SECRET for a RED future -
Six issues affecting Restructuring of Electricity Distribution

C T Gaunt
Department of Electrical Engineering, University of Cape Town

1 Introduction

20 years ago, in the mid-1980s, power station construction in South Africa was proceeding fast, as Eskom built its way out of the power shortages earlier in the decade. Then consumption growth slowed, and suddenly there was too much capacity. There were two important responses; electrification and restructuring.

By 1990 electrification was envisaged as Electricity for All. It became the National Electrification Programme and between them the two programmes doubled the number of households in South Africa with access to electricity. The cost was high, about R10bn, but the contribution to meeting socio-economic and social objectives was substantial.

The electrification proposals were accompanied by proposals for restructuring. Radical restructuring was justified as necessary to achieve the ambitious numerical objectives, fund the electrification programmes, reduce prices, and generate many other benefits. There were many proposals and progress reports to AMEU meetings and elsewhere, but compared with electrification, negligible achievements have been made with restructuring, although the costs have been significant. The proposals have created uncertainty in the industry and contributed to the neglect of maintenance, loss of experienced staff and widespread failures of supply. Perhaps the cost of restructuring has exceeded the cost of electrification?

This paper explores six broad issues likely to affect how these two processes, electrification and restructuring, may develop in the future.

2 Fundamentals

Most of the participants in the electricity supply industry agree on the fundamentals, although this may not be apparent to those outside the debates! The common objective is development, which can be characterised as having three components:

- Economic development pursues efficiency, growth and financial return.
- Social development is concerned with equity, justice and poverty alleviation.
- Socio-economic development seeks long-term sustainable changes of lifestyle.

The differences between the participants in development arise from their differences in values, interests and resources. The contestation of resources leads to apparent conflict between the participants and is essentially political, though not necessarily a party-political activity. The outcomes of the political processes are structures and systems of control and influence. These structures and systems may distort the attainment of the original objectives, through the effect often referred to as unintended consequences.

Unintended consequences usually arise from a lack of awareness or an inadequate understanding of the situation, in this case the electricity distribution industry and all it encompasses. Misinformation and mistakes in decision-making are seldom reversible, demonstrating the importance of information that is clear, accurate, appropriate and easy to understand. Given the size and complexity of the electricity distribution industry, the information does not always meet this specification!

Also, given the irreversibility of most decisions and events, it is necessary to recognise that, whatever the history, progress can only be made by recognising the reality of the present situation and moving forward from that position. The following issues are discussed in that context. To limit the complexity, the discussion is constrained to electricity distribution, although many aspects apply similarly to transmission and generation.

3 Open SECRET

Based on my own experience and analysis of the distribution industry in South Africa, I have identified what I consider to be six significant issues: Skills, Entitlement, Capacity, Reliability, Environment and Tariffs. They cannot be completely separated from each other, and an alternative analysis might identify alternative clusters of characteristics, but they provide a useful format.

3.1 Capacity

The limits of the capacity of the national electricity network have been very evident recently. Frequent interruptions, compared with international benchmarks, affect urban and rural areas. Significant failures have occurred in all the main cities, with the disruptions in the Western Cape being arguably the most evident and costly for the economy. The limits of generating capacity were identified in forecasts prepared in the 1990s, which appear to have been reasonably accurate. With all generation committed, the delivery networks are also operating close to their limits, particularly when the inevitable faults occur and N-1 contingency planning is shown to be inadequate. Even without faults, the domestic customer load research programme has identified that the supply voltages for many customers are well outside the quality of supply limits adopted as regulatory standards. Networks operating close to capacity and with large voltage drop incur high technical losses.

While the capacity of the power system is a problem for some, there are others who do not even have access. Electrification reached nearly 70% of households in 1999, but since then the net rate of connections has only just kept pace with the construction of new households, with the result that access had increased to only 72% by 2005. (Note: This figure does not appear to have been published and is derived from various reports of connections and household numbers.) At this rate, and with the present level of allocations from the National Electrification Fund, it is unlikely that universal access will be achieved by 2012 in accordance with government policy.

The implementation of load shedding, whether voluntary or imposed, and the unsupplied demand of those who have no access distort the reporting of the real demand for electricity.

The problems of the capacity of the networks indicate the limited ability of the institutions responsible for electricity distribution to improve the situation.

So, the issue is: The distribution industry does not have enough electricity to meet customer requirements, the networks do not reach all the customers, the existing networks are under severe strain, and the institutions themselves cannot respond adequately to the needs.

3.2 Entitlement

The problems of capacity lead naturally to consideration of who is entitled to have electricity. Since electricity supports economic, socio-economic and social development, it appears that industry, commerce, other institutions and households all have a right to consume. Constitutionally, municipalities have the rights and responsibilities to supply electricity to customers in their areas. Similarly, the national utility, now Eskom, was established to ensure the adequate and economical supply of electricity to those requiring it, in support of national development. Clearly entitlement in the electricity sector is complex.

One change from the period of giddy power station building of the 80s has been in the concern for the environment. The need for and desirability of large fossil-fuel burning power stations is now more than a financial decision based on costs and potential tariff revenue. Serious consideration must be given to emissions and alternative uses for the fuels, various technologies for generating electricity or alternatives for reducing the energy used. Within this context, it might become acceptable in future to restrict the consumption of electricity by the large customers who presently appear to be limited only by their willingness to pay.

At the other end of the scale, the social entitlement of domestic customers to electricity drives the electrification programme and the provision of free electricity. Even then, many poor households cannot afford sufficient electricity for heating energy, and alternatives like paraffin and LPG are always under consideration. However, the value of subsidising the delivery of more than one form

of energy raises questions about which form is the most appropriate and why it should be supported to the exclusion of other interests.

The issue is: While both customers and suppliers are entitled to participate in electricity delivery, the conditions under which supply should be provided are unclear.

3.3 Environment

Concern about the environment and climate change is strongly affecting the electricity industry in Europe and North America. Natural gas is preferred to oil and coal because of the lower carbon dioxide emissions per unit of electrical energy generated, but the maximum improvement is less than 25%. Renewable energy sources have no carbon emissions, as in wind generation, or have a short life-cycle such that the emissions equal the carbon absorption, as in generation from sugar cane bagasse.

The major problem with electricity from renewable sources is the high cost compared with conventional central generation, at least when based on normal financial analysis.

Most “renewable electricity” is financially viable only when policies are expressed in financial terms, such as carbon taxes, emissions trading and direct subsidies, or when government regulations dictate that a proportion of electricity must be generated from renewable sources. However, since any taxes or extra costs are part of the economic system, the support of renewable electricity through policy instruments distorts the allocation of resources through the market system. Further, subsidies for renewables reduce the availability of funds to subsidise other socially desirable processes, such as electrification and poverty alleviation.

Many developed countries have established environmental policies and substantial subsidies that create financially viable opportunities for small scale dispersed generation (DG) from renewable sources. DG and renewable energy technologies have significant implications for the planning and operation of electricity systems, including the emergence of active distribution networks.

Intrinsically viable generation possibilities, such as from bagasse or hydro power stations, require new grid codes and similar regulatory support to reduce the artificial barriers protecting monopolistic utilities. In contrast, “environmental” programmes that are not financially and economically viable weaken developing countries that are already short of resources for development, and should not be supported by special regulations.

Nuclear generation shares some of the advantages of renewable generation, such as negligible carbon or sulphur emissions. While concern is expressed at the high cost of waste management, financial analysis using even low net discount rates shows that the negative effects of long-term future costs on project viability are small. Accordingly nuclear power is emerging as an environmentally acceptable source with low costs similar to coal power stations.

The issue is: Central generation and conventional distribution, with limited DG supported by suitable grid codes and international subsidies, may provide the most attractive electricity supply in South Africa for a long time, while some other renewable energy policies may not be justifiable locally despite the importance of environmental sustainability.

3.4 Tariffs

While diversity of supply capacity was an objective of the White Paper on Energy Policy (in 1998), the distribution objectives clearly pursued uniformity, leading to proposals for six equal Regional Electricity Distributors playing on level fields, despite differences between customer density, economic activity and network development in various parts of the country. Restructuring was justified in part as necessary for tariff rationalisation and raising the funds for electrification, but the result would be to conceal cross-funding and subsidies within the Distributors.

The National Electricity Regulator was unable to achieve any tariff rationalisation in ten years, for any class of customer, despite tariff rationalisation being one of its objectives. The large number of complex tariffs makes it difficult to monitor and assist the few utilities that are financially unstable for a variety of reasons. Conventional objectives of tariff design, including stability, cost reflectivity, and transparency of subsidies, appear to have been submerged by the emphasis on restructuring of the institutions. Although the municipal demarcation process has shown that tariff changes can be forced by merging utilities, restructuring is not a precondition for tariff rationalisation. In contrast, the agglomeration of customers by ESCOs (electricity service companies) has allowed them and selected customers to benefit from distortions in tariffs, without adding value in the form of physical infrastructure, operations or maintenance.

Even when opportunities arose to adopt country-wide tariffs, such as a proposed single structure Basic Electricity Support Tariff, it was

decided instead to allow municipalities to introduce Free Basic Electricity (FBE) in whatever form they wished. This freedom appears to have contributed to the situation in which some customers deserving social subsidies still do not have FBE. Similarly, the acceptability of off-grid electrification was compromised by inconsistently high tariffs for small quantities of energy, in the order of R60 per month for 6 kWh.

In spite of the general lack of progress towards the objectives of tariff policy, much has been learnt about tariffs and pricing. The elasticity of demand for small customers has been measured and demand market participation has indicated the willingness of larger customers to shed load when financially compensated. This information could usefully inform tariff design in future.

Finally, the National Electrification Programme met its numerical objectives without funds freed from a restructured industry, and subsequently the government recognised the desirability of funding large social investments from the central fiscus. These developments indicate that the concepts of tariffs, funding and utility structure underlying the proposals for change were apparently incorrect.

The issue is: Why has tariff rationalisation, which has significant potential for implementing economic and social policies without radical organisational change, been virtually neglected?

3.5 Reliability

Tariffs represent the costs of supplying electricity. However, tariffs do not represent interruptions costs, which have become more visible in South Africa recently because of the widespread and extended blackouts in metropolitan areas, and claims that the interruptions have had a substantial impact on economic activity. In rural areas also, there are concerns that the costs of interruptions are substantial. Closely related to the cost of an interruption is the value or worth of an uninterrupted supply.

The development of national grids was a response to the need for increased reliability at acceptable cost. Interconnection of power stations and loads allowed the possibility of losing any one generator to be covered by the capacity of all the rest. This led to the concept of N-1 contingency planning, by which a whole system should be able to operate adequately with any one component out of service. However, as systems grow, the probability of more than one component not being available increases. One failure might not be noticed until the next failure initiates collapse, or multiple failures occur before the first can be repaired. Therefore, large systems require more sophisticated approaches to reliability, including the separation of risk and consequence, and the integration of planning, operations and maintenance.

Reliability is not limited to interruptions. Voltage quality, in terms of variation of voltage magnitude, voltage dips, harmonics and unbalance, affects the efficiency with which electricity can be used by the customers.

Many countries are trying to use integrated power systems, which were developed to improve reliability, as vehicles to impose energy competition. In the absence of true competition that can accommodate the many customers' different requirements, reliability is usually managed through performance regulation. However, since failure is a stochastic (probability) event, the actual performance may not be an accurate representation of the character of the system, and imposing severe post-event penalties is probably counter-productive in terms of effective system management.

The issue is: Reliability is the result of a complex relationship between planning, operations and maintenance, which are largely technical activities that should take into account the costs of both supply and interruptions, and is not easily managed by utility profit objectives and financial penalties for failures.

3.6 Skills

The core business of an electricity utility is the supply of electricity and the primary capability needed is technical. Practical technical skills and engineering understanding and experience are vital for planning, building, operating and maintaining the physical system that delivers electricity to customers. Shortages of those skills lead to problems: safety and costs depend on the physical integrity of the power system, protection systems determine the response to faults and the reliability of the supply, and metering is needed for revenue collection. There are clearly deficiencies in all these areas.

Technical skills and experience do not come in faceless packages. They are supplied by people with different expectations. Some want to belong to small communities while others want the scope and promotion opportunities of large organisations. Diverse utilities suit the needs of different people, as well as providing

varied experience. If suitable opportunities are denied, then people move to other utilities or into other businesses. Uniform institutions, like the proposed regional electricity distributors, do not provide the diverse conditions needed to train and retain the best skills and experience.

Successful development requires that the best use is made of all the skills and experience available. The industry cannot afford to pursue racial and gender transformation so aggressively that it limits capacity. For example, consulting engineers carry out many tasks that are not sufficiently continuous to justify full time staff in small and medium municipalities. Recently however, some local and provincial government tender requirements have been so restrictive that even black-owned consultancies cannot qualify without supplementary points for disability or women. Large utilities also have problems, with widespread reports of under-investment in human capital. And in competition with new projects, the less visible areas of operations and maintenance suffer most from shortages of skills.

The universities and technical colleges contribute substantially to preparing new entrants to the industry and have potential to provide “continuing education”, but are under-resourced in funds, staff and adequately prepared students.

The issue is: Present policies are inadequate for training and retaining the technical and engineering skills needed for viable electricity distribution, and uncertainty makes conditions worse.

4 Electricity Distribution in the future

These six issues are complex, but not a secret. Improving electricity distribution depends on understanding the complexity and adopting realistic policies and programmes to replace the simplistic proposals that treat only one issue at a time.

What then can we expect of electrification and restructuring?

4.1 Electrification

Environmental pressure will encourage the adoption of some renewables technologies, but they will be limited by high costs and a lack of local subsidies in favour of meeting other social and economic needs. The greatest emphasis will be on grid electrification. It will be necessary to develop entitlement and reliability policies regarding to whom, how and under what conditions electricity will be distributed.

Progress will be made towards building the network capacity for universal access, accepting that the technical innovation required and the high marginal cost of reaching deep-rural customers, such as in Limpopo and Eastern Cape, will delay completion. The need for demand management and effective and efficient poverty alleviation will probably lead to new tariffs for electrification customers. Continued financial support at adequate levels will be needed from the National Treasury to meet the national objectives of electrification and poverty alleviation. The eventual success of electrification will depend on the utilities retaining the skills needed to implement innovative systems and operate and maintain them.

4.2 Restructuring

Examination of the complex issues demonstrates the inadequacy of the simplistic concept of Regional Electricity Distributors and the radical and risky change they represent. A variety of initiatives and approaches is needed to make the best use of capacity and resources. A process of incremental change generates fewer unexpected consequences. Recognising that it is unnecessary to fix what isn’t broken, competition by comparison can be introduced. The performance of utilities in all categories of economic, socio-economic and social development can be compared. Successful utilities should be encouraged and supported. Those failing in their responsibilities need to change or be taken over by others, transferring the assets at no cost along with the obligations.

This incremental approach builds on the institutional capacity and diversity of the successful municipalities and encourages responsible municipal management. It will allow time to stabilise the systems, processes and human resources that have been disrupted by successive mergers of about 800 municipal and provincial electricity authorities into fewer than 190 utilities. Urgent attention is needed to human resources or skills and aligning tariffs.

The Regulator (now NERSA) should be responsible for comparing the utilities, withholding licenses from the ineffective ones unable to meet their obligations, and guiding tariffs reform. For example, it is evident that the costs of supplying electricity may be higher in some places than in others. National tariff rationalisation will need to be supported by

transparent subsidy transfers to support the more costly distribution.

Many other aspects also need attention, but removing the uncertainty and confusion inherent in the proposed REDs restructuring makes it possible to give attention to the details. NERSA could be strengthened by incorporating EDI Holdings, which has capacity but no purpose without radical restructuring. A strong Regulator with clarity of vision and purpose could contribute significantly to incremental restructuring of electricity distribution in South Africa.

5 A new vision

Rapid electrification and new visions for energy policies and regulation, which characterised the exciting 90s, plodded and stumbled through the first half of this decade. The electricity industry and the country cannot wait another five or fifteen years for new impetus to develop. Eskom is taking bold initiatives to remedy the deficiencies in generation and transmission. The municipalities should be equally bold in delivering the electricity to customers to support economic and social development.

There is no future in simplistic restructuring proposals. Failure to act constructively increases the problems and risks of the industry and the possibility it will fail in ways demonstrated in various other African countries. Municipalities have responsibilities and they must meet them in the context of the existing structure of the electricity industry. However, this is not a justification for business as usual. The problems are complex, and many changes are needed to improve the delivery of electricity. This analysis tries to create a better awareness of the relationships so that the participants can use their own information and logic to develop appropriate policies, and act on them.

There should be no secret in successfully restructuring electricity distribution. It's simply part of our business.

Prof C T Gaunt, Department of Electrical Engineering, University of Cape Town, Private Bag, Rondebosch, 7701 South Africa.
ctg@ebe.uct.ac.za

Trevor Gaunt's working experience has included equipment manufacturing, system protection, network analysis and planning, project management, organisation and tariff studies, and now at UCT teaching and research. He presented papers to the AMEU Technical Meetings in 1988 and 2002 and Conventions in 1991, 1993 and 2003.