38% of households were electrified [NER 1995:10-12][35].

The NER was designated as the official repository of electricity industry statistics, and electrification statistics between 1995 and the end of 2003. The proportion of households electrified in subsequent years was calculated using a simple model, which took the sum of the number of electrified households reported in the previous year and new connections made during the current year, and divided this total by the total number of households in the current year.

The disadvantages of this model were that it was dependent on the accuracy of the previous year figure, and it did not take into account the 'de-electrification' of settlements

[35] Calculated on the basis of the number of domestic customers of all distribution utilities in the country.

or disconnections, which has not been quantified.[36] Nor does it take into account illegal connections, the quantity of which are unknown, but anecdotally reported to be relatively high.

Whereas state agencies used the NER method until around 2004, this method was abandoned for current assessments: the DME uses estimates based on survey data from Stats SA, which are higher than other estimates, and Eskom uses a variety of methods including extrapolation from the 2001 census and GIS-based methods.

### 4.4.1 Estimates from different sources

The data depicted in figure 4.4 illustrates the significant differences that exist between the different estimates of the percentage of total households electrified.

The first data set reflects the proportion of households that use electricity for lighting, based on data from Stats SA's October Household Survey (OHS) (conducted from 1995 to 1999), July General Household Survey (GHS) (from 2002 until the present) and 1996 and 2001 October Censuses.

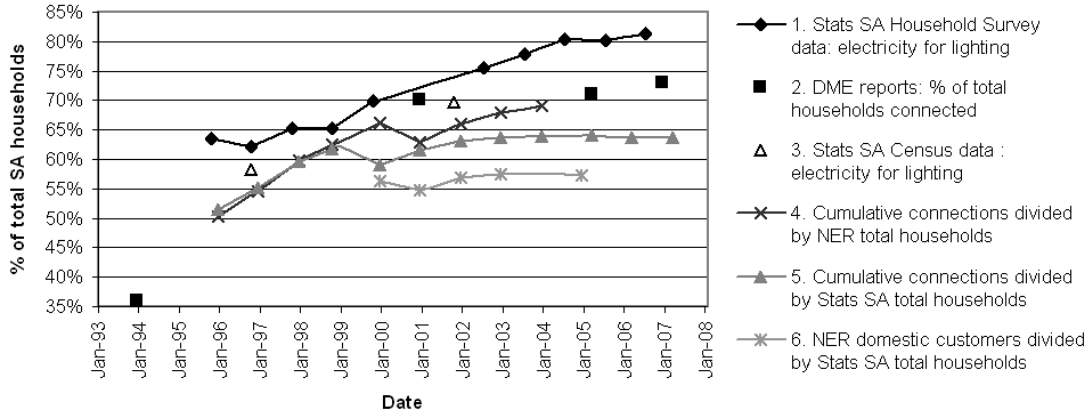


**Figure 4.4**: Different estimates, derived from published data, of the percentage of total South African households that are electrified.

The Household Survey data appear to overestimate the amount of households that use electricity for lighting (data set 1) by around 4% when compared with the corresponding electricity for lighting data from the 1996 and 2001 censuses (data set 3).

The DME occasionally reports on the percentage of total households electrified; these reports are shown as data set 2, from three sources: [DME 2001:90], [DME 2005:26] and [DME 2006d:39].

The NER reported total connected households percentages in its 'Lighting up South Africa' reports between 1996 and 2003 (data set 4), based on the cumulative connections divided by the total number of households. Since some, if not all of the

[36] Most of the new electricity connections to low-income households were undertaken with pre-payment meters. Thus there have been relatively few physical disconnections, although some sources believe the number of disconnections to be high. However, when household budgets are under strain, electricity may not be used.

NER's household figures are wrong, as shown earlier in figure 4.2, a recalculation using Stats SA total households data shows a much lower percentage electrified (data set 5).

Finally, the NER published the total number of domestic electricity customers in its 'Electricity Supply Statistics for South Africa' reports from 1999 to 2004. These figures, divided by Stats SA total households, are shown in figure 4.4 as data set 6.

# 5 Universal Access by 2012

As described earlier, the dominant planning assumption during the 1990s was that 80% of households would be electrified by 2012. This changed to 100% of households with Thabo Mbeki's announcement in 2004 of the Universal Access goal. In response, both Eskom and the DME formulated their own Universal Access Plans (UAP), although Eskom's plan only applies to Eskom supply areas.

This section explores the requirements of Universal Access in more detail, by firstly presenting an overview of the current state of progress of the electrification programme towards Universal Access and the connection targets that drove this progress, and then examining the DME's UAP response within the context of the targets and budgets required to electrify 100% of South African households by 2012.

## 5.1 Progress towards Universal Access

Figure 5.1 gives an overview of the current state of progress of the electrification programme towards Universal Access. The first and sixth data sets in this figure indicate the total number of past, present and future households in South Africa as a baseline against which to measure the past and present number of cumulative households electrified (data set 2). It is evident that since 2006 the gap between the first and third data sets have been widening, representing an increasing electrification backlog, as was shown in figure 4.3.

Also, up to 2002, figure 5.1 illustrates that all the connection targets set for the electrification programme were met. The first such target was set by Eskom in 1992, when it committed to bringing electricity to at least an additional 5 million people by 1997 [Eskom 1992:16], which translates into 1.25 million households of 4 persons each.

Two years later, in 1994, Eskom undertook to electrify 1.75 million households by the year 2000 in terms of its RDP agreement, with municipalities responsible for 750,000 connections during the same period. Eskom reached its target in 1999, as indicated by comparing data sets 3 (the cumulative connections made by Eskom since January 1991) with data set 4 (Eskom targets), and subsequently made and reached another commitment to electrify an additional 600,000 homes between 2000 and 2002 [Eskom AR 2001:64]. The municipalities significantly exceeded their target.

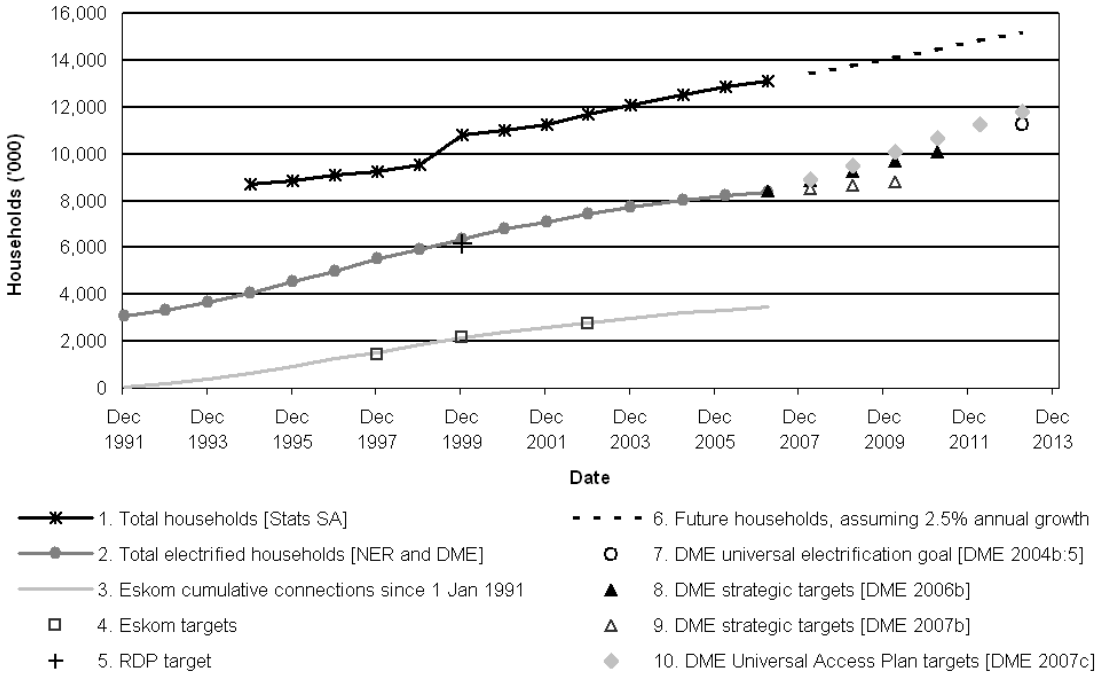


**Figure 5.1**: Total households versus total electricity connections, shown with Eskom cumulative connections since 1991 and Eskom, DME and RDP connection targets.

After the Universal Access goal was announced, the DME increased their strategic connection targets. While the targets for 06/07 were kept the same as in 05/06 (215,000 households and 1,050 schools and clinics), the targets for the years thereafter until March 2011 were increased to 415,000 households and 2,100 schools and clinics [DEM 2006b:26], represented by data set 8.

These targets fit into the DME's strategic vision "*to electrify 500000 households annually (subject to the allocation of adequate funds) with effect from 2007/8 financial year at an estimated cost of R2.5 billion per annum.*" [DME 2006b:5]

However, from around 2004 the INEP started facing a number of challenges, the most important being inadequate sub-transmission (bulk) infrastructure in rural areas [DME 2007b:7], resulting in the DME's targets being missed by a large margin, as shown in table 5.1. In addition only R1.4 billion was allocated for electrification in the 07/08 financial year, and the 07/08 connection targets were reduced from 415,000 to 150,000 households, with the emphasis placed on schools and clinics.

In the March 2007 strategic report the 08/09 and 09/10 targets for the INEP were also reduced, to 150000 households per year (data set 9), even though Minister B P Sonjica states in the same report: "*The commitment to universal access to all our people by 2012 remains at the centre of our efforts* …" [DME 2007b:3]

| | Strategic targets (households : schools : clinics) | Budgeted targets (households : schools : clinics) | Actual connections (households : schools : clinics) |
|---|---|---|---|

| | | | |
|---|---|---|---|
| 05/06 | 215,000 : 1,000 : 50 | 193,171 : 411 : 28 | 173,244 : 498 : 28 |
| 06/07 | 215,000 : 1,000 : 50 | 160,920 : 926 : 23 | 152,125 : 272 : 23 |

**Table 5.1**: Recent strategic and budgeted targets vs. actual connections published by the DME.

## 5.2 Requirements for Universal Access

In terms of the cumulative connections versus the total households shown in figure 5.1, it is clear that the current target of 150,000 household connections per year will not even start to address the electrification backlog, much less the Universal Access goal. Eskom's annual report confirms this: "*The prospects for achieving the goal of universal access by 2012 are at risk, but can still be done if adequate budget is allocated nationally to DME…*" [Eskom 2007:19] But what targets and budget are then required to reach Universal Access?

### 5.2.1 The DME's Universal Access Plan

The DME attempts to answer this question in their Universal Access Plan (UAP), which is not available publicly, but is summarised in a presentation available on its website [DME 2007c]. The capital expenditure and connections required according to this plan are shown in table 5.2.

| | Target: total connections per year | Connections cost (R million) | Bulk infrastructure (R million) | Refurbishment / Rehabilitation cost (R million) | Total per year (R million) |
|---|---|---|---|---|---|
| 07/08 | 569,422 | R 3,417 | R 1,025 | R 512 | R 4,954 |
| 08/09 | 571,854 | R 3,485 | R 1,045 | R 584 | R 5,115 |
| 09/10 | 574,334 | R 3,555 | R 1,066 | R 666 | R 5,287 |
| 10/11 | 576,864 | R 3,626 | R 1,088 | R 759 | R 5,473 |
| 11/12 | 579,444 | R 3,698 | R 1,109 | R 866 | R 5,673 |
| 12/13 | 582,076 | R 3,772 | R 1,132 | R 987 | R 5,891 |

**Table 5.2**: Targets and budgets for the DME's Universal Access Plan [DME 2007c].

These targets and projected expenditures are based on a total (i.e. including bulk infrastructure and refurbishment) connection cost of R8,700 per connection in 2008, increasing by around 3% per annum. It is clear from table 5.2 that the projected expenditure requirement for the DME's UAP, at around R5 billion per year, is far in excess of the INEP grant of R1.4 billion for 2007/8.

In addition, data set 10 in figure 5.1, which represents the DME's UAP targets, illustrates that the targets do not achieve universal access for all households in South Africa by March 2013, but only increase the estimated proportion of electrified households from 64% in 2007 (data set 5 in figure 4.4) to 77% in 2013.

From the above it is clear that the DME's definition of Universal Access does not take into account any growth in the total number of households in South Africa since the goal was announced in 2004. This is confirmed in its strategic report of 2004: "*The INEP has*

*seen 4.06 million households … electrified since 1994. The programme is set to continue for the next 8 years until the 3.5 million backlog of connections is eliminated.*" [DME 2004b-:5]. Data set 7 in figure 5.1 shows the Universal Access goal implied by this statement.

It is interesting to note that the DME's UAP does not refer to off-grid electrification, and implies that universal access will be via the grid.

### 5.2.2 100% of households electrified scenario

A number of assumptions need to be made in order to project the requirements for 100% access to electricity by all households by March 2013, e.g. that the household growth will continue at the current rate used by Stats SA of around 2.5% per year, and that the current amount of connections as reported by the DME is correct (that is, not actually much lower due to disconnection or higher due to informal and illegal connections).

With these assumptions the difference between the current number of households connected and the total number of households by 2013 is around 6.9 million households. This translates into a connection target of roughly 1.15 million households per year until 2012, at an annual total expenditure of R10 billion, rising to R11.6 billion by 2013, assuming the same costs per connection as used in the DME's UAP.

Targets and adequate funding are however not the only requirements to return annual connections to levels exceeding 250 000 per year; project management, technical skills and adequate supply of material like transformers are also crucial.

## 5.3 Observations

The following observations may be made from the analysis in this and the previous section:

- Significant gaps and discrepancies appeared in published annual connections data after 2003, when the DME took over responsibility for electrification data from the NER. Only a part of this uncertainty could be blamed on non-reporting by local authorities.
- In addition, total annual capital expenditure on electrification and the associated cost per connection were not clearly reported in most DME annual reports after 2003. This is due to lack of clarity in reporting of the impact of reallocations towards bulk infrastructure, under- and over-spending and rollovers from previous years on total expenditure.
- The range of published percentages of total households electrified (57-80% in 2005) is significant. Different definitions of total households, along with

disconnections and illegal and informal connections appear to play a significant role in the discrepancies between published data.

- It appears that no effort is made by state agencies to compile information on disconnections and illegal and informal connections and place it in the public domain. This information is, however, crucial for accurate calculation of the percentage of total households with access to electricity.
- Stats SA reports that the population growth and the steady decrease in the number of people per household since 1996 result in roughly 350'000 new South African households per year. Since 2003, this new household formation annually outstrips the electrification programme's connections and increases the electrification backlog.
- Even if an adequate budget were made available to the INEP, the DME's Universal Access Plan would only increase the estimated percentage of total households electrified from 64% in 2007 to roughly 80% in 2013 (if annual estimated household growth is taken into account). This percentage is still far short of the 100% envisioned.
- Due to budget constraints since 2005, the DME's revision of actual annual connection targets is well below the proposed strategic targets.
- Challenges like inadequate sub-transmission (bulk) infrastructure in rural areas will most likely result in a future increase in real cost-per-connection expenditure.

In order to provide access to electricity to 100% of 2012 households in South Africa by 2012, more than one million new connections would be required per year at an annual expenditure exceeding R10 billion. It is likely that the management and technical capacity and equipment supplies currently existing in South Africa cannot support such high annual connections targets within the next few years.

# 6 Technology development

Technological development during the electrification programme was mainly driven and facilitated by the requirement to reduce costs, since the cost per connection was one area in which the financial performance of the electrification programme could be improved, given the political difficulties of lowering connection targets or altering tariff structures.

Four broad technology development phases can be identified, as shown in figure 6.1, and offer a structure within which to analyse the development of technology preceding

and during the electrification programme[37]. It is informative to note the interaction between these four phases and the previously identified policy, institutional and financing phases.

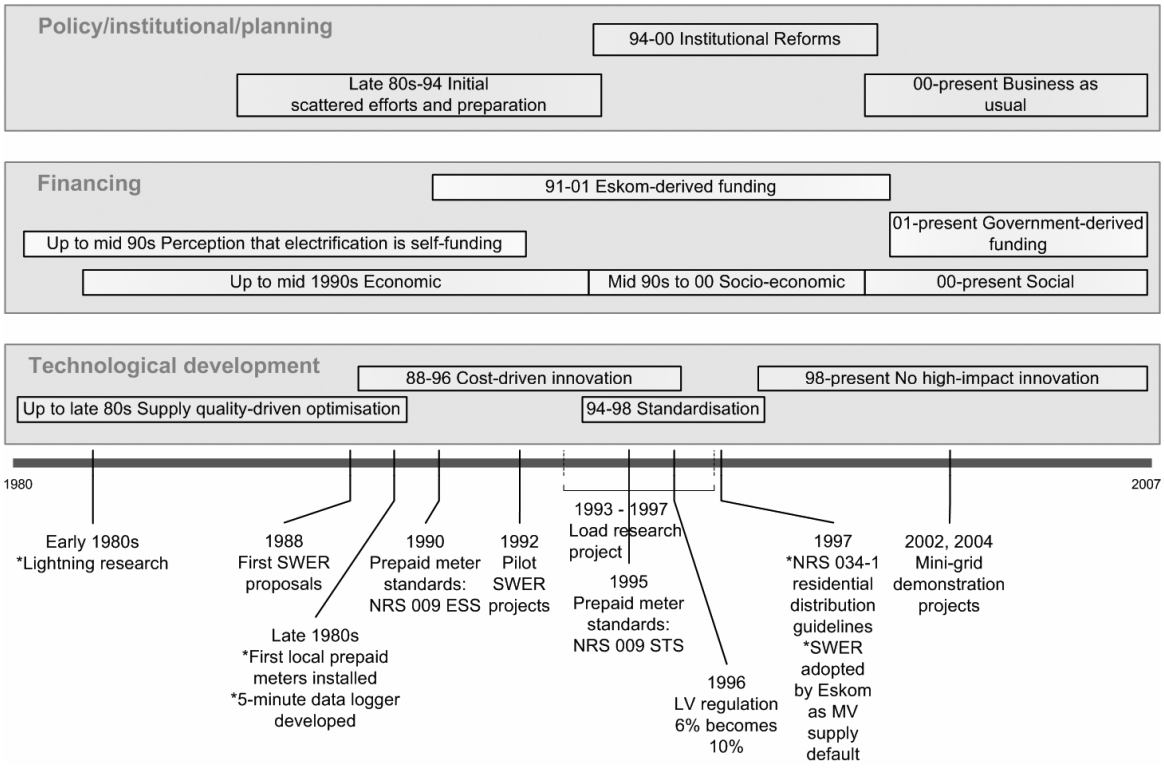


**Figure 6.1:** Technology development phases shown with Planning/Policy/Institutional and Financing phases and significant technology development events

## 6.1 Phase 1: Supply quality driven optimisation

During the pre-electrification programme of the 1980s primarily customers that could afford to pay in full were connected to the electricity supply network. The emphasis, therefore, was on providing high quality and reliable supply while minimising subsequent capital expenditure on network reinforcement, with connection cost only a secondary criterion in most utilities. This led to supply-quality-driven optimisation of technology. e.g. through substantial research into the impact of lightning on distribution lines by Escom and the Council for Scientific and Industrial Research (CSIR), and through constantly improved medium-voltage (MV) line designs.

During this period the majority of MV distribution systems, both urban and rural, provided three-phase supplies (i.e. three or four conductors) while most low voltage (LV) systems provided three-phase supplies to larger customers and single-phase supplies from the three-phase distribution to smaller customers such as households.

[37] See [Gaunt 2003] for a more in-depth analysis of technology developments during the electrification process.

In addition the models of domestic loads used in South Africa (i.e. models of the load requirements of customers, which is crucial to avoid over- or under-design of the distribution system) were mostly based on the work of American and European researchers in the 1940s and 1950s and UK guidelines, despite obvious differences between the energy consumption of customers there and in South Africa.

## 6.2 Phases 2 and 3: cost-driven optimisation and standardisation

Optimisation of technology design and performance could not offer significant further cost benefits by the time the 'Electricity for All' programme was initiated in the late 1980s. Although innovations like the context-sensitive use of concrete poles and cheaper conductors did cut costs, more radical changes were needed.

These radical changes occurred within three broad categories: firstly it became evident that significant cost-savings could be realised by changing conservative design specifications to those more suited to the requirements of typical customers. This realisation led to changes in both quality of supply and domestic load model specifications. Secondly innovative technologies like prepayment electricity meters and the broader adoption of unshielded and single-phase lines significantly reduced both capital and ongoing costs per connection. Finally, implementation processes were optimised in interaction with the electrification programme. These three categories are explored in more detail below.

### 6.2.1 Design specification changes

Design specification changes significantly affected electrification cost in two particular areas: domestic load modelling and quality of supply.

*Domestic load research*

In the late 1980s Herman [1991] developed data loggers that could make continuous time-synchronised measurements of individual customer loads averaged over short periods of typically 5 minutes, and from which the data could be downloaded every several weeks. These data loggers were used to collect electricity consumption data from communities in a Load Research Project from 1993, which informed the development of new design parameters to replace the more conservative parameters in use during the 1980s. The new parameters were standardised in the national design guideline for the design of residential distribution systems in 1997.

The impact of load research is clearly illustrated by design load specifications changes over time. Urban design loads dropped from up to 7 kVA per household during the 1980s, to around 3 kVA in the early 1990s, down to around 1.5 kVA in 2003. Rural

design standards dropped from around 2.5 kVA per household initially, to 0.4 kVA in 2003, with significant associated savings in distribution infrastructure.

*Quality of supply specifications*

Not all customers require the same quality of supply. Customers with continuous production systems and sophisticated machinery are financially sensitive to supply quality problems, while for most domestic customers these problems are more a nuisance than a cost. Tariff subsidies also play a role: is a subsidised customer entitled to the same supply quality as customers paying the full or even premium costs?

In the light of this, the allowable voltage regulation on LV systems in South Africa was increased from ±6% of nominal voltage to ±10% in 1996.

This relaxation of LV quality of supply specifications in association with other network design specification changes allowed network designers to specify a 'light' rather than a robust MV and LV network, with associated reduction in investment costs.

### 6.2.2 Innovative technologies

The adoption of innovative technologies often paralleled the development of new design specification parameters: for example, the introduction of single-phase lines would not have occurred if system planners were forced to specify unnecessarily high line capacities due to conservative design-load specifications.

*Single-phase lines*

Until 1990, nearly all MV distribution lines in Southern Africa were three-wire, three-phase lines, because they allowed subsequent extension of the line to other loads. Omitting the third phase for supplies to small loads, i.e. using two-wire, two-phase conductors, allows a substantial savings in conductor and structure costs. The logical next step was to omit another phase conductor, adopting single wire, earth return (SWER) technology with only one phase conductor instead of three.

Two main obstacles had to be overcome in adopting single-phase (i.e. two-phase and SWER lines) supplies: perceptions that single-phase supplies are inadequate for large motor loads (which require three phase supplies); and perceptions that the systems represented a decrease in reliability.

The first obstacle was overcome by the development of a large single-phase motor by Witwatersrand University and a local manufacturer, and locally made power electronic single-to-three-phase converters. The cost of these solutions is usually insignificant compared with the savings on the distribution scheme as a whole.

Secondly, the reliability of single-phase lines is much higher than the reliability of conventional three-phase lines, as fewer components are exposed to environmental stress for the same length of line.

The adoption of single-phase technology contributed significantly to reducing the rural cost per connection during the electrification programme. For the cost of a three-phase line, almost three SWER lines can be built, reaching more customers in for the same cost.

*Prepayment metering*

The first locally developed prepayment meters were introduced during the late 1980s. The objectives were to remove the need for postal delivery addresses for billing, reduce the costs of reading meters, and reduce non-payment by helping customers not to incur unaffordable consumption costs, which was already a problem in many township areas [Tewaria and Shahb 2003].

Eskom and most municipalities adopted prepaid metering on a large scale after 1990, with the meters usually installed in households with 'readyboards', a distribution board placed in a central location in a house or shack which contained one or two plug sockets and a light, facilitating electricity use without further house wiring.

Prepayment metering suffered a number of development problems, including the incompatibilities of proprietary systems with each other that led to problems when early manufacturing companies went out of business or were taken over, or utilities wanted to change suppliers. To address this problem, in 1990 Eskom, the major municipalities and the meter manufacturers developed the first industry standard for prepayment meters, NRS 009: Electricity sales systems.

Following this standardisation, the meters still only recognised tokens issued by vending machines from the same manufacturer, until a common vending system with a standard transfer specification (STS) was developed and adopted under NRS 009 in 1995, allowing all meters to accept tokens from any vending station.

### 6.2.3 Implementation processes

Innovative technologies and design specification changes alone are, however, insufficient to explain the changes that occurred during the electrification programme. Implementation processes played a crucial role, including greater use of decision-aiding techniques and tools, for example the GIS based electrification prioritisation tools developed by Banks et al. [2000], adoption of new financial evaluation methods (e.g. the modified Internal Rate of Return method used by Eskom), computer-based asset management, and software for feeder design [Dwolatsky & Meyer 1996]. Planning

processes that included social aspects like community liaison also evolved [Stephen & Sokopo 2001].

Research activity by a cohort of specialists prior to commencement of the NEP was crucial to the success of the electrification programme [Dwolatsky 2001], as was the ongoing development of skilled designers to implement the programme. Knowledge sharing and transfer also occurred across all spheres related to electrification, encouraged by a number of workshops and conferences.

The decision to use an implementation process of blanket electrification (i.e. provide supply to all potential customers in an area, and also known as area coverage) instead of selective electrification (connect only the customers applying and paying for connections) during the electrification programme allowed Eskom to plan on a long term rather than an ad hoc basis, and removed cumbersome quoting and payment procedures [Dingley 1988]. In addition it reduced perceptions of unfairness or economic discrimination as everyone in the area gets access to electricity. A higher proportion of poor households were reached, which through tariff subsidies, established the potential for subsequent poverty alleviation. Disadvantages include the lower average consumption of customers and higher total operating costs than with selective electrification.

Eskom's adoption of the blanket approach after 1995 significantly lowered connections costs.

## 6.3 Phase 4: no high-impact innovation

No technology innovations after the late 1990s had a significant impact on the electrification programme in terms of cost per connection or increased annual connections.

A potentially innovative off-grid network arrangement, the mini-grid, was tested through two demonstration projects in the Eastern Cape, commissioned between 2002 and 2004. Instead of individual off-grid household installations, a mini-grid distributes energy from a local generation source, e.g. mini-hydro, PV, wind, diesel or a combination of these, to several households located close to each other and the source. The mini-grid can be potentially integrated into the national grid at a later stage.

The Hluleka nature reserve (11 kW) and the nearby community of Lucingweni's (86 kW) minigrid systems were however both non-functional by the end of 2006 due to mainly social and institutional problems. Despite these problems, mini-grid systems are technically feasible, and possibly financially viable when compared with initial SHS electrification followed by eventual connection to the national grid.

# 7 Social and economic impacts

Electrification has a number of social and economic impacts. This section will assess the effect of the South African electrification programme around two questions: 1) What impact has the programme had on household energy use? and 2) What economic impact has the programme had?

## 7.1 Data availability

One of the fundamental problems with measuring outcomes of the electrification programme is the availability of data. National data is limited, with no accurate public data on complex phenomena such as disconnections, illegal and informal connections[38] (which are apparently widespread). A number of scattered studies provide a brief national picture but important qualitative information on the complexities of the effect of electrification on low-income households and communities is not available.

### 7.1.1 National data

The main source of national data is Stats SA, which measures household access to services through annual household surveys and national censuses. A selection of surveyed indicators are shown in figure 7.1, based on data from the October Household Survey (OHS) (conducted from 1995 to 1999), the July General Household Survey (GHS) (from 2002 until the present) and 1996 and 2001 October Census data.

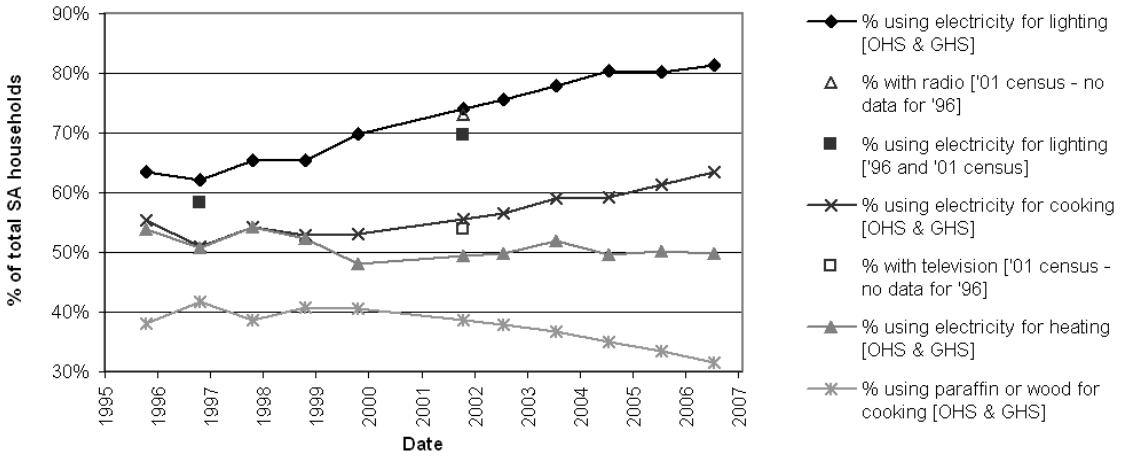


**Figure 7.1**: South African households access to services [Stats SA OHS, GHS and Census]

In addition to Stats SA, data has been collected since 2002 from INEP implementers on the impacts of electrification projects on local business and employment, via a compulsory reporting process. This data is collated by the Electricity Policy section of the DME, but is not in the public domain. A summary of the jobs created directly by the

[38] Informal connections are extensions of electricity supply from one household to another by householders (thus the electricity is still metered), whereas illegal connections comprise connections to the distribution grid by householders or their agents that bypass metering systems.

programme, as well as expenditure on SMME, BEE and BWO companies is reported annually in NER, DME and Eskom reports, as shown in table 7.1. (02/03 data includes both Eskom and Municipality figures, while 04/05 data [DME 2005:27] is only from Eskom. No information on the sources of later data was published).

| | Total capital expenditure ('000) | Socio-economic expenditure ('000) | Socio-economic expenditure (% of total) | *Spend through BEE companies ('000)* | *Spend through BWO companies ('000)* | *Spend through SMMEs ('000)* | Jobs created |
|---|---|---|---|---|---|---|---|
| 2001 | 909,440 | 174,783 | 19.2% | 54,680 | - | 120,103 | 3,233 |
| 2002 | 899,070 | 180,501 | 20.1% | 41,562 | - | 138,939 | 3,132 |
| 2003 | 931,310 | 162,123 | 17.4% | 92,784 | - | 69,339 | 3,199 |
| 02/03 | 923,400 | 394,800 | 42.8% | 394,800 | - | - | 2,587 |
| 03/04 | - | - | - | - | - | - | - |
| 04/05 | 1,260,000 | 508,999 | 40.4% | 77,584 | 112,278 | 319,136 | 4,721 |
| 05/06 | 1,176,000 | 453,542 | 38.6% | 77,156 | 125,344 | 251,042 | 2,586 |
| 06/07 | 897,232 | 560,861 | 62.5% | 278,197 | 63,369 | 219,295 | 5,255 |

**Table 7.1**: Electrification programme socio-economic expenditure. 2001-2003 published by NER [2003] from responses by 77 (73 in 2003) distribution licensees, 02/03 to 06/07 from the relevant DME annual reports.

### 7.1.2 Data from studies

Mainly two types of studies were done on the impact of electrification: baseline-type studies which identified problems, and impact studies which evaluated whether the programme was solving the problems identified in the baseline-type studies.

Significant base-line studies were done as part of a DME review on the RDP stage of the electrification programme [DME 2001b], and as part of a pilot research project into options for a basic electricity support tariff [UCT 2003], which culminated in the implementation of FBE.

Numerous studies exist on the impact of electrification in South Africa. The EDRC published a series of reports on energy use in individual households, economic activity in communities, and the availability and efficacy of services like education and health, including [Rogerson 1997], [Ross et al. 1997] and [Wentzel et al. 1997]. The relationship between energy and poverty is explored in reports published by the Global Network on Energy for Sustainable Development (GNESD) with the ERC, e.g [Prasad and Visagie 2005, 2006], while an unusual longitudinal study explores electrification's impact over time on the consumption patterns in rural villages [Madubansi and Shackleton 2006]. A comprehensive bibliography on energy access publications can be found in [Karekezi et al. 2003]. A major problem in impact studies is the high cost of collecting useful data from a representatively large sample of the population.

## 7.2 Electrification's impact on household energy use

The trends in households electricity usage apparent from the survey data shown in figure 7.1 indicates an increasing use of electricity for lighting, a far slower rate of increase for cooking, a static and even slightly-declining use for heating, and a steady reduction in the use of paraffin or wood for cooking.

However, the way in which the Stats SA surveys are structured has some limitations. To begin with, the indication by a specific household of the main energy carrier per energy service is likely to mask a more complex and dynamic pattern of use. Research in South Africa and elsewhere during the 1990s, e.g. [Mehlwana & Qase 1998], identified multiple fuel use[39] as the norm in low-income households, for a variety of budgetary and other reasons.

Furthermore the data in figure 7.1 does not differentiate between households with different income levels. Yet "…*it appears as though many of the effects of electrification are themselves related to income levels, with many effects found to be present or stronger in higher income groups. Low income electrified households appear to have fuel choice patterns similar to those of un-electrified households, and electricity appears to be an additional fuel and an additional expense for those households*." [Davis and Ward 1995:14]. The quoted study further notes that the use of candles and thermal fuels persists after electrification in these low-income households. An interesting result of the correlation between income and electricity use is reported in a post-electrification case study of a poor community: "*electrification increases inequities between rich and poor households*" [Wentzel et al. 1997].

Although use for lighting and media (especially radio and to a lesser extent TV – see figure 7.1) is widespread, the limited impact of electrification on thermal applications undermines the total utility of the electrification programme, since the majority of negative externalities of particularly paraffin, wood and coal use (e.g. local and indoor air pollution) stem from cooking and heating applications. Madubansi and Shackleton [2006] indicates that the slow but steady migration of households towards using electricity for thermal applications reported by Stats SA does not necessarily apply in rural areas: "…*for thermal needs, most notably cooking, fuelwood has remained the most widespread fuel, and the amount used per month has not changed, despite increasing scarcity of wood in the local environment*." Reasons for the non-use of electricity for thermal applications are

[39] I.e. using several energy carriers/appliances for the same energy service, as well as using different energy carriers for different services.

complex, and vary from cultural inertia to change [Sebitosi & Pillay 2005] to the perceived affordability of electricity[40].

A study by Davis [1995] on the electricity consumption by low-income households indicated that consumption grew quickly after electrification but often to a very low plateau, with up to 80% of households in certain areas consuming less than 100 kWh per month three years after electrification.

### 7.2.1 The impact of Free Basic Electricity

The introduction of FBE was partly in response to the realisation that electrification is not synonymous with a migration by low-income households to electricity.

Case studies reported in UCT [2003] have shown that the introduction of FBE has increased the use of electricity for lighting, and that the use of other energy carriers for cooking and heating has fallen significantly. However, the authors note that "*it is unlikely that poor households will abandon multiple fuel use even in the long term*" [UCT 2003:18].

The fact that by March 2007 only 65% of households reconfigured by Eskom for FBE consume their full FBE allocation (see table 7.2) indicates that the FBE programme is also not entirely successful in one of its other goals: addressing the impact of income disparities on household energy use. This might partly be due to a number of reasons reported by UCT [2003], including that the recipients of FBE do not understand how it works, and that vendors are unwilling to supply the recipients with FBE credits without some form of compensation.

| | Munics contracted with Eskom for FBE (%) | Eskom households approved for FBE ('000) | Eskom meters reconfigured for FBE ('000) | Eskom households who consumed FBE allocation (%) | Total households receiving FBE ('000) [DME] | Eligible households receiving FBE (%) [DME] |
|---|---|---|---|---|---|---|
| 03 | 35% | 425 | - | - | - | - |
| Dec03-Mar05 | 88% | 750 | 585 | 57% | 3,500 | - |
| 05/06 | 98% | 1,254 | 1,048 | 55% | - | 60% |
| 06/07 | 97% | 1,182 | 1,074 | 65% | - | 70% |

**Table 7.2**: Free Basic Electricity delivery, published in Eskom and DME annual reports.

Howells et al. [2006] raises the question of whether electricity is the best energy carrier for thermal use in low-income households, given that methane or LPG are safe, clean, easy to use and in most cases affordable alternatives. DME's 06/07 strategic plan gives an indication of future policy in this regard: "*With the electrification of households, a need for cooking and heating energy carriers has been identified… It is for this reason that*

[40] Unlike paraffin, electricity use is not easy to budget for on a daily basis, and appliances are much more expensive. However, most analyses indicate that electricity is usually cheaper in the long term than alternatives, except firewood when it is available for collection and low value is attached to the labour.

*provision of LPG and other renewable energy sources* (sic) *to households will be intensified. It is envisaged that these energy carriers will in future be included in the basket of free basic energy provision.*" [DME 2006b :5]

### 7.3 Other impacts

Studies on whether electrification stimulates economic growth, e.g. [Borchers & Hofmeyr 1997] and [Rogerson 1997], have concluded that electrification does stimulate the establishment and growth of local businesses, although inputs like market access and financing play a more important role. The DME [2001b:21] report lists anecdotal evidence that electrification led to significant opportunities for entrepreneurial activity.

Assessing the extent to which electrification has contributed to increased racial equity in South Africa is difficult: the only publicly available figures on the racial equity impact of electrification are the amount of electrification funds channelled through BEE and BWO enterprises (see table 7.1).

The jobs created by the electrification programme appear to be largely temporary (197 permanent and 2390 temporary jobs are reported in DME [2003]), and although the number of jobs appears to be increasing (5255 in 06/07 - refer to table 7.1), it is still low when viewed in the light of the DME's strategic target of creating one new informal job for every R100000 of INEP capital expenditure [DME 2004b:32], which translates into 8970 informal jobs for the R897 million spend in the INEP in 06/07.

# 8 Conclusion

Despite the unorthodox way in which South Africa's electrification programme emerged, several patterns of institutional and policy development are evident. First, the policy uncertainty and turmoil associated with the transition, far from being a negative influence on the programme, were essential to its success, since electrification was placed suddenly and strongly on the agenda, and did not encounter obstacles from traditional state agencies, which were partly or completely marginalised; it is unlikely that a less extreme 'policy window' would have led to the same outcome. A programme on a smaller scale would have been a dismal failure with household growth outstripping electrification.

However, while government institutions were sidelined, three other groups played an essential role. First, Eskom's role was crucial, for a number of reasons. First, it could mobilise unique resources (managerial-technical skills, financial, economies of scale), largely due to the De Villiers Commission instigated reforms in the 1980s and Eskom's low capital requirements at the time. To have attempted to fund the programme from the fiscus would probably have delayed its implementation for years. Second, Eskom acted

as a significant resource to central government in facilitating the development of organisational capacity within government (both in the NER and the DME).

The second important group was local government. While this sector was highly fragmented and faced many challenges, a few of the better managed municipal distributors made a significant contribution to the overall electrification effort.

A third group which was vital to the programme were the university-based electricity researchers who participated in the Old Mutual / Nedcor scenarios and the energy policy analysts/activists in the EDRC/ANC, who facilitated the political legitimacy of the programme so essential to its sustainability, and who, with NELF, were the architects of the 'accelerated' programme. Independent policy research capacity on this scale in developing countries is not often present, and was probably a unique ingredient of the transition.

A notable feature of the programme was the length of time it took to develop an electrification policy and implementation system in government – approximately 12 years from the inception of the programme. However, the INEP is now a substantial agency, with a budget of R1.4 billion and an extensive planning system. The emergence of INEP in the DME in its present form was in turn dependent on a) existing organisational resources (Eskom, the NER) being placed at its disposal for a significant period of time, and b) the development of a range of accompanying institutions during the transition, including a new local government regime, a new spatial planning system, and significant reforms in central government, all of which took several years in most instances to begin operating effectively. It is tempting to suggest that an alternative model, a truly national utility (such as EdF) would have been more efficient; however, the current structure of Eskom and the municipal utilities accommodates a significant degree of institutional diversity in implementation, which was identified in the 2001 review of the National Electrification Programme as one of the programme's strength [Borchers et al 2001:v].

Technology development played an essential role in reducing the real cost per connection (through innovations like SWER lines and leaner, more flexible design specifications) and reaching the social aims of the electrification programme (through innovations like prepayment metering and processes like blanket electrification). Strong research activity and knowledge sharing were crucial components in this process.

The last notable trend was the interesting transition of electrification from a socially desirable (but economically limited) activity to an imperative, brought about broadly by a powerful democratic drive and commitment to service delivery (including the electoral significance of achieving RDP targets). As a result, the programme as a whole has extended its scope of activities, funding the whole capital cost of connection, providing

bulk infrastructure, and providing various forms of capacity support to local authorities, as well as the separate FBE programme.

Still, access to electricity by 100% of South Africa's 2012 households is practically impossible by this stage due to significant financial and capacity obstacles. Although the government has made a clear statement of policy preference for Universal Access by 2012/13, the funding available for electrification is significantly below the level required to meet even the DME's Universal Access Plan targets, which would result in roughly 80% access by 2012. Meeting even these targets requires strong political backing, hugely increased electrification budget allocations, and a dramatic step-up in terms of capacity.

In light of this analysis, the government needs to consider the political and social implications of not meeting the Universal Access goal by 2012, and should then reassess existing electrification targets, together with the efficiency of current electrification progress measurement and reporting systems. Ultimately, a more realistic and achievable set of planning targets will need to be developed.

In addition to the potential of not meeting the Universal Access Plan, there are several side effects of the success of the programme, the main one being, ironically, the neglect of other aspects of household energy provision. There has been a lack of sustained political interest in developing the DME's capacity to draft and implement an integrated household energy policy, which on paper is an important policy goal, but in reality has not been pursued. Another significant side-effect can be termed 'policy creep' – the tendency of the programme's prestige and success to result in it addressing a wider range of problems which might be better addressed elsewhere, such as capacity problems in local distributors, the persistence of which is partly the outcome of the failure of policy initiatives in other areas, specifically the EDI restructuring process. On the whole, however, it is difficult to underestimate the significance of the electrification programme on the welfare of South Africans.

The replication of the South African experience may, however, be limited, due to a number of reasons: first, the nature of the political transition; second, the presence of a strong national utility, in many respects unencumbered by the kinds of problems which usually face developing country utilities; and third, a dominant industrial load base which absorbed various forms of cross-subsidies when the programme was initiated.

However, several lessons can be drawn. One of the most interesting is probably the institutional and planning arrangements which the South African programme has developed; another is the significance of the development of appropriate cost-driven technical innovations and standards, and the third, proposed by Gaunt [2005], is the

clear acknowledgement of the social function of electrification and its funding from the fiscus (rather than through cross-subsidies).

# References


ANC 1994, *The Reconstruction and Development Programme: A Policy Framework*, African National Congress, Johannesburg

Banks DI, Mocke F, Jonck EC, Labuschagne E & Eberhard R 2000, *Electrification Planning Decision Support Tool*, Domestic use of energy conference, Cape Town, April

Borchers M & Hofmeyer I 1997, *Rural Electrification supply options to support health, education and SMME development*, EDRC, University of Cape Town

Conradie SR & Messerschmidt LJM 2000, *A Symphony of Power*, Chris Van Rensburg Publications, Johannesburg

Davis M 1995, *Electricity consumption growth in newly electrified settlements*, EDRC, University of Cape Town

Davis M and Ward S 1995, Household energy-use patterns in rural areas: the effects of access to electricity, EDRC, University of Cape Town

Davis M 1997, *Electrification and institutional reform in power utilities: case studies in South Africa and Switzerland*, Unpublished DPhil thesis, University of Sussex

De Villiers et al 1984, *Report of the commission of inquiry into the supply of electricity in the Republic of South Africa*, Government Press, October

DME 1998, *White Paper on Energy Policy*, Department of Minerals and Energy, Pretoria

DME 2001, *Annual Report 00/01*, Department of Minerals and Energy, Pretoria

DME 2001b, Borchers M, Qase N, Gaunt T, Mavhungu J, Winkler H, Afrane-Okese Y & Thom C, *National Electrification Programme evaluation: Summary report*, Evaluation commissioned by the Department of Minerals & Energy and the Development Bank of Southern Africa, Cape Town, EDRC, University of Cape Town

DME 2004, *Annual Report 03/04*, Department of Minerals and Energy, Pretoria

DME 2004b, *Strategic Report 04/05 – 06/07*, Department of Minerals and Energy, Pretoria

DME 2005, *Annual Report 04/05*, Department of Minerals and Energy, Pretoria

DME 2006, *Annual Report 05/06*, Department of Minerals and Energy, Pretoria

DME 2006b, *Strategic Report 06/07 – 10/11*, Department of Minerals and Energy, Pretoria

DME 2006c, *Integrated National Electrification Programme to Achieve Universal Access to Electricity by 2012 – Masterplan*, Department of Minerals and Energy, Pretoria

DME 2006d, *Digest of South African energy statistics*, Directorate: energy planning and development, Department of Minerals and Energy, Pretoria

DME 2007, *Annual Report 06/07*, Department of Minerals and Energy, Pretoria

DME 2007b, *Strategic Report 07/08 – 09/10*, Department of Minerals and Energy, Pretoria

DME 2007c, *Powerpoint presentation by M P Masemola on the DME's universal access plan*, www.dme.gov.za, Department of Minerals and Energy, Pretoria

Dingley CE 1987, *Some issues related to the electrification of the underdeveloped areas of South Africa*, SAIEE Conference, August

Dingley CE 1988, *A review of electrification programmes in six countries,* University of Cape Town, September

Dingley CE 1990, *Electricity for all in South Africa: The need and the means*, Department of Electrical and Electronic Engineering, University of Cape Town

Dwolatzky B, Meyer A S 1996, *A software-based design methodology for the design of low-cost electrical reticulation networks*, CIRED 9, IEE Conference Publication No. 438, pp.6.8.1 – 6.8.3

Dwolatzky B, 2001, *The Contribution by Academic Institutions to Electrification in South Africa*, Proceedings of the International Conference on Electrical Engineering and Technology (ICEET01)

Eberhard A & Van Horen C 1995, *Poverty and Power: Energy and the South African State*, UCT Press, Cape Town

Eberhard, A 1984, *Energy and poverty in urban and peri-urban areas around Cape Town*, Conference paper 155, Second Carnegie inquiry into poverty and development in southern Africa, Cape Town

Eberhard, A 1986, *Energy consumption patterns in underdeveloped areas in South Africa*, Energy Research Institute, University of Cape Town

Eskom 1987, *Annual report 1987*, Megawatt Park, Johannesburg

Eskom 1990, *Annual report 1990*, Megawatt Park, Johannesburg

Eskom 1991, *Annual report 1991*, Megawatt Park, Johannesburg

Eskom 1992, *Annual report 1992*, Megawatt Park, Johannesburg

Eskom 1994, *Annual report 1994*, Megawatt Park, Johannesburg

Eskom 2001, *Annual report 2001*, Megawatt Park, Johannesburg

Eskom 2003, *Annual report 2003*, Megawatt Park, Johannesburg

Eskom 2004, *Annual report 2004*, Megawatt Park, Johannesburg

Eskom 2007, *Annual report 2007*, Megawatt Park, Johannesburg

Gaunt 2003, *Electrification Technology and Processes to Meet Economic and Social Objectives in Southern Africa*, PhD Thesis, Department of Electrical Engineering, University of Cape Town

Gaunt 2005, *Meeting electrification's social objectives in South Africa, and implications for developing countries*. Energy Policy, Vol 33, pp1309-1317

Howells M, Victor D, Gaunt T, Elias R and Alfstad T 2006, *Beyond free electricity: The costs of electric cooking in poor households and a market-friendly alternative*, Energy Policy, Volume 34, Issue 17, November, p3351-3358

Horwitz R 1994, *Apartheid, it's demise and electricity: The development of the institutional and regulatory structures of the South African electricity system*, EDRC, Cape Town

IAEA 2005, *Energy Indicators for Sustainable Development: Guidelines and Methodologies*, International Atomic Energy Agency, Vienna, April

Karekezi S, Kimani J and Mutiga A 2003, *Updated Draft Annotated Bibliography Version 4, Energy Access Theme*, Global Network on Energy for Sustainable Development, www.afrepren.org

Kingdon JW 1995, *Agendas, Alternatives, and Public Policies*, HarperCollins College Publishers, New York

Madubansi M and Shackleton C.M 2006, *Changing energy profiles and consumption patterns following electrification in five rural villages, South Africa*, Energy Policy 34, 4081–4092

Mbeki T 2004, *Address of the President of South Africa, Thabo Mbeki, to the first joint sitting of the third democratic Parliament, Cape Town*, 21 May 2004

McRae I 2006, *The Test of Leadership: 50 Years in the Electricity Supply Industry in South Africa*, EE Publishers

Mehlwana MA & Qase N 1998, *The contours of domesticity, energy consumption and poverty: The social determinants of energy use in low-income urban households in Cape Town's townships (1995-1997)*, EDRC, Cape Town

NELF 1993, *NELF News September 1993 No.1*, National Electrification Forum, Midrand

NER 1998, *Lighting Up South Africa 1998*, National Electricity Regulator, Pretoria

NER 2003, *Lighting Up South Africa 2003*, National Electricity Regulator, Pretoria

NER 2005, *Electricity Supply Statistics for South Africa 2005*, National Electricity Regulator, Pretoria

Prasad G and Visagie E 2005, *Renewable energy technologies for poverty alleviation, Initial assessment report: South Africa*, Global Network on Energy for Sustainable Development, Energy Research Centre, University of Cape Town

Prasad G and Visagie E 2006, *Impact of energy reforms on the poor in Southern Africa*, Global Network on Energy for Sustainable Development, Energy Research Centre, University of Cape Town

Rogerson CM 1997, *Rural electrification and the SMME economy in South Africa*, EDRC, University of Cape Town

Ross F, Matzopoulos R and Phillips R 1997, *The role of rural electrification in promoting health in South Africa*, EDRC, University of Cape Town

SA Government 2002, *Government Gazette 25088*, South African Government

Sebitosi AB & Pillay P 2005, *Energy services in sub-saharan Africa: how conductive is the Environment?*, Energy Policy Journal 33, p2044-2051

Segal N 2007, *Breaking the Mould - the role of Scenarios in shaping South Africa's future*, Sun Press, Stellenbosch

Stats SA 1994, *1994 October Household Survey*, Statistics South Africa, Pretoria

Stats SA 2000, *Census in Brief – The people of South Africa: population census 1996 – Summary Report*, Statistics South Africa, Pretoria

Stats SA 2003, *Investigation into appropriate definitions of urban and rural areas for South Africa*, Census 2001, Statistics South Africa, Pretoria

Stats SA 2005, *Census 2001: achieving a better life for all – progress between Census 1996 and Census 2001*, Statistics South Africa, Pretoria

Stats SA 2006, 2006 General Household Survey, Statistics South Africa, Pretoria

Stephen D & Sokopo I 2001, *On the subject of innovation: response from Eskom*, in DME 2001b

Tewaria D.D. and Shahb T 2003, *An assessment of South African prepaid electricity experiment, lessons learned, and their policy implications for developing countries*, Energy Policy 31, 911–927

Theron P (ed) 1992, *Proceeding of the ANC National meeting on Electrification, 6-7 February 1992*, University of Cape Town, Centre for Development Studies

UCT 2002, *Options for a basic electricity support tariff*, Research project 400903, University of Cape Town, 28 February

UCT 2003, *Options for a basic electricity support tariff: supplementary report*, Research project 400903, University of Cape Town

Wentzel M, Manzini M, Mulaudzi C, Sehlapelo D, Wood C 1997, *A post-electrification study of the Mafefe electrification project*, EDRC, University of Cape Town