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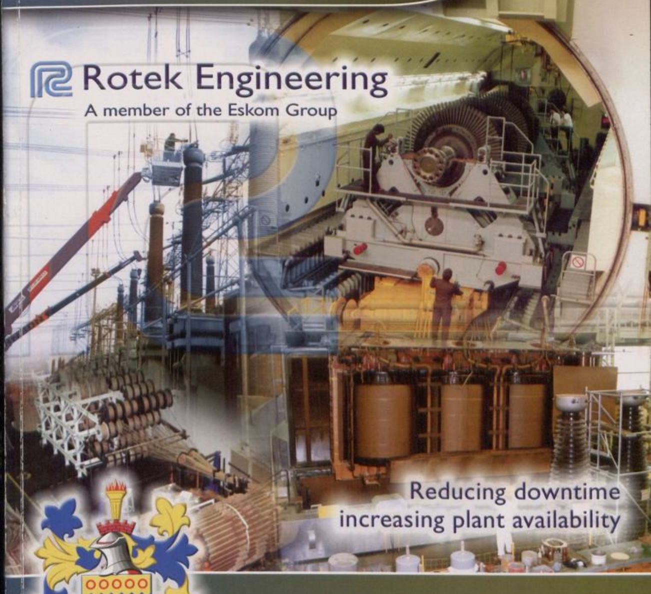
2003

Special AMEU Proceedings Edition

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**SPECIAL ISSUE**
**AMEU Convention Proceedings**
*Pietermaritzburg • Msunduzi 25 - 27 August 2003*

# Maintenance engineering: Rotek's unique capabilities

Information from Rotek Engineering

**Rotek Engineering focuses on maintenance engineering, including the repair, refurbishment, life extension, condition monitoring, spares provision, training and maintenance management of transformers, switchgear, turbines, generators and auxiliary plant (e.g. pumps, valves, cranes, etc.), as well as pump stations and pipelines.**

This capability is supported by one of the largest workshops of its kind in the world at Rosherville, capable of machining equipment up to 300 tons, turbo-generator plant up to 960 MW, and transformer repair up to 800 MVA and 765 kV.

Rotek has developed extensive resources, including skills, machinery and equipment, with fixed workshops at Rosherville and at most South African power stations, as well as mobile and containerised workshops, stores and offices.

Rotek is an ISO 9000-2000 listed company, and its business management system reflects the multitude of procedures required to work on all types, makes and technologies of power generation, transmission and distribution equipment.

Some of Rotek's unique capabilities, which translate into cost savings for the country and the customer, are detailed as follows:

- Stationery turbine blades, which operate in a highly abrasive high pressure steam environment, are refurbished as new at a cost of less than 40 % of their imported cost.
- Techniques have been developed for generator rotor rewinds, whereby the copper bars in the rotor are refurbished and re-used, saving some R3-million rand in foreign exchange for a 600 MW generator.
- Project management and engineering initiatives have enabled Rotek to cut the times of general overhauls on steam turbines and associated generators and auxiliary plant, from three months to under 40 days.
- For the past 25 years, Rotek has operated and maintained the bulk water schemes in Mpumalanga that supply water to South African power stations. Techniques have been developed to replace total medium voltage switchgear panels while the system is live, thus ensuring that the pump stations, which are required to supply water on a 24-hour basis, need not be switched off.
- Rotek has installed vibration monitoring equipment at a number of power stations, as well in most of the petro-chemical plants in the country, enabling remote monitoring by Rotek so that breakdowns can be predicted and customers notified, thus preventing catastrophic unscheduled shutdowns. Remote condition monitoring is also undertaken on transformers and switchgear, enabling preventative maintenance.
- For life-extension of power plant, Rotek undertakes the manufacture of spare parts through sophisticated reverse engineering and finite element analysis. This has major cost saving implications for older equipment where spares are no longer available, and where the customer would otherwise have to replace the total equipment (normally imported) at a major capital cost. A typical example of spares manufacture is that of coil retaining rings, which are manufactured by Rotek at 60% of the imported cost.
- On-site machining techniques have also been developed, which cut down both the price of maintenance, as well as minimising transport costs. Rotek has also developed a facility to re-metal white-metal bearings and, together with a technology partner from the USA, is able to recommend solutions to its customers' bearing problems.
- Rotek has developed a world leading transformer care programme, one element of which is the Dry Keep® on-line transformer oil moisture filter. This transformer care programme has been so successful that the majority of sales are for export – to the UK, Australia, USA and many African countries.
- Rotek has an extensive transformer oil facility, which includes storage and transport logistics and infrastructure testing, purification and regeneration.
- Rotek has a cooperation agreement with the South African Bureau of Standards, whereby two of the SABS' impulse generators are stationed at Rosherville, and the customer saves on transport and labour, which may be in excess of 60 % of the testing cost.

In its fourteen years as a commercialised company, Rotek has developed a unique facility enabling it to save money for both its customers and the country.

It can be said that for every rand of turnover that Rotek generates, the country saves a rand.

Contact Mike Cary, Managing Director, Rotek Engineering, Tel: (011) 629-4455, mike.cary@eskom.co.za Δ

# AMEU Proceedings
## 58th Convention

## "Electricity powering southern Africa"




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# Forword

by Peter Fowles, president of the AMEU

**Perceptions of the success of the 58th AMEU Convention will, no doubt, vary among the 520 delegates and their partners who attended, depending on their expectations for the event and their personal experiences over the four days.**

The numerous letters, e-mail messages and telephone calls we have received, expressing appreciation and offering congratulations on a successful Convention, lead us to believe that many were enriched by the experience. Certainly for our small, hardworking team it was a memorable time with emotions swinging from horror and embarrassment during the opening session power failure, to elation and pride that just about everything came together as planned. The team spirit engendered within Pietermaritzburg Electricity personnel through the process was incredible as was the supportive, happy disposition of the delegates.

No event such as the Convention is possible without the support and cooperation of a large number of people and organizations. They have been thanked publicly and privately but it would be appropriate in this publication to record our appreciation for the contribution made by our sponsors, the AMEU Affiliates and the authors and presenters of our papers.

The Convention theme, 'Electricity Powering Southern Africa', allowed for a wide range of papers, four being presented by speakers from Europe. Phindile Nzimande's key note address on the 'Road Ahead' for the recently formed EDI Holdings Company and restructuring of the South African electricity distribution industry set the tone for many of the papers presented on the first day.

Restructuring of the industry is an issue that has dragged on for a long time and I believe many participants in the debate, and many observers, are heartily sick of the lack of action in moving toward the Government's vision for six autonomous regional electricity distributors (REDs). The uncertainty has had the effect of discrediting the process and demoralizing many of the players who are unsure of what to do, when to do it, and who will provide the necessary funding.

It was thus with a collective sigh of relief that the EDI Holdings Company began life on 1 July 2003. We were fortunate that the CEO, Phindile Nzimande, was able to share with the delegates her plans to breathe life into the company that will steer our industry toward the desired end state. I have, on behalf of AMEU, offered Phinde our very best wishes and all the support that we can provide in assisting her to achieve her goals. She will need every bit of help she can get as I believe that we still have a bumpy road ahead. Phinde made it clear that she is planning on a phased approach to the establishment of the REDs and that the ring-fencing of the distribution businesses should be nearing completion within 24 months.

What is not clear is how the ring-fencing and asset valuation exercise will be funded. Many municipal electricity distribution businesses would probably not be in a position to undertake this exercise unless they receive assistance with expertise and funding. I, unfortunately, am not privy to whether any allowance has been made for such funding in the National budget for the year beginning April 2004. If not, much of the necessary work may not be completed in time. Whether Phinde receives any political support in the period leading up to national and local government elections in 2004 remains to be seen. If this is not clear and strong, it is my view that very little movement will be made toward the final objective.

This support, and direction it gives, will also be essential in resolving the conflicting messages emanating from the current draft of the EDI Restructuring Bill. Who believes that allowing local authorities the choice as to whether they wish to join a RED or not, or establishing the REDs as municipal entities, is a wise route to follow in providing for the future success of the provision of electricity in South Africa?

I warned during the Convention of the dangers of not moving quickly towards a more effective distribution industry structure or suffer the consequences of restructuring by default. The last word for me however came from Richard Frantz of Merz and McLellan who, in his impromptu and fascinating presentation on the recent New York power failure, highlighted that we are all missing or avoiding a real problem that faces our service industry - the decline of experienced engineering, technology and artisan resources, for which there is no quick solution. Experience cannot be taught or imported by training.

We are delighted that Chris Yelland of EE Publishers will be publishing the Proceedings of our Convention. I trust that our expanded audience will enjoy this publication and benefit from its contents.

Peter Fowles, president of the AMEU Δ

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**What is ENERGIZE?**

ENERGIZE - Power Journal of the SAIEE - is a technical journal, published by EE Publishers, in English, eleven times per annum, serving the power electrical engineering industry of Southern Africa.

**Mission Statement**

ENERGIZE strives to keep readers abreast of the latest technologies, developments, applications and news in the field of power electrical engineering, by the publication of original, relevant, high quality articles, by expert authors. ENERGIZE provides a forum of communication for the power electrical industry of Southern Africa, and for SAIEE members in this field.

**Statement of Editorial Policy**

ENERGIZE publishes technical and semi-technical articles regarding the generation, transmission, distribution and application of electrical power and energy.

ENERGIZE also publishes relevant institute, industry, company, project, product, technology, people and event news, as well as relevant views, opinion, comment and analysis.

# Welcome address

by Clr. G H Zondi, mayor of Pietermaritzburg

The Msunduzi Municipality is greatly honoured to be hosting the 58th Convention of the AMEU with the theme 'Electricity Powering southern Africa'. I note that the last occasion this city hosted an AMEU Convention was in 1973 when the late Mr. Jack Waddy was inducted as your president. The City is proud to note that we have also had two previous presidents in Colonel Ewer in 1935 and Mr. Charles Hallé in 1950.

The theme of your convention is extremely appropriate as electricity is not only one of the basic services we are striving to deliver to all the people of South Africa to improve their quality of life, it is also a key factor in stimulating development.

The Msunduzi Municipality is making a concerted effort to attract new business to our area to stimulate our economy and provide much needed employment opportunities for the numerous poor and unemployed people in our area. To this end our council organised an investment promotion conference in Pietermaritzburg last week. We are very conscious that there are a number of factors that commercial and industrial developers use to evaluate an investment decision and that a reliable, quality supply of electricity at competitive tariffs is often high on their list of priorities.

We are very aware of the national government decision to embark on a

restructuring of the electricity distribution industry and I will be very interested to hear the presentation by your key note speaker, Ms. Phindile Nzimande.

The Msunduzi Municipality area of jurisdiction includes almost 50 000 customers serviced by Eskom. From a political perspective this situation is far from ideal as we would like common tariffs and service standards for all our constituents.

The necessity to do something about this situation has been recognised by our council and included as a flagship project in our integrated development plan. Our requirement to investigate our electricity service delivery mechanism and prepare for the seemingly inevitable restructuring was included in the Msunduzi Municipality's application to National Treasury for restructuring grant funding.

Proposals will shortly be requested from service providers to take our council through the Section 78 process required by the Municipal Systems Act. This will possibly be followed by a ringfencing and asset valuation exercise to prepare for the final restructuring model.

As a politician, I would like to appeal to you to keep in mind two very important aspects as the restructuring process develops:

One is the importance of the contribution of electricity revenue to municipal finances. Electricity income represents some 40% of our total revenue and the contribution to the Rates Fund some R50-million this financial year. Then we must bear in mind our constitutional obligation to provide services to our people and ultimately be answerable to them.

I wish you well over the next few days and on behalf of the Msunduzi Municipality, I extend a warm welcome to all delegates attending this convention.

We are very proud that Peter Fowles will shortly be inducted as your new president and assure him of his council's support over the next two years. I am sure that he will find it to be a rewarding experience. Δ

***AMEU EXECUTIVE COMMITTEE***

**Back Row:** *Jean Venter (Gen. Sec.), Sandile Maphumulo (eThekwini), Danie van Wyk (uMhlathuze), Sy Gourrah (Buffalo City), Clr. James Nxumalo (eThekwini), Hennie Auret (//Khara Hais), Clr. Willem Juries (//Khara Hais), Clr. Boyce Tokota (Nelson Mandela), Hannes Roos (Ekurhuleni), Clr. Lungile Nxiba (Ekurhuleni).*
**Middle Row:** *Clr. Chris Ngobeni, Clr. Dumo Plaatjie (Sedibeng), Clr. Sipho Khuzwayo (eThekwini), Clr. Desmond Halley (Buffalo City), Trevor van Niekerk (Affiliates), George Ferreira (Nelson Mandela), Pierre van den Heever (Tzaneen), Evert van Helden (Sedibeng), Neil Croucher (Cape Town), Clr. Zakhile Mngany (uMhlathuze).*
**Front Row:** *Al Fortmann (Tech. Sec.), Howard Whitehead (Past Pres., Hon. Mem., eThekwini), Harden Beck (Past Pres., Hon. Mem., Buffalo City), John Ehrich (Past Pres., Tshwane), Peter Fowles (President, Msunduzi), Danie Potgieter (Pres. Elect, Polokwane), At van der Merwe (Past Pres., Hon. Mem., Mangaung), Max Clarke (Pub. Sec., Hon. Mem).*

# Valedictory report

by John Ehrich, outgoing president of the AMEU

**The past presidents in their valedictory addresses have all alluded to the restructuring of the electricity industry - initially with uncertainty and prediction and later with hope. Although uncertainty, or outstanding issues still exist, progress has been made and I would briefly like to sketch to you this progress.**

## Restructuring of the electricity industry

In the bigger picture of the electrical industry restructuring (EDI), two processes are in motion, one being driven by the Department of Public Enterprises (DPE) and the other by the Department of Minerals and Energy (DME).

The DPE has been trusted with the restructuring of the generation and transmission section of the industry which is largely Eskom related and the DME with the distribution section of the industry. This split in my view does result in co-ordination problems and must be carefully managed.

Firstly, let me focus on the DPE process.

DPE have established an Interdepartmental Task Team (ITT) to drive the process. I was appointed as the AMEU/SALGA representative on this task team and good progress has been made to date. The process basically involves the following:

- The grouping of Eskom Generation into a number of generation clusters, with the view to selling off 30 % of Eskom Generation. A stipulation is that initially 10% thereof should be to black empowerment companies.
- The separation of Transmission from Eskom followed by the establishment of an independent transmission company wholely owned by central Government.
- The establishment of a multi-market model for energy trading and the introduction of competition. Representatives from the AMEU/SALGA have served continually on the Multi-Market Model Workgroup and intermittently on the Generation Work Group. Recommendations from DPE on these initiatives can be expected in due course to finalize the "blue prints" if we can call it that.

These proposed changes obviously impact upon Distribution and therefore meetings have been held between DPE and DME to co-ordinate this process.

These restructuring proposals could go a long way to resolving some of the frustrations that municipal distributors have experienced with issues such as monopoly generation, transmission tariffs and the big brother dominant position that Eskom holds on the supply industry.

Turning now to the DME process which directly impacts on our members, the process has been slow, sometimes stalled in my opinion, and frustrating for members, but nevertheless I think that an important milestone has been reached, a turning point which should provide as all with hope for the future. Proof hereof is sitting on stage.

Pinde Nzimande the chief executive officer of the Holding Company which has finally been established to facilitate the restructuring of the electricity distribution industry. Pinde, from all of us congratulations we wish you well, and you can be assured of our support. The hope that we have rests with you and we are looking forward to progress and the eventual establishment of the REDs.

It is with disappointment however that I must mention that certain changes to the process have taken place over the last year and these have not been transparent. Consultation with the Electricity Distribution Industry Restructuring Committee (EDIRC)has not taken place and these changes will have a dramatic impact on the end result. It is my feeling that stakeholders were excluded from this process and I would strongly recommend that stakeholder consultation be revisited. This process I hope will now be managed by the Holding Company.

In my estimation the six REDs should be established within five years. This then still allows municipalities time to prepare for the REDs. I would advise that the following be noted by members:

- Keep councils informed by regular progress reports to Council and Holding Company
- Keep staff members informed of progress
- Where possible, municipalities should ring fence their undertakings in order to be aware of what the department entails.
- Co-operation and interaction between Eskom Distribution and municipalities must take place to enhance and support the process.
- Metro's should take the lead in each RED by forming either separate operating entities or fully fledged business units.

We have seen progress on this issue with City Power having been established and now Manguang (Bloemfontein) following suit. I can only encourage Metro's and Municipalities to follow this route. Allow me to thank At van der Merwe, Howard Whitehead and Peter Fowles for their direct involvement in the restructuring process.

## AMEU

Looking at our own association, in the light of these impending changes, the burning question of course is what of the future of the AMEU? The AMEU enjoys strong recognition nationally with its 88 years of existence and its wealth of experience and expertise. These characteristics should not be lost to the industry and therefore a committee, chaired by Peter Fowles, was established to consider future options. Contact has been made with various role-players and discussions have taken place, but more work needs to be done before consultation can take place with our members.

It is my view that the AMEU should be taking other role players on board and transforming into a body or association or company for that matter. The AMEU should not only continue to promote the present interaction between members but also provide broader services to the REDs and further a field through a more permanent structure with permanent staff.

However the AMEU has undergone change in the last couple of years and the following positive changes need to be highlighted:

- Changes to the constitution allowing broader membership and thereby improving representation.
- A proposed change to the constitution, which will be dealt with shortly to enhance representation on the Executive Council.
- Eskom Distribution having become a fully-fledged member of the AMEU.
- The restructuring of the structures of the AMEU with further refinement to follow.

During my term of office one of my goals was to enhance participation of councilors, in the affairs of the AMEU. To this extent I encouraged attendance of councilors at Exco meetings, and even went as far as promoting attendance at branch meetings. One of the political successes of the year was the inclusion of AMEU Executive Council politicians to the SALGA Political Reference Group.

The AMEU remains an association of influence and stature. One only has to look to the attendance of the Tshwane Convention in 2001, the //Khara Hais meeting in 2002, and here again this morning, to gauge the respect it enjoys.

This must be preserved.

### Free basic electricity

The provision of free basic electricity to residential consumers in the country has been fraught with problems. After municipal elections in 2000, elected politicians were keen to implement free basic electricity, and understandably so. However this resulted in certain municipalities providing the free services while Eskom and others did not. Due to a lack of Government policy, varying methods were used to introduce the service, resulting in some customers receiving the services and others not. This led to political pressure within certain areas to deliver and in particular for Eskom to deliver.

Government has introduced a national policy and both municipalities and Eskom are finding it difficult to meet the implementation requirements in order to deliver. In my opinion Eskom seem reticent to absorb some of the costs, resulting in municipalities being reluctant to enter into service level agreements with Eskom. Funding of this free service is also a problem and the monies provided by central Government, taking the Eskom stance into account are not sufficient. The funding mechanism needs to be reviewed.

Nevertheless it is imperative that this service be implemented as soon as possible and I would request that AMEU political members become more involved in the process to influence the Ministry of Planning and Local Government for an acceptable, practical and speedy solution.

### Electrification

Municipalities have over the last ten years contributed enormously to the electrification of the country. The process has been centralised, streamlined and managed more effectively in recent years. Further refinement is still necessary. Municipalities must continue to participate in this program and through our representation on the National Electrification Advisory Committee further enable municipalities to deliver.

### Employment equity

Within the process of transformation and restructuring, electricity departments must promote employment equity issues. Each municipality should have an employment equity policy and an implementation programme with defined goals. It is a fact that the pool of previously disadvantaged individuals qualified as engineers, technicians and technologists and with municipal experience, is limited. External adverts for such candidates have also not produced suitable results, bearing in mind the relatively low municipal salary scales. It is therefore necessary that processes be put in place to address this issue. The AMEU needs to formulate a workable proposal and submit this to SALGA for consideration.

### Theft of conductor and cable

All electricity distribution institutions in South Africa are suffering from the impact of the theft of conductor and cable. The negative impact resulting from the uncontrolled theft of conductor material is an increasing cost burden but more importantly, the interruption of customer service and supply. The AMEU has through its legal and statutory committee suggested certain interventions to help curb the problem. However a national drive is necessary to foster community involvement in stemming this problem.

I would therefore like to appeal to the councilors present to participate in structuring a national drive to obtain community participation to address the problem.

### Conclusion

In conclusion it is my firm belief that within five to seven years from now many positive changes will have taken place. The industry as we know it today will be very different. We however as the AMEU, a major stakeholder in the process, can and must continue to influence the process to ensure that the end result is beneficial to all our stakeholders.

It is a huge task and many resources will be drawn upon to deliver, but I am confident that we can obtain the results.

Chairperson, I would like to close by thanking the AMEU for giving me the opportunity of serving you in the office of president.

I would also like to express my appreciation to the Tshwane Metro Council for their support, the members of the Executive Council, Jean Venter of Van der Walt and Company, my senior staff members of Tshwane Electricity and to all members for their support. Δ

# Inauguration address

by Peter Fowles, incoming president of the AMEU

It is a great honour and privilege for me to be standing here as president of your Association for the next two years. The AMEU has an extremely rich and proud history and I, like my predecessors, will do everything within my power to uphold its ideals and objectives.

Let me begin by extending a few words of thanks.

Firstly to our immediate past president, John Ehrich. John, you have lived up to your commitment of 'change for the benefit of all' and I would like to thank you for your enthusiastic and dedicated leadership over the past two years. I would also like to express my sincere thanks to the council of the Msunduzi Municipality for their support and understanding of the demands of the presidency, and for agreeing to host this convention.

To my team in Pietermaritzburg, my thanks and appreciation for their efforts in preparing for this convention and for their support while I am away on AMEU business. For many years my wife Marilyn and daughters, Bridget and Ashleigh, have coped with my frequent absences from home for the AMEU. They have graciously accepted that this will continue for another two years and I wish to thank them wit all my heart.

Ladies and gentlemen, the various committees of the AMEU have addressed numerous issues of interest or concern to its members over the years. Without doubt though, the main issue that has challenged the minds of your executive council and indeed, most of our members, for a number of years now has been the restructuring of the electricity distribution industry.

But are we any further forward on this issue than we were at the last convention?

We have been privileged today to have had Phinde Nzimande share with us her vision and plans for the formation of the restructured industry.

Her message is one of hope that perhaps at last we can see in the foreseeable future an electricity distribution industry comprising autonomous regional distributors that can best serve our customers in a business-like and commercial manner. I like to call this the 'high road' scenario.

There are though, still a number of uncertainties that could further delay the process and test our patience and resolve even more. A few of these are:

- With elections just around the corner, will the relevant national government politicians see the EDI restructuring as a top priority, and give Phinde and her team the necessary support?
- What is the intention of the drafters of the EDI Restructuring Bill in making the REDs municipal entities and then giving local authorities the choice as to whether they wish to join a RED or not?
- What will Eskom's reaction be to this intention to strip it of its distribution assets and hand them over to local authorities?

John Erich (right) handing over the AMEU presidency to Peter Fowles

A number of alternate scenarios spring from an analysis of these and other uncertainties facing our industry. One of these could be labelled the 'low road' scenario, in which little or no progress is made toward achieving the intended restructuring.

In this case, a number of the smaller, and maybe not-so-small, municipal distributors stumble on with dwindling skill bases and a shortage of funds to adequately maintain their networks, never mind being able to carry out necessary system reinforcement and expansion, while being pressured by their customers and the NER to keep tariffs low and improve their quality of supply and service. Is it possible that some of these distributors may collapse and Eskom be required to take over their responsibilities? This is, I believe, the often postulated 'restructuring by default' scenario.

Perhaps there is a 'middle road' scenario. Here, a number of enlightened local authorities resolve to ringfence and corporatise their electricity service in the manner of City Power, and more recently Mangaung.

To my knowledge, a number of others are actively considering this option. Those who do not follow this process may end up like those in the 'low road' scenario and we can picture the resulting industry structure as a larger Eskom distribution area together with a few strong corporatised municipal distributors.

A lot of water may still flow under the bridge but it is my conviction that we should aim for the 'high road'. Our major challenge then over the next few years is to determine how we can positively influence the achievement of Phinde's vision. I therefore wish to convey to Phinde our very best wishes for success in her endeavours and assure her that the AMEU will be there to support her to roll out the best solution, just as the AMEU has supported the industry for the last 88 years.

In the meantime, the lights are kept burning and electricity services are being extended to many new areas in South Africa by dedicated men and women who carry out this essential service, often under-resourced in skills and funding. I think you are unsung heroes of our country and I hope and pray that one day you will be rewarded for your efforts.

Ladies and gentlemen, I hope that each and every one of you will leave this convention having been enriched by the experience. It is my fervent wish that you enjoy your stay in our lovely city, Pietermaritzburg.

I look forward to being of service to you and the AMEU for the next two years. Δ

# The REDs: making it work

by Dr. Shaheen Ahmed, PB Power (South Africa), and Ralph Parmella, PB Power (UK)

**The Electricity Supply Industry (ESI) in South Africa is poised to undergo fundamental change over the next few years. The impetus for this change stems from a commitment by Government to implement its policy of restructuring the industry, the guiding principles of which are embodied in the White Paper on Energy Policy. A key objective of the restructuring policy is to achieve a combination of increased competitiveness and focused regulation to ensure a self-sustaining industry ultimately serving to benefit the electricity customers.**

The restructuring of the electricity distribution sector (EDI) has been at the forefront of the ESI transformation over the past decade culminating in a comprehensive sector-restructuring plan being developed for implementation. This plan will see the integration of several hundred electricity distributors (including the electricity businesses of municipalities and Eskom Distribution) into six Regional Electricity Distributors (REDs). The Department of Minerals and Energy (DME) in South Africa has formulated the steps and the time frames for the restructuring of the Electricity Distribution Industry (EDI). The six REDs will be formed initially from the ringfenced electricity business units of the metropolitan areas.

It is expected that from Day 1 of RED formation, the REDs will continue the process of integrating the ringfenced electricity business units of municipalities and Eskom Distribution until all the business units within the RED geographical area have been incorporated. During this integration period, the REDs will be dealing with complex issues involving people, processes and systems, service delivery, efficiency enhancement, establishing a sound business culture and improving financial performance. In many countries, the distribution restructuring processes have yielded significant benefits. In the UK, between 1990 and 2000 there has been efficiency improvement of around 250 % measured in terms of customers per employee. This has been driven by a reduction in the number of employees from 96 000 in 1990 to 42 000 in 2000.

In Australia, between 1994 and 2000 there has been efficiency improvement of 25%, also measured in terms of customers per employee. Between 1990 and 2000 in the UK there has been a reduction in minutes lost per customer of nearly 40 % and in Australia there have been reductions in minutes lost per customer as high as 64 %. Some commentators argue that these levels of benefits can only be achieved if the restructuring is accompanied by a change in ownership (i.e. privatisation of the parastatal utilities). Others argue that ownership does not matter and as long as the institutional arrangements are well designed, similar levels of benefits can be achieved.

It is generally expected that the REDs will achieve significant improvement in performance over time, due to economies of scale and size, enhanced efficiencies and improved governance arrangements. These factors, in themselves, may not be sufficient to ensure the success of the REDs. It is essential that the various key players in the industry fulfil their roles and responsibilities in making the REDs work. Failure to do so may result in the performance being severely compromised which would impact on the sustainability of the entire ESI. The success of the REDs in the medium term will to a large extent depend on the skill with which the RED integration process is managed. It is essential that the REDs, once completely constituted, set the stage for extracting the much-anticipated benefits that have been the driving force behind the restructuring efforts. There is a huge expectation that the REDs will achieve high levels of service delivery, efficiency and sustainable financial performance; otherwise all these efforts would have been wasted.

This paper draws a comparison between the performance of state owned enterprises (SOE) and privatised enterprises and investigates whether the REDs as SOE can be expected to achieve performance improvement similar to privatised enterprises in other countries. Structural and process issues that would need to be addressed to set the stage for enhancing performance are identified. The roles that three key players (the RED Management, the Regulator and the Shareholders) have to perform in the RED integration period to ensure the success of the RED in the medium term are identified.

Finally, performance comparisons are drawn between distribution utilities in the UK and Australia providing an indication of the benefits that can be expected from the RED's in the longer term.

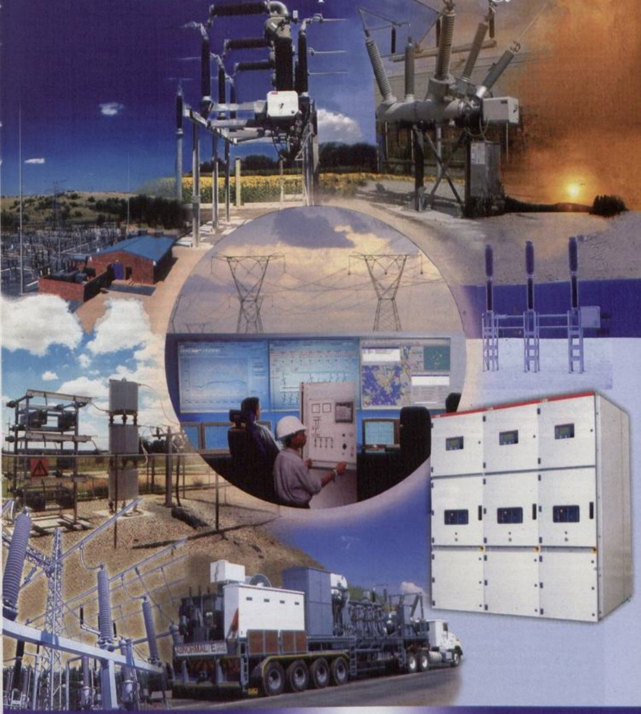
## State enterprise reform and privatisation

The debates about whether it is better to reform state owned enterprises (SOE) or to privatise them have been ongoing for many decades and will continue to rage well after RED formation. It is well recognised that the performance of state owned enterprises, particularly in the developing world, has fallen far short of the levels of performance prevalent in privatised enterprise. Many commentators, including the World Bank, have argued that not only have state owned enterprises been inefficient in many countries in the recent past, but that this inefficiency is inherent in the ownership of the enterprise and that privatised companies will always perform better. It is further argued that the poor performance of SOE's can be put down to a range of factors, including:

- Multiple and often contradictory objectives set by government. The SOE's may be required to achieve commercial profit and to contribute to meeting social objectives, preference for domestic suppliers, economic and political objectives. These objectives may include employment creation, subsidising the poor, subsidising strategic investments, anti-inflationary measures, etc.
- Lack of management autonomy. The SOE management are often restricted by controls and regulations that limit their freedom of decision-making. The result is that the SOE may be induced to operate more like civil service departments than commercial enterprises.
- Inadequate staffing particularly at managerial level. While the staff numbers in the SOE are usually high in order to meet national employment creation objectives, it is often the case that the key staff are not appropriately skilled for the job. In addition, the salaries paid to the SOE managers are well below those in privatised enterprises. The result is that the most skilled managers will elect not to work for SOEs.
- Prevalence of political interference, corruption and nepotism. In many cases jobs are allocated on the basis of political affiliation, aggressive credit management policies are not encouraged and tariffs are kept low in order to retain popular support.

While these factors may be prevalent in most SOEs in developing countries, it is misleading to conclude that these factors characterise the intrinsic and inextricable essence of SOEs. It is well known that SOEs can be encouraged to behave like privatised enterprises by undergoing the process of commercialisation. In this case, the SOE is directed to maximise its profits and its managers can be rewarded by means of performance-related bonuses. This process has been under way in several power utilities in the region primarily driven by the World Bank as a precursor to privatisation of these SOEs. Notwithstanding the potential for commercialising SOEs, the key weakness that appears to be prevalent in SOEs, when compared to privatised companies, is the inherent difficulty that they have in pursuing profit and efficiency objectives. The central problem in this regard relates to the control, accountability and monitoring of managers within the SOE.

With public ownership, property rights are diffused across a large number of shareholders and no individual has the incentive to incur the substantial information costs required to monitor and control the SOE management. Control may be exercised for the public by the state



bureaucracy, but this form of control is weak or it pursues objectives that contradict enterprise efficiency. Furthermore, with soft budget constraints, SOEs debt will be covered by government thus not encouraging prudent performance management. With private ownership a possible mechanism for control operates through the capital markets, where share prices will be linked with performance, and underperforming companies will be vulnerable to hostile takeovers.

Thus, the capital markets can act as an effective external regulator although this is may not be particularly effective in the relatively small capital markets of the developing world (even in developed economies, the threats of takeover are more closely related to size than to internal efficiency, so that smaller firms are more likely to face capital market discipline than large firms). The question that needs to be addressed for the EDI in South Africa is whether the REDs, being state-owned, can achieve levels of performance similar to those experienced by privatised distribution companies in other parts of the world. Does the state ownership of the RED, with all the associated trappings thereof, constrain the levels of performance enhancement that can be achieved and if so are the expectations for RED performance unrealistic? Are there any measures that need to be taken to ensure that the state ownership of the REDs is not fatal to the success of the REDs.

- *Clarification and simplification of objectives:* Government will, in general, impose multiple and sometimes contradictory objectives on the SOE comprising both non-commercial (social, economic, political, etc) and commercial objectives. The non-commercial objectives will result in decreased commercial profitability in the SOE unless provision is made to compensate the SOE.

  While it may be unavoidable and in fact desirable for the SOE to meet some non-commercial objectives, it is critical that the SOE is burdened only with those non-commercial objectives that it can deal with in an effective and efficient manner. It is therefore essential that an assessment of each objective be made to determine whether the SOE is in fact the most effective policy instrument for meeting the objective. Recent experience has shown that the SOE is in most cases not the most effective vehicle for achieving broad socio-economic objectives such as employment creation for the poor, anti-inflationary policies, etc. which may be better served through sound fiscal and monetary policy.

  On the other hand, it may be appropriate to assign the objective of price subsidisation of poor consumers to the SOE. In such cases, it is essential that the financial impact of the subsidisation be quantified and allowed for in the performance targeting or alternatively provided for through a separate external funding mechanism. Thus, in assigning the objectives to the SOE, the commercial objectives should dominate while non-commercial objectives should be imposed only in exceptional and clearly defined cases. In general, the broad conflicting objectives of government tend to be satisfied in an optimal manner if the SOE is given commercially focussed objectives that incorporate the impact of meeting only the essential non-commercial objectives assigned to the SOE.
- *Balancing autonomy with accountability:* The SOE will be unable to function effectively if they are managed as government departments subject to civil service rules and controls. The SOE managers must have the autonomy to take the decisions and risks in response to market opportunities. The greater autonomy must be balanced by the recognition that the enterprise still needs to be accountable to government. This potential conflict between autonomy and accountability can be described as the need for greater operational autonomy but at the same time greater strategic accountability. The Boards of Directors of SOEs should comprise independent technically qualified directors, rather than political appointees.
- *Establishing appropriate evaluation and incentive mechanisms:* The performance of the SOE against key performance indicators (KPI's) should form the basis of evaluation and incentive mechanism. The KPI's should be developed on the basis of rigorous budgeting and financial forecasting processes. Managers and other staff need adequate incentives to strive for performance improvements. Incentive schemes for the staff should be based on the performance against targets over which they have control. The remuneration needs to be comparable with the private sector so that the most skilled staff can be attracted to the SOE. In the same vein, there is a need to remove legal obstacles to the retrenchment of labour which may result in layoffs of workers who are no longer needed.
- *Establishing either a competitive market environment or appropriate forms of external regulation:* Operational autonomy implies a focus on commercial profitability which implies freedom of decision-making and accepting the financial implications of such decisions. In such an environment there is a need for a hard budget constraint i.e. debts incurred by the SOE will not automatically be covered by the government thus mimicking the capital market discipline mechanism found in privatised markets. Commercial profitability is a poor indicator of efficiency in situations where market imperfections exist or where government-imposed distortions exist. Thus, there is a need for regulation which may take the form of control of output prices.

Once these strategies have been put into place, it is necessary that the role players play their part in making it work. In the South African EDI, there are a large number of players with a complex set of interests and responsibilities. In this paper, we focus on the roles of three key players namely, the RED Management, the Regulator and the Shareholders (national Government, local Government and Eskom). It is essential that the Holding Company ensure that the activities of these three players are coordinated to fulfil these roles effectively.

In the following section, we describe the roles that the three key players must perform during the RED integration period.

**Roles of key players**

*The RED management*

During the RED integration period the RED Management will be tasked with establishing the foundation for sustainable RED performance in the medium to long term. In addition, the Management should also seek to achieve short term performance benefits which will serve to meet the expectations of the industry after such a long awaited restructuring process. The activities should focus on improvements in the distribution and retail parts of its business, implementing processes, procedures, systems and appropriate management information systems. These activities can be categorized as follows:

*Service delivery*

In order to establish the foundation for improved and sustainable service delivery, the RED management should:

- Develop a sound business culture that is aimed at meeting the objectives
- Develop appropriate management information systems
- Develop accurate asset registers consistent with long-term asset management policies
- Establish and meet the appropriate quality of service and quality of supply standards
- Establish processes and systems to manage the increased geographical areas
- Establish and implement appropriate customer service arrangements
- Introduce effective billing, meter reading and customer management systems

It is expected that significant short term performance improvements can be achieved by focusing on the retail parts of the business during the RED integration period.

*Efficiency*

- Conduct skills audit and utilization forecast
- Establish organisational structures consistent with business requirements leading to:

  Overall institutional strengthening (high quality management and staff)

  Improved operational efficiency (lower Opex)

  Improved revenue position (positive cash flow, targeted Capex, increased return on investment, etc.)
- Implement performance management system
- Enforce efficient retail management system

*Financial performance*

- Publish accurate definitions of fiscal responsibilities

- Develop RED masterplan
- Establish capital and revenue operating policies
- Establish asset management policies
- Develop budgets to meet policies, Masterplan requirements and fiscal responsibilities
- Establish appropriate KPI's
- Implement appropriate financial and accounting systems
- Develop financial forecasting models
- Develop tariffs based on long run marginal costs

**The regulator**

The South African Electricity Regulation Act of 2002 [1] states:

"The mission of the national electricity regulatory authority is to regulate the electricity supply industry in accordance with the regulatory framework embodied in this Act, so as to ensure that the electricity supply service needs of existing and future electricity customers are met in the most efficient, cost effective and sustainable manner." The Act also contains a long list of regulatory principles, two of which are as follows:

"regulate in a manner that sustains and encourages improvement in efficiency, economy and reliability in electricity supply so as to enable the supply and demand for electricity to be met having regard to prevailing Government policy;"

"have regard to the long-term sustainability of licensees and the need of licensees to be able to finance the carrying out of their licensed activities;"

So, in a nutshell, the regulator is required to look after customer interests, encourage improvements in efficiency and reliability in a manner that ensures long-term financial sustainability of the RED's (licensees).

To carry out this mission we believe that the regulator should focus on:

*Relationships*

- Establish a cooperative, non-adversarial relationship with the REDs (avoid the mistakes of other jurisdictions)
- Ensure that regulatory process is transparent (specifically required by the act which states; "regulate in a manner that is transparent and fair;")

*Regulatory framework*

- Publish precise details of regulatory principles and policies
- Establish a regulatory timetable consistent with the RED integration timetable
- In conjunction with the REDs, develop economically justifiable reliability, quality of supply and quality of service standards
- Approve tariffs based on cost reflective signals

**The shareholders**

The shareholders will comprise national and local Government and possibly Eskom.

We believe that national Government should:

- Formulate policy around the EDI
- Set the rules for strategic accountability measurement
- Determine which non-commercial objectives should be assigned to the RED and which should not
- Allow the RED freedom to manage its customers

The shareholders should NOT:

- Interfere in the day-to-day management of the RED
- Be involved in customer management policies of the RED
- Allow political interference in the management of the RED

In general, the shareholders should behave in a cooperative non-adversarial manner that will encourage the improved performance of the RED taking full regard of the regulatory framework, the legislative environment and national policy objectives.

**Comparison of performance of distribution companies**

Before embarking on a cross-border comparison of electricity distribution companies it is important to recognize that a large number of problems arise when efficiencies are compared.

A recent Eurolectric report [2] lists these difficulties as:

- Cost levels vary among countries, which influences the total cost of operating a distribution grid
- Differences in accounting principles, tax legislation and labour legislation make it difficult to compare accounts
- Environmental factors such as forest and urbanisation can influence the cost of operations, and make direct comparisons of companies difficult
- The history of a country or region has a direct impact on the electricity distribution network (e.g. the age profile of the grid will reflect the periods of high economic growth)
- A number of other factors also make it difficult to compare the performance of electricity distributors across borders. It is more complex to benchmark companies in conditions, which vary strongly, as the chosen model must take all these differences into account. This implies the risk that international benchmarking can produce erroneous conclusions that can be damaging if used for regulation.

Recognising these difficulties it is the intention of this paper to use the cross-border comparisons simply to illustrate that full privatization of SOEs may not be necessary to achieve the high levels of service delivery, efficiency and sustainable financial performance that the creation of the RED's is expected to provide. The change from SOEs to either privatized or corporatised entities may be examined by looking at what has happened in the UK and Australia. Australia presents an interesting case as Victoria went down the path of full privatization while NSW has taken the corporatisation route.

*Reliability*

In all three jurisdictions considered the reliability of customer supply improved significantly following restructuring, whether through privatization or corporatisation. As a typical example over the period 1986 to 2000 the customer minutes lost in the UK, measured in terms of a 10 year rolling average, reduced from 146 to 91 minutes (38 %) with nearly all of this improvement occurring post privatisation . In NSW the reduction in customer minutes lost reduced by 24 % and in Victoria by 64 %.

In the UK incidence of faults (measured in terms of a 10 year rolling average in SAIFI) over the period 1986 to 2000 reduced from 106 to 97 (8 %) interruptions per 100 connected customers. Over the same period the fault duration (measured in terms of a 10 year rolling average in SAIDI) reduced from 178 to 111 (38 %) minutes per connected customer. All of the three jurisdictions considered made significant improvements in all reliability indices.

It is also generally true that the largest improvements were made in the fully privatized utilities, however significant improvements were also made in corporatised utilities. From the perspective of this paper therefore it is fair to say that if correctly structured and managed the REDs, as corporatised utilities, should be able to significantly improve their reliability performance.

*Productivity gains*

It is notoriously difficult to compare productivity figures between utilities in the same jurisdiction never mind across borders. However, if we choose customers per employee as an example of increased productivity then between 1994 and 2000 all the states in Australia made significant improvements.

It is interesting to note that NSW and Queensland (corporatised utilities) made improvements of 78 % and 63 % of the improvements made in Victoria (privatized utility) over the same period. In the fully privatized UK EDI, the improvement in productivity measured in terms of customers per employee over the period 1990 to 2000 was 250 %. Over the same period the improvement in productivity measured in terms of units distributed per employee was 200 % [3].

While these figures would tend to indicate that fully privatized utilities could achieve greater levels of productivity than corporatised utilities the figures must be treated with care. Firstly they represent a relatively small (but very important) sample of privatized/corporatised utilities. Secondly the figures do not show the effects of outsourcing which is much more prevalent in the privatized utilities than in the corporatised utilities. Once again, from the perspective of this paper therefore it is fair to say that if correctly structured and managed the RED's, as corporatised utilities, should be able to produce significant productivity gains.

## Conclusions

The authors have worked on reform, regulation and privatisation issues for governments, regulators and utilities in numerous countries including South Africa, the UK, Australia, New Zealand, Singapore, Abu Dhabi and Argentina. From the experience obtained in these and other jurisdictions, and from the points raised in this paper the authors believe that the REDs can be made to work and achieve the high levels of service delivery, efficiency and sustainable financial performance that is required provided the following points are implemented. In assigning the RED objectives, the commercial objectives should dominate while non-commercial objectives should be imposed only in exceptional and clearly defined cases.

The REDs should be given commercially focussed objectives that incorporate the impact of meeting only the essential non-commercial objectives assigned to them. The managers of the REDs must have the autonomy to take the decisions and risks in response to market opportunities. This greater autonomy must be balanced by the recognition that the enterprise still needs to be accountable to government.

This potential conflict between autonomy and accountability can be described as the need for greater operational autonomy but at the same time greater strategic accountability. The boards of directors of REDs should be selected on a meritocratic basis and comprise independent technically qualified directors, rather than political appointees. The performance of the REDs should be measured against key performance indicators (KPIs) that should form the basis of an evaluation and incentive mechanism.

The KPIs should be developed on the basis of rigorous budgeting and financial forecasting processes.

Managers and other staff will need adequate incentives to strive for performance improvements. Incentive schemes for the staff should be developed based on the performance against targets over which they have control. Their remuneration needs to be comparable with the private sector so that the most skilled staff can be attracted to the REDs. Legal obstacles should be removed to the retrenchment of labour that may result in layoffs of workers who are no longer needed to allow the REDs to meet their performance targets. Commercial profitability is a poor indicator of efficiency in situations where market imperfections exist or where government-imposed distortions exist.

Thus, there is a need for regulation that should take the form of control of output prices. Each of the key players in the EDI i.e. RED Management, Regulator and Shareholders, should recognize and implement their roles as outlined in this paper to make the process work.

The Holding Company will need to play a decisive role in ensuring that the roles and responsibilities are well understood and that the activities of the key players are directed at fulfilling these. Although the available information is limited, experience from other jurisdictions would indicate that even though they are not privatized the REDs should be able to achieve the high levels of improvement in service delivery, efficiency and sustainable financial performance that is expected of them provided they are correctly structured, staffed and directed and are given the necessary autonomy to manage their business.

The structures and processes that have been put into place for the restructuring of the electricity distribution industry in South Africa set the stage for significant improvement in the performance of the ESI. The next steps towards implementation will be crucial in ensuring the success of the process. It is essential that the key players have a clear appreciation of the roles they have to play and that their activities are appropriately coordinated to meeting the core objectives of the restructuring. The success or failure of the REDs in the short and medium term will, to a large extent, depend on how well these roles are understood and the manner in which they will be carried out.

## Acknowledgements

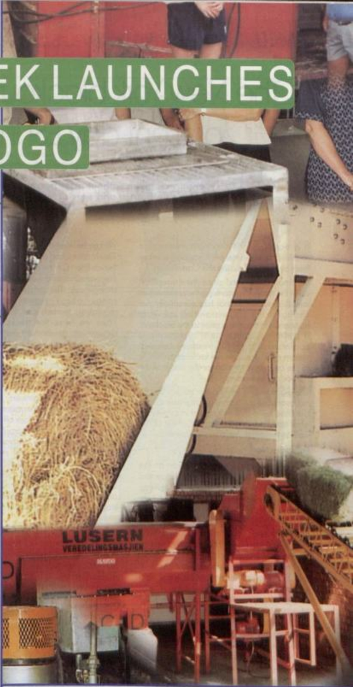
The opinions expressed in this paper are entirely those of the authors who express their gratitude and thanks to their colleagues for the assistance in preparing the paper, and to the directors of PB Power in South Africa and the UK for permission to publish the paper.

[1] ESI Regulation Bill 02-09-2002, Electricity Regulation Bill (to be introduced), Minister of Minerals and Energy

[2] Eurolectric report: Pan European Benchmarking of Electricity Distribution Companies 2003-230-001 Dec 2002

[3] Data obtained from Ofgem publications over the period 1995 to 2000. Δ

# AGRELEK LAUNCHES NEW LOGO

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# The New York blackout - lessons for the present day ESI in South Africa

by Richard Frantz, managing director, Merz and McLellan, Johannesburg

**This presentation was given without prior preparation at the request of the AMEU president in acknowledgement of the significance and special interest of the "New York" power failure on 14 August, less than 10 days before the commencement of the 2003 AMEU Convention in Pietermaritzburg/Msunduzi.**

It is based on the available information received at the time from various sources both before and during the Convention.

Information received since the convention up to the time of transcribing the presentation into this written format has essentially not changed the understanding of what happened in the hours prior to the blackout. If anything, subsequent reports have confirmed that communications between system operators and the facilities available to the operators to monitor the status of the networks was inadequate.

The diagrams included in this transcript were not available at the time of the presentation, but have been added to assist in conveying what had happened in the NE of the US as well as the other messages presented.

### Introduction

I have prepared this presentation at the request of the president at the commencement of the convention proceedings on Monday, given the significance of the New York power failure. The presentation is based on consultations that I have made with colleagues and Merz and McLellan associates around the world, Trevor Gaunt had also shared with me the information he had with him here at the convention which has been invaluable in collaborating the information I have gathered informally from my various sources. I have also drawn on early reports from my sister who lives in Princeton just south of New York, brother-in-law who works in Manhattan and Peter Elder's son Glen Elder who lives in Burlington, Vermont.

Not having had to prepare this presentation in advance I will be giving it without the ubiquitous Power Point visuals. But I do have some other "graphics" to demonstrate the principal which was a classic feature of the eventual system collapse to help in the understanding the complexity of phenomena that arise as a power system breaks up.

As I have sat here since Monday and pondered what has been presented by the many speakers, I have also realised that there is a subtle message between what happened in New York and much of what has been presented here. We are missing a point somehow in all this restructuring. I fear that we are not tackling the real problem, so that the problem will still be there, if and when, we have gone through the present expensive game. I have an analogy, or parable to use the biblical phrase, which illustrates this.

We can be likened to the good ship Titanic after it had passed through the ice floe. On the deck we have the orchestra and band playing stirring music. The consultants, with songs about restructuring, regulating, markets and trading. Then we have the deckchair department; government and the like, trying to work out the rules for arranging the chairs, and debating what colour to paint them after they have chucked them overboard and before they put them back again. Meanwhile the engineers are drowning in the engine room as they desperately try to block off the water gushing in, and as someone added yesterday as I privately debated this analogy, not even being given the tools, the funds, "the maintenance and repair budget", to do the job. The music and colour of the deckchairs won't stop the real challenge of the ship sinking.

Then compare this with the extraordinary events of the last two years. Enron went belly up and its management got found out and booted out, but the lights did not go out. But when the power systems in New York two week ago were stressed, a technical phenomena, which needed real engineers with experience to try and control what was happening, the lights went out.

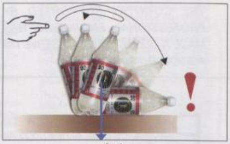


Fig. 1

Fig. 2

In the sequence of events, one of the final phenomena which occurred on the power grid and generation system that precipitated the eventual collapse, is something which is little understood, even by many respected power engineers I have met over the years. To try and help you understand what this is I have put together a little demonstration to give a graphic illustration or analogy. Not having days to put together power point pictures, I have resorted to the "school-kids-project-needed-for-tomorrow" approach and have made use of what is available right here in the Convention hall, the Comrades water bottles.

A power grid and generation system is inherently unstable. Power flows in the system as soon as it moves away from its only stable position - equivalent to the bottle standing upside down on its narrow top and then being pushed over. If I start to push it it falls over, it collapses as illustrated in Fig. 2

Power systems have controls to overcome this instability, the governors and voltage regulators of the generators which control the real and reactive power. This can be likened to the bottle standing in its intended upright orientation on the wide base. The bottle can be pushed over at an angle from its most stable position, equivalent to more power flowing in the system and still rock back to the stable position of standing upright on its wide base as illustrated in Fig. 1. Clearly if I push it over too far, it will still fall over and collapse. This can come about if excessive power is being moved over the system. It also arises when there are sudden changes in the power being conveyed which will result in the system and also the bottle rocking or swinging. But again the rocking and swinging have limits and if these get too excessive, go too far, the bottle, or the power system, still falls over and collapses. Strong power systems, are essentially more stable, which can be likened to a bottle with a wide base. A weak system, can be likened to a narrow bottle as I also have here and the energy the water inside. The narrow bottle, the weak system falls over when you have only pushed it a small way, compared with the broad based bottle. Simplistically, the more transmission links or the higher the transmission voltage of these links, the stronger the grid system, so the larger the angle and the greater the power before it all falls over.

I hope this will help you to remember this phenomenon of instability that is always there, and that was a feature of the eventual collapse of the New York power system.

Not unexpectedly, the failure in New York is complex; the grid is in itself complex and widely interconnected. The system is also bedevilled by business politics - many players with vested interest, and rules. A familiar word in the deliberations of the last two days: "we are developing the rules". And of course legal liability. So for a start no one is now admitting too much or releasing any more information as to the power failure.

What I can convey here today is a summary of what we have been able to access in the public domain and our interpretation of it based on our knowledge of power systems. I could be wrong. I also don't intend going into too much detail. For those who would like more detail bearing in mind, that they are based on one or two sources, Trevor Gaunt is your man. He has a power point presentation.

To try and make some sense of the confusion of it all, I have grouped everything under a number of headings.

### The scene – technical

- Two generating units were out of service, removed from the system. Some more power had to be shifted over the grid network. Moving it further from its central stable position.
- The New York load was down, reasons not given, so their generators were exporting to Ontario in Canada. "The trading market" relying on the grid transmission.
- Alarms that warn that the grid links are in a critical operating state were not functional.

These alarms were part of the precautions that were introduced after the massive power failure that occurred in the 1970s.

### The events

- Another generating unit in Ohio tripped clearly stressing the grid network.
- A major 345 kV grid line (#1) tripped. Reasons not known but could have been overloading. It is to be noted that the lines are short, and are run right up to their thermal limits. Unlike the long transmission systems of Eskom in SA.
- The second line (#2), obviously heavily loaded as a result of the first line tripping, flashed to a tree that had grown up under the line. The conductor sag increased with the heavy load current flowing, reducing the clearance to the tree. A maintenance issue. It can be postulated that if the tree had been cut so that the flashover had not occurred the rest of the events would not have happened. This may be the most significant feature in the whole sequence of events leading to the ultimate failure.
- Remaining lines and interconnectors then became overloaded. Analysis of American Electric Power (AEP) report can be summarised as 7 x 138 kV lines tripped and 4 x 345 kV lines tripped in the space of 30 minutes. One line also experienced a single phase to earth fault. This could have been another tree, as my sister did report that two trees were involved. No doubt the lines of the other power companies in the grid were also tripping at the same time on overload. There is a report of the power company to the north of AEP in Ohio, First Electric, having lines to Canada being heavily loaded.
- AEP have also reported 2 x 135 kV circuit breaker failures during this whole sequence of events. It is not clear whether this was a normal lock out occurrence after unsuccessful reclosures. But the report in one case refers to a 345 kV circuit breaker opening as a backup procedure. This implies some sort of failure of the downstream circuit breaker. At this stage it is clear that parts of the system also separated as there is a report of a delay in reclosing of the 345 kV circuit breaker because of the need to synchronise the two systems.
- The system then went unstable. The interconnecting grid had obviously become too weak, analogous to the narrow bottle of my demonstration. Power swings are reported. Power surging back and forth through the system between generators. Not unlike water sloshing backwards and forwards in a bathtub. There is a report of 2000 MW flowing backwards and forwards in a transmission line that was only rated for 200 MW.
- The voltage then became unstable and the voltage of the system started collapsing as the system could no longer deliver to itself enough Mvar to hold the voltage. Alistair Cooke reported in his letter from America on Sunday of seeing the element of the lamp in his TV room

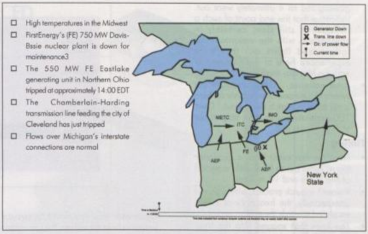



Fig. 3: Precondition 8/13/03 15:06 EDT

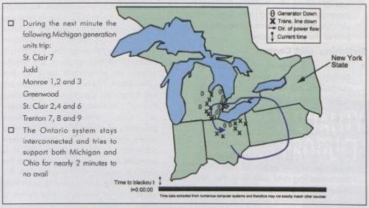



Fig. 4: 16:10:46 EDT. Then seconds later - Blackout!

glowing red till it ultimately went out. Indicative that the end point of such a collapse is still slow, certainly in comparison with the instantaneous failure and lights out that were experienced here at the Convention early on Monday morning.

- Total collapse. Generators on the system tripped one after another as there is no load to match the output. Over 100 generating units were tripped out at this ultimate end.

**Timing**

- From the first event from a generator trip to lights out to New York, a period of two hours and 10 minutes.
- It wasn't a quick process, although not unexpectedly, the frequency of events escalated towards the end.
- The lines that sagged into the tree, eventually flashed over 32 minutes after the reported generator unit trip. This was 26 minutes after the first unexplained interconnecting grid line trip. An indication of the thermal delay that is part of the whole process.

**Switching and Control**

- There is a report of inadequate communication between company controllers, not helped by the need for intermediate players in the energy trading and regulatory environment.
- As I have already recounted, towards the end events were occurring too fast to allow any effective communication.
- AEP interconnectors. All lines tripped automatically by overload protection, disconnecting and islanding the AEP system to continue on its own and maintaining supply within the islanded system. They were fortunate that their own generation more or less matched their own load.
- In some areas operators also managed to manually isolate and maintain the system and supply. Examples of this were my sister in Princeton and also Peter Elder's son in Vermont where no power interruptions were experienced. The citizens of Vermont could look out across the lake to the darkness in New York state on the western shores of the lake.

**Contributing factors, or the non-technical scene**

- The modern ESI business and environment. The ones that we are trying to copy. Too many players and regulators in the investment decisions.
- The decision-makers and managers probably did not understand the consequences of complex system phenomena of instability and power swings. The critical balance between business as a short-term financial endeavour and technical quality, the engineering component and a long-term investment issue. (The engineers left to drown in the flooding engine room.)

  (A report subsequent to this presentation records that in one instance where a Generator was requested to reduce output to help the system, the Generator refused to do so on instructions from his Marketing Management).

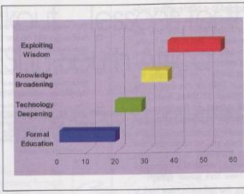



Fig. 5

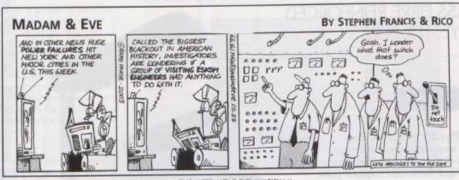
- The regulatory environment, especially as practiced in the US. I would refer you to the comments made by Richard Fairbairn in his paper of International Trends: Regulating the Electricity Distribution Industries of the World which he presented here at the Convention. The two factors at issue are the American practice of regulating through rate of return, the so called input regulation, which tends to have processes which are long, and the more recent move towards incentive based schemes. As Richard records, it is intended to ensure the best use of the existing systems. This implies that the operators are incentivised to push their systems to the limit and certainly not to invest in capacity to handle emergency conditions which in the New York case have occurred at thirty year intervals.
- This is the heart of the problem. Investment to improve system stability in emergency conditions has no real rate of return as it does not lead to selling more energy under normal conditions and hence increased revenue.
- This is all in the realm of probability, assessing events which have a time between the occurrences, the failures, of twenty or thirty years. Factors which engineers may understand but in my experience are rarely understood by financial people who in addition are generally incentivised by short-term performance and returns. If anything their solution would be to insure against such an event.

  Such investments should really be balanced against the loss of revenue that occurs with the power failure. And this raises the question as to how much income was lost over the two day outage and in addition what was the loss to the US and possibly the world economy. What is the real value of electrical power? The Australians have estimated that it is 200 times its selling price.
- Rules. These have been introduced in the face of the dangers of litigation that can arise from operator error. They seek to minimise the operator's personal responsibility, acknowledging that operators being human can sometimes err. But in a complex operation rules can never cover every eventuality. The northeast US power grid is a complex system where the theories of chaos most certainly apply. Compare the statements made at this convention yesterday regarding the drawing up of rules, and independent assessments of these rules. Rules may be an easy alternative to experience but they can lead to false impression that operators and managers have a full understanding of what they are responsible for and control. Given situations that are outside the rules, they may be found to be wanting unless they have been endowed with good experience.

**Restoration of supplies**

- Restoration took one to two days. Not hours or minutes. The question will be asked, why?
- The dominant factor in this is the preponderance of nuclear power stations on the power systems. When the nuclear reactors are forced to shut down under emergency conditions from full load, the reactors become what is called "poisoned". This is a chemical reaction that occurs within the reactor and as a consequence it takes between 24 and 48 hours before the "poisoning" is cleared and the reactor can be brought up to full load again.
- System switching and inevitable spurious faults that manifest themselves in a shutdown situation; the system cannot be brought back into service again as one total block. It would also impose a step function load increase on the generators which they would not be able to respond to.

So what we see is that the power grid and system supplying the NE of the US was subject to complex technical phenomena, which would require the foresight of good engineering experience and understanding to anticipate what ultimately would develop




THE ALTERNATIVE EXPLANATION II
(With acknowledgement to the Johannesburg Star, Stephen Francis and Rico - August 18 2003)



and enable timely remedial switching and isolation of loads and grid interconnectors.

A sequence of events that brought the financial centre and the mightiest city of the world to a grinding halt.

Yet in all our deliberations at this Convention little has been said about the engineers in the industry and the experience which the industry needs to function properly, the people who are the intellectual capital of the electricity supply industry.

If there is any mention of any human resources matters, it is invariably focused on trade unions, whose members are not the intellectual capital, the knowledge, that will maintain the quality of service as the industry enters the future.

The engineers seem to be the forgotten people left drowning in the engine room of our ESI and EDI. We must not be mislead.

Knowledge and intellectual capital is all about experience, years of experience, education and training as illustrated Fig. 4. It is a lot more than skills. (Acknowledgement: Professor Brian Mellit, President IEE 2001/2. Presidential inaugural address).

I trust that this presentation has given you some idea of what probably happened in New York. As I mentioned in the beginning it may be wrong in some detail, but I don't believe if I am wrong in the loud message it conveys in terms of all that has been said or rather not said in this hall over these last three days.

The music may have sounded good, the new deckchairs may look good when they are eventually reassembled on the deck. But don't forget that those in the engine room plugging the hole are the key to solving the real problem that has faced our ESI and EDI for many years. Δ

# The financial implications of REDs

by Chris Gadsten, National Treasury, Department of Finance

**The move towards REDs is now gathering speed, particularly with the introduction of the EDI Holding Company. REDs will impact on a wide range of groups in several different and important ways. This paper will look at the financial implications of the move to REDs. It is intended to provide only a high level strategic assessment of the financial issues arising out of REDs. It is not in any way a conclusive or comprehensive assessment.**

The paper is structured according to the financial implications of REDs on different stakeholders. The stakeholders considered are the REDs themselves; municipalities; customers; Eskom and Government. The paper does not cover the implications for employees within the sector, this is not to underestimate the importance of this issue, but it is beyond the scope of this paper.

The majority of the financial implications outlined in this paper are of critical importance to the success of the restructuring of the electricity distribution industry. If they are not adequately dealt with during the restructuring, or if the right platform is not put in place for them to be handled in the future, the restructuring of the sector could well fail. A failure of the restructuring will not only have a direct influence on REDs and their customers, but also on the economic well being of the country.

## The financial implications of restructuring for REDs

In a sense it is obvious that the creation of REDs will have financial impacts for REDs. But there are critical financial issues related to the success of REDs that are worth outlining here. They all relate to a fundamental requirement of EDI restructuring, which is that it must create financially viable and sustainable REDs. This means that they must have access to revenue streams to cover their costs, and that they must be structured, managed and incentivised to operate as both efficient and effective institutions. This section will look at both their revenue/cost structure, and their corporate governance.

*RED cost/revenue structure*

The starting point of any discussion about RED financial viability has to be their boundaries. To be viable, REDs will need to have a representative customer base, that does not bias their income earning potential. What this means in practice is that REDs will need enough large profitable customers (essentially commercial), to cross-subsidise lower income domestic customers. This equation underlies the economics of any electricity distribution operation, as the extent of the electrification programme and infeasibility of charging poor consumers the marginal costs of their supply mean that cross-subsidies will always be needed.

The boundaries discussion is close to being finalised, and the Holding Company should make a final recommendation on the issue. This will allow proper financial planning for REDs.

It is the RED tariff regime that will determine income flows. Currently within RED boundaries there are on average about 30 different tariff structures: Eskom's plus the municipalities within that RED. These will need to be rationalised, as quickly as possible, into a single RED tariff structure that provides the RED with an adequate income. Within this structure important decisions will need to be made about cross-subsidies, and the extent to which these should be allowed. The final say on tariff structures must come from the National Electricity Regulator, which is working on the framework for RED tariffs. However cross-subsidy policy needs to be determined by the Department for Minerals and Energy. This is also being worked on, and if REDs are to be introduced on schedule, definitive judgements about both these issues will need to be made during 2004.

Without a coherent tariff structure and a robust revenue base, the financial sustainability of REDs can not be guaranteed.

*Corporate governance*

If REDs are to be successful they will need to have effective corporate governance structures in place, which ensur both accountability for the activities of the RED and that REDs are run in the best interests of all their stakeholders. Municipal ownership of REDs provides an opportunity for this, whether they are municipal or public entities, but the right corporate governance structures must be put in place. This means an independent board, accountable to its shareholders for an agreed corporate plan. No shareholder must have undue influence over a RED.

However putting these worthy aims into action will not be easy. Each RED is likely to have at least 40 shareholders, all with different voting strengths, but with one or two very significant shareholdings (from the metros). They will need to find ways to take collective decisions, but also they will need to resist the temptation to meddle too much in the affairs of the REDs.

*The Holding Company role*

The EDI Holding Company will have a crucial role in putting the REDs onto the right path. Although at the end of the day the responsibility for the financial success of REDs will depend on their managers and shareholders, the Holding Company needs to ensure that REDs are set up in the right environment and with the right policies to ensure financial sustainability.

## The financial implications of restructuring for municipalities

Municipalities are key players in EDI. Their interest goes beyond simply that of the merger of their electricity departments, it cuts to the heart of their income earning capacity and the way in which they influence the delivery of services in their areas. Currently electricity is vital to municipality income both through the surpluses that municipalities earn, and through its role in billing for services provided by the municipality. The potential costs of EDI are also important to municipalities.

*Impact on municipal electricity surplus*

There is no exact way to estimate the income municipalities earn on electricity, but the two studies that have been done suggest that it is sizable. The first of these studies was part of the initial research work on EDI restructuring, this was carried out by PWC, who estimated the total surplus to be R2,4-billion in 2000. A second survey, by SALGA (carried out by PDG consulting) suggested a surplus of R2,7-billion in 2002.The surplus is in effect an implicit levy on electricity, PWC estimated this levy to be 12,3 %, whilst the SALGA survey estimated a levy of 14,5 %.

| Municipality | Implicit levy rate |
|---|---|
| uMhlathuze | 2,64 % |
| Johannesburg | 6,82 % |
| eThekwini | 7,54 % |
| Mangaung | 11,25 % |
| Nelson Mandela | 17,81 % |
| Tshwane | 18,34 % |
| Ekurhuleni | 19,23 % |
| Khara Hais | 37,11 % |

*Table 1: Implicit electricity levy rates in sample municipalities (SALGA survey)*

| Municipality | Difference in surplus estimates |
|---|---|
| uMhlathuze | -26 % |
| Johannesburg | -33 % |
| eThekwini | 140 % |
| Mangaung | 16 % |
| Nelson Mandela | 21 % |
| Tshwane | 45 % |
| Ekurhuleni | 63 % |
| Khara Hais | 45 % |

*Table 2: Variation in electricity levy estimates between SALGA and PWC surveys*

The implicit levy rates vary significantly across municipalities, as the table below shows, using the SALGA data.

However not only do we not have any reliable estimates of the total surplus, accurate estimates of the surpluses within individual municipalities are even harder to obtain. The two surveys provide very different estimates of the implicit levy rate in different municipalities. Table 2 shows the percentage variation between the PWC and SALGA estimates of surpluses, where a variation of 100% means that the SALGA survey suggests a surplus twice that of the PWC estimate.

| Municipality | % of rates income |
|---|---|
| uMhlathuze | 11 % |
| Johannesburg | 8 % |
| eThekwini | 10 % |
| Mangaung | 12 % |
| Nelson Mandela | 39 % |
| Tshwane | 28 % |
| Ekurhuleni | 61 % |
| Khara Hais | 114 % |

*Table 3: Surplus as proportion of rates income (SALGA data)*

What we do know is that the electricity surplus is an important source of municipal income. Table 3 shows the surplus as a percentage of rates income.

The move to REDs will remove this income source from municipalities, creating real problems for the sustainability of municipal finances. It is clear that municipalities will need to replace this income source. The Government has committed itself to delivering an alternative income source. There are two main options for this: an explicit municipal levy on electricity or a central grant. However it should be noted that the National Treasury is reviewing the overall fiscal framework for local government, and other revenue options may emerge from this review.

A municipal levy on electricity would effectively be a transparent replacement of the current arrangement where municipalities exert an implicit levy on electricity. There are several ways in which a levy could be implemented. One option would be for a standard levy across all municipalities, set so as to recover the total surplus currently earned. An alternative would be for municipalities to be able to set their own levy rates, perhaps up to a cap. The second option would not only provide local choice, but would also allow municipalities to set rates so as to recover their current surpluses. The cap on levy rates would provide an upper ceiling, and could be phased in over several years to help those municipalities whose current surpluses would require levy rates above the cap.

The practicalities of such a levy would be complicated, and issues such as large users will need to be dealt with. Large users do not currently pay any implicit levy and exerting a significant levy on them would have a significant impact on the economics of their operations.

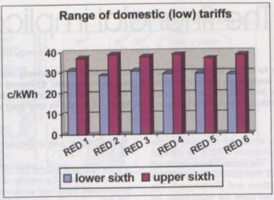



Fig. 1

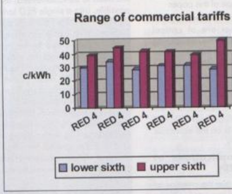



Fig. 2

A central grant would allocate funds to municipalities, either from general fiscal income, or from a national electricity tax. This option is economically efficient, through the use of a national tax base, however it would be impossible to accurately replace the current surpluses. Over time the relevance of such a grant would be severely diminished, with increasing pressure for it to be merged into the equitable share.

The replacement of the municipal surpluses is being worked on by the National Treasury, in consultation with other departments.

*Impact on municipal revenue systems*

Municipal electricity functions are often critical to municipalities revenue earning systems. They play both an important role in billing, and are sometimes used as a credit control tool. The move to REDs must not lead to a severe reduction in municipalities revenue earning capacity, through either stripping out electricity billing sections and leaving behind a weakened municipal billing system, or unhelpful competition for household repayment capacity.

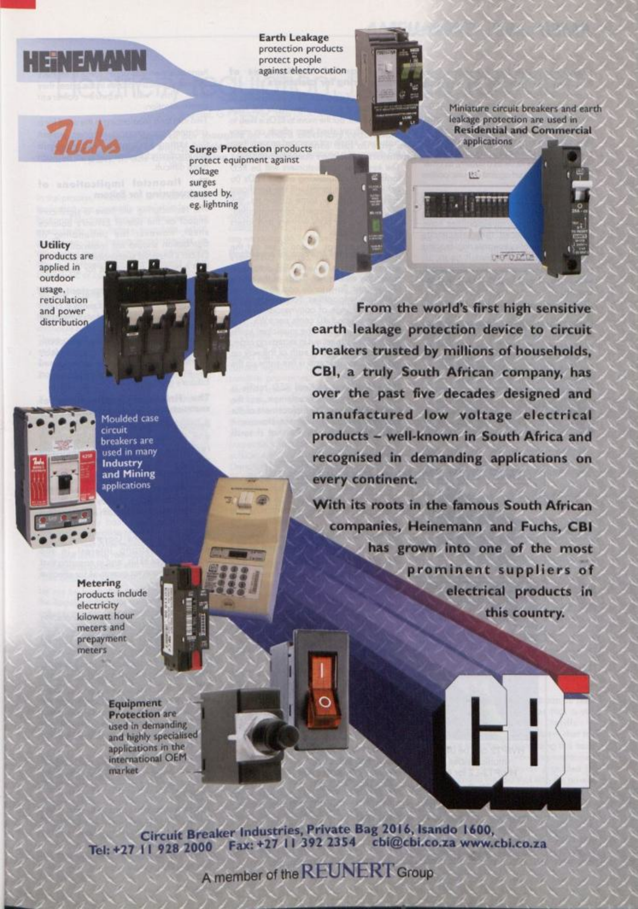
Municipalities need to retain effective billing systems post REDs. However the development of REDs may be an opportunity, rather than a threat, to develop more effective billing systems. There are a range of options that with collaboration between municipalities and REDs, could lead to more effective billing systems. These include a shared service between REDs and municipalities, and the potential for contracting out between the two parties or to a third party.

The use of electricity as a credit control tool is a contentious issue, and there are strong grounds to believe that it will not be an effective option in the future. The legality of its use has been questioned, and it is unclear whether it is an effective tool currently in any case, there is no data on the extent to which municipalities currently use it as a credit control tool. In addition, the implementation of the free basic electricity policy is likely to make it difficult to disconnect customers who have paid for their electricity, but not for other municipal services.

The National Treasury is considering doing work on this issue, again in consultation with other stakeholders.

*The costs of EDI restructuring*

The one-off costs of putting REDs in place is a contentious issue. A SALGA estimate has put these costs as high as R1,7-billion, however the extent to which these are true


HEINEMANN
Fuchs
Earth Leakage protection products protect people against electrocution
Miniature circuit breakers and earth leakage protection are used in Residential and Commercial applications
Surge Protection products protect equipment against voltage surges caused by, eg. lightning
Utility products are applied in outdoor usage, reticulation and power distribution
From the world's first high sensitive earth leakage protection device to circuit breakers trusted by millions of households, CBI, a truly South African company, has over the past five decades designed and manufactured low voltage electrical products – well-known in South Africa and recognised in demanding applications on every continent.
With its roots in the famous South African companies, Heinemann and Fuchs, CBI has grown into one of the most prominent suppliers of electrical products in this country.
Moulded case circuit breakers are used in many Industry and Mining applications
Metering products include electricity kilowatt hour meters and prepayment meters
Equipment Protection are used in demanding and highly specialised applications in the international OEM market
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A member of the REUNERT Group

restructuring costs is open to question. Over R1-billion of this estimate is due to deposits customers have paid, and the need for municipalities to pay these over to REDs, however this is not a cost in the true sense of the word, as it is simply a transfer of deposited money which does not belong to municipalities. These deposits can be transferred to the REDs as a liability, as other debts will be, to be set against a municipalities asset contribution.

The move to REDs will incur ring-fencing costs. However here again the picture is complicated. Some municipalities have already ring-fenced their electricity functions, any policy towards ring-fencing costs needs to ensure that it treats all municipalities equitably, including those who have already paid for their ring-fencing.

*Municipal shareholding in REDs*

The transfer of the Eskom stake in distribution should be of significant benefit to municipalities. Not only will it allow for complete local control over distribution, but it is also a considerable financial transfer. However to benefit from their shareholdings municipalities will need to ensure that effective corporate governance structures are in place, and that they have robust service delivery agreements in place.

### The financial implications of restructuring for customers

The overall effect of EDI on customers should be positive, if it is not, then REDs will have been a failure. But the move to REDs is likely to have significant short term effects on many customers, if this is not managed properly there is a danger of a negative customer reaction.

The key issue for customers will be RED tariffs. Tariff rebalancing across REDs (to achieve uniform tariffs) will see significant moves in tariffs for some customers, this will need to be properly communicated, as there will be both winners and losers from this process.

The charts in Figs. 1 and 2 set out the range of tariffs for certain customers across the REDs. It uses NER data, and shows the middle two thirds of the range of domestic (low) tariffs and commercial tariffs in municipalities. So for example in RED 1 the range of commercial tariffs is between 30 and 40 cents per kWh. This means that when all the municipal tariffs within RED 1 are set out in increasing order, 30 cents is the tariff a sixth of the way up the order, and 40 cents is five sixths up the order.

The exact level of final RED tariffs is complicated by Eskom customers, and the eventual policy on the replacement of the municipal electricity surpluses. However it is clear from the charts that if tariff harmonisation is to occur, some customers will see significant moves in the prices they see. This will require coherent communication.

Tied into tariff rebalancing is the need for a coherent policy on cross-subsidies, without this setting RED tariffs and therefore ensuring financial sustainability will be much more difficult.

### The financial implications of restructuring for Eskom

The restructuring will have a significant impact on the size of Eskom's balance sheet, however the unbundling of distribution should not materially affect Eskom's financial sustainability, assuming that it receives a fair price for generated energy.

The two main financial effects will be through any impact on Eskom's credit rating and the competition for contestable customers.

A lower credit rating, if this were to occur, would increase Eskom's cost of debt. Contestable customers can be competed for, and capturing these should support Eskom's profitability.

### The financial implications of restructuring for Government

Beyond funding the EDI Holding Company, and any financial consequences of replacing the municipal electricity surpluses, there is no direct financial implication for Government.

The Government's main interest is in the effectiveness and efficiency of the sector, given its importance to both economic and social well-being.

For this reason the Government has a particularly strong interest in the governance of REDs, and in ensuring that they face the correct incentives for effective service delivery.

### Conclusion

This paper has provided an overview of some of the key financial implications arising from REDs. It has not attempted to suggest solutions to all these problems. However it is vital that all the issues outlined in this paper are dealt with in a coherent and sustainable way.

The success of REDs, and ultimately the strength of their service delivery, will depend on whether they are well run organisations with sustainable balance sheets.

Alongside this, municipalities need to benefit from the move to REDs. They face issues specific to them that will also need to be addressed.

The responsibility for addressing the key issues outlined in the paper lie with several different bodies, frequently with multiple bodies, and it is incumbent on all of them to seek workable solutions that will ensure the success of REDs. Δ

# Electricity regulation: the way forward

by W O Barnard, G P Fleischer, and Dr. X. Mkhwanazi, National Electricity Regulator

**This paper shares some of our thoughts on where electricity regulation is heading, against the backdrop of imminent changes in policy, legislation and governance that directly affects the electricity supply industry (EDI). In this brief discussion I will for obvious reasons concentrate on the distribution field.**

In the process, I would like to recap on the tools that are currently available for the National Electricity Regulator (Regulator) to execute its regulatory mandate, what problems are being experienced in attempting to fulfil its mandate, and finally, how it is foreseen that developments in the EDI would, or could, affect the Regulator.

### What tools are available

Without getting too technical, the Regulator has in effect three main tools or mechanisms available to regulate the electricity industry. These are:

- the issuing of licences;
- approving tariffs for licensees; and
- stipulating information required from licensees.

As far as licences are concerned, currently issued licences in essence repeats the requirements as outlined in the Regulator's enabling legislation, namely: "The Electricity Act of 1987", as amended. With the help of industry officials, technical standards, namely NRS 047 and NRS 048, respectively dealing with customer service and power quality, have been developed and compliance with them are now included as licence conditions. To augment NRS 048, a directive dealing with power quality has also been issued. Although information provision by licensees are entrenched in the legislation and licences, I will deal with the requirements, issues and problems associated with this aspect after I have dealt with tariff approval.

Let me be frank, the one tool (power) that the Regulator has that causes "pain" to the industry is the tariff approval power. As you are aware, this power has been disputed by licensees on a number of occasions, on one occasion nearly ending up in the Pretoria High Court. However, until changed by legislation or proven unconstitutional, this is the one tool in the arsenal that the Regulator can use to curtail rising electricity prices, rationalise the large number of different tariffs existing, provide incentives to licensees to reduce technical losses, improve quality of supply and electricity distribution networks, etc. Is the regulator using this tool effectively? In short, this is really an essential tool, i.e. THE tool. I will return to this aspect a little later.

Finally, perhaps not a tool in the true sense of the word, but certainly an aid, and a very essential aid at that, available to the Regulator is the requirement for licensees to provide the Regulator with such information as is necessary to effectively regulate the industry. Let me state this categorically, without the right information, at the right time, the Regulator would be flying blind and would not be able to fulfil its obligation to society at large and electricity customers and suppliers specifically. How are we doing on this score? More later.

### Problems in current legislation

I do not want to use this opportunity to analyse current legislation with a view to identify perceived shortcomings or omissions. After all, the Regulator does not make national policy or determine the legislative framework within which it wants to operate. However, notwithstanding the foregoing statement, I believe there is an aspect that should be mentioned, namely, current legislation does entail insufficient punitive provisions. For instance, fines currently extend from a maximum of R200 per day for not supplying requested information to a maximum of R1 000 or imprisonment for hindering and obstructing persons authorised by the NER from inspecting licensed premises. Hardly sufficient to discourage non-compliance. Deviating for a moment, the new proposed ESI Regulatory Bill does improve this situation markedly and should ease the position in cases where the Regulator finds itself in a position where it has to resort to drastic measures.

### Analysis of problems currently being experienced

So against the backdrop of the tools available to the Regulator and shortcomings in current legislation, what problems are being experienced? The answer is fairly simple, namely, the lack of timely provided accurate and relevant information. Currently the Regulator requires licensees to provide returns in the form of Distribution Information Returns, the so called D-forms. These forms provide the Regulator with essential information in order to fulfil its mandate. The information spans financial information, electrical purchases and sales, customer and plant details, tariff information and customer service and quality of power statistical information. The information is used in the tariff approval process, publishing annually the Electricity Supply Statistics and monitoring customer service and power quality. In addition, electrification statistics are required to be submitted to monitor electrification progress and assist with the allocation of electrification funds. Finally, current legislation requires the submission annually of audited financial statements.

Are we on track as far as information is concerned? I believe the answer must be no, although improvements are being recorded. Just have a look at the annual Electricity Supply Statistics publication and see how many licensees have not submitted information at all and in how many cases the information is not all supplies. What, however, is not visible, is the number of returns that require messaging after being checked by validation processes to correct figures submitted, for example in the wrong units. Why, if the form require sales in kWh do we find that some licensees provide MWh (and even GWh) figures. Similarly, financial figures that should be in R000's, is sometime entered in Rand values or even R millions. I want to assure you that this causes the Regulator a large volume of unnecessary work. It would be so much simpler if the information is properly validated and correctly entered at the source of entry.

Let me provide some facts and figures so that you can get a feel of what I am talking about. As part of the process to pave the way to rationalise tariffs and assist in the approval of tariff applications by licensees, the Regulator regularly analyses submissions of D-forms and tariff applications.

The position at the end of June is depicted in the following table.

| Description | Number (%) |
|---|---|
| Number of municipality entities licensed for distributing electricity | 175 (100 %) |
| Municipal entities that have applied for tariff changes in current cycle | 107 (61 %) |
| Municipal entities that have unapproved tariffs | 48 (27 %) |
| Municipal entities that have submitted completed 2001/2002 D-form information *** | 122 (70 %) |
| *** Please note that information submission and completeness figure pertains to the information required for tariff approval purposes, not for plant details, customer service , power quality, etc. | |

From the foregoing analysis it can be seen that the number of licensees that is still applying non-approved tariffs is unacceptably high. The problem that the Regulator is facing in addressing this issue is twofold, namely the previously mentioned lack of punitive measures provided by legislation and the fact that with the advent of industry restructuring, tariff rationalisation and monitoring will be entering a new phase.

The lack and/or the quality of the of information is slowing down the tariff application process dramatically. Hence, why it is in the majority of times not possible for the NER to process the applications in time.

Although not reflected in the above statistics, an underlying problem to tariff approval, especially if one wants to use rate of return regulation is the lack of proper ringfenced electricity departments/ functions within municipalities. This problem will hopefully be reduced, if not totally eliminated, once the ringfencing exercise as is required in terms of the industry restructuring plan is completed.

### What does the future hold from a regulatory perspective?

Although I can spend more of the available time discussing the problems being experienced by the Regulator, including issues, often interrelated, such as apparent lack of maintenance by some licensees of distribution assets, poor, or at best, only mediocre customer care, inadequate attention to reducing technical (and non-technical) losses, etc., I do not think that it will serve any purpose to continue with this theme here. It is time to look forward and not spend the time dwelling on the here and now. We have a good idea of what we need to look out for in the future, without having to fall in the trap of analysis paralysis. So, the industry restructuring and the proposed enabling EDI Restructuring Bill, in conjunction with the new ESI Regulatory Bill, is going to solve all the problems, right? No, wrong! The challenges to the Regulator, and to you the industry stakeholders, are not going to disappear. Some of the current problems and frustrations will most probably continue plaguing us for some time to come. In addition brand new, perhaps even more difficult to solve, problems will most likely rear their ugly heads. Will we be able to solve them? Yes, unequivocally, yes! Provided all of us work together to achieve it.

The first major uncertainty concerning the future dispensation that the Regulator, and the distribution industry, faces results from the current proposed EDI Restructuring Bill. This Bill, as you are all aware, deviates from the PricewaterhouseCoopers (PwC) Blueprint recommendation regarding the mandatory transferring of municipal electricity undertakings to the Regional Electricity Distributors (REDs).

The Restructuring Bill is based on a voluntary transfer system, which implies that REDs could possibly vary from just, on the one hand, Eskom's distribution function, presuming that it will be decreed that Eskom's distribution business will be transferred to the REDs, to REDs incorporating a mixture of Metro - and other municipal electricity distribution functions in various proportions. However, it is very likely that not all Metro's and municipalities will transfer their distribution assets to the REDs. This, you will realise, could vastly change the complexity of the Regulation of the industry. Currently the Regulator is, with the aid of consultants, working on the new regulatory framework, licence requirements, performance monitoring reporting - and industry information requirements as well as a tariff rationalisation approach and strategy based on the premise that all municipal electricity distribution businesses would be incorporated in the six REDs. All these aspects would need major rethinking if the model as proposed by the Restructuring Bill eventually becomes the definitive model.

To illustrate the added complexity, let us just look at two aspects, namely licensing and tariff rationalisation.

Although the licensing framework and requirements for the six distribution businesses has not yet been finalised, it had been foreseen that licenses would primarily be issued only to the six REDs, with perhaps a very small number of private distributors. Now, metros and municipalities that do not transfer their distribution businesses to the REDs would require to be separately licensed, possibly with similar, but not identical, licence conditions to those of the REDs. This will certainly increase the number of licences to be issued and the number of entities that would have to be monitored for compliance with the stipulated licence conditions. This aspect, together with the one mentioned in the next paragraph, would probably result in a larger workforce than originally foreseen by the Regulator under the proposed PwC model.

As it is, tariff rationalisation under the proposed PwC model is already fraught with problems in a multi-jurisdictional regulatory environment. This, however, becomes multifold more complex in the model prescribed by the ESI Regulatory Bill. In the PwC model, the Regulator together with the EDI Holdings Company and the industry at large have to finalise how the very large number of existing tariffs are to be rationalised to a small number of "standard" tariffs. Although, as stated, the process has not yet been finalised, it would probably entail that not only the tariffs for the REDs would be approved by the Regulator but also the process or various tariff paths for the municipalities to ultimately conform to the approved "average" tariffs of the REDs. These paths would presumably have to be determined by the REDs so that over a pre-agreed period of time the tariffs charged within the different municipality conform to the average RED tariffs.

These tariff paths and timeframes should ideally require approval by both the NER and the appropriate multi-jurisdictional municipal service districts or municipalities, the NER in its capacity as industry regulator and the latter entities in their capacity as service authorities. I believe that you will agree with me that this in itself will present a major challenge to managers and personnel of EDI Holdings, the REDs, the NER and municipalities.

However, the ESI Regulatory Bill model now effectively imply that, over and above the involvement of the Regulator in the described process, it will also still have to possibly steer the tariffs, at this stage for an unknown number of metros and/or municipalities, as a separate exercise. Certainly not an easy task when one considers the extent of the number of tariffs currently in existence!

Please note that I have outlined the above mentioned complicating factors arising from the currently proposed EDI Restructuring Bill merely to illustrate the implications from a regulatory perspective and not to use this forum as an opportunity to debate the content of the proposed Bill. This is not the time nor the place to do so, many other forums and mechanisms exist to debate the contents of the Bill.

Aspects or issues that I do not have to time to spend sufficient time on during this presentation, but as mentioned earlier are extremely important include issues such as: poor, or at best, only mediocre customer care, inadequate attention to reducing technical (and non-technical) losses and what constitutes a "commercially" acceptable rate of return on distribution assets and the associated "effort" being spent by distribution personnel in providing a reliable and affordable electrical supply to customers?

In addition to what degree is insufficient maintenance and refurbishment being carried out on current distribution assets? If insufficient maintenance is being carried out, is this a consequence of low tariff levels or, perhaps, too high surplus margins? The debate on these, and other similar issues will have to continue in order to firm-up on the appropriate way forward for the Regulator.

### Conclusion

As indicated at the start of this presentation, within the time available, it was only possible to briefly touch on problems currently being experienced by the Regulator and try and extrapolate some of these to the future. Perhaps I have not spent enough time on the way forward which, after all, is the title of this paper.

But, I hope you will accept that I find it difficult to discuss a definitive way forward as there are still so many unresolved questions and issues. Suffice to say that with the appointment of the board and chief executive officer for EDI Holdings, a major step forward has been taken to start the very necessary electricity distribution reform process and the Regulator, and its personnel are keen, able and willing to rise to any challenges that may present themselves during the process.

Provided we keep our lines of communications between ourselves open and remain prepared to listen and learn from each other, the electricity distribution industry will go from strength to strength for the benefit of all customers and stakeholders. I am sure that we will together find the appropriate level of regulation required, what represents the correct tariff levels to assure long term justifiable financial viability and what the ideal industry structure is.

Please let us figuratively take hands and together build a electricity distribution industry that could serve as a model for the world, and in the process take the National Electricity Regulator one step closer to its vision of becoming a recognised world class regulator.

Without your assistance, co-operation and support, this vision would remain a pipe dream, with very little chance of being realised. Δ

NATIONAL ELECTRICITY REGULATOR

**The National Electricity Regulator (NER) believes that electricity is the dynamo for economic growth and development of South Africa and its people.**

**Electricity has the power to transform ordinary people's lives, stimulate the creation of new businesses, create jobs and make the South African industry more competitive internationally.**

Many millions in South Africa and in the rest of the African continent are waiting to share in the benefits brought by electricity. The NER, therefore, is justifiably proud to be elected first Chair of the African Forum for Utility Regulators (AFUR), which aims to support the development of effective utility regulation in Africa; and to be a founding member of the Regional Electricity Regulatory Association (RERA), which aims to coordinate regional policy for the electricity supply industry (ESI) of the Southern African Community (SADC) region.

These developments are in line with broad international trends in which regulators agree to co-operate with each other across borders. This usually provides significant benefits arising from shared resources and a common understanding. The NER is the regulatory authority over the ESI in South Africa. It is a statutory body, established on 1 April 1995 in terms of the Electricity Act, No 41 of 1987, as amended by the Electricity Amendment Acts of 1994 and 1995. The Minister of Minerals and Energy appoints Board Members, including the Chief Executive Officer, and, once appointed, the NER acts independently and reports to Parliament.

The NER has national jurisdiction over generators, transmitters and distributors of electricity and exercises its powers through the issue, modification and revocation of licenses. It protects electricity customers by ensuring cost-effective prices, optimal quality of supply and service and amicable resolution of disputes in the ESI.

The NER is funded from a levy (approved by the Minister of Minerals and Energy) imposed annually on generators of electricity that is passed on to all customers of electricity. Customers therefore pay for the protection they receive from the NER, and the general body of taxpayers is relieved of this obligation.

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# International trends: regulating the electricity distribution industries of the world

by Richard Fairbairn, IPA Energy Consulting, Edinburgh, United Kingdom.

**Restructuring of electricity businesses across the world is leading to developments in measures employed to monitor the prices paid and quality delivered by both competitive and non-competitive parts of the industry. In the competitive sectors, i.e. generation and supply, strong commercial incentives can naturally develop to drive down prices and improve quality.**

In monopoly sectors, the same commercial pressures do not exist, and instead efficiency pressures must be created through regulation. There is a fine balance that must be struck between reducing prices and improving quality, and it is an ongoing challenge that regulators and distributors across the world are facing up to. Customers are keen to see price reductions, but are not prepared to see deterioration in the level of service they receive. The form of regulation must therefore recognise the seemingly conflicting demands of price and quality.

These concerns have driven the development of new forms of distribution regulation, using increasingly sophisticated price controls. Incentive schemes have been designed to reward good performance (or penalise poor performance) depending on the outputs achieved. In order that these 'output' based performance incentives do not jeopardise longer term quality of supply, performance monitoring can be combined with additional controls on business 'inputs', to protect the long-term health of assets and avoid system deterioration. IPA's staff has been at the forefront of developing regulatory frameworks across the World. This paper is based upon IPA's recent experience across the world, and more specifically the experience in South Africa, Lesotho and Mozambique.

### The objective of regulation

Regulation is a tool that can be used to deliver improvements in a sector, but the form of regulation adopted must be carefully considered in order that it achieves what is required. Regulators generally have the overriding obligation to act in the best interest of consumers, in addition to other specific duties that may be placed on them by Government. Regulation normally forms an integral part of a reform process that has main objectives to:

- Increase efficiency and reduce costs;
- Maintain or enhance security of supply;
- Increase customer access and choice;
- Encourage private investment; and
- Ensure the long-term financial viability of the regulatee.

In African countries, such as Lesotho and Mozambique where IPA has recent experience, increasing electrification rates are an additional key driver for reform. Increasingly governments are also looking to electricity regulators to take on more environmental responsibilities, such as in Ireland where protection of the environment is a higher legislative priority than the duty to protect the interests of rural customers, the disadvantaged and the elderly (Irish Government - Electricity Regulation Act, 1999, Condition 9).

### Routes to meet objectives

In most European countries these objectives can be realised through the introduction of competition to force price reductions through innovation and efficiency improvement, and through various forms of incentive based regulation designed to reduce prices and improve the quality and availability of supply. Even in the monopoly activities, market based environmental mechanisms can be used and the price regulation will have to take into account the cost of meeting environmental targets. In many emerging economies final price reductions may not be the driving factor, as tariffs are often already below cost reflective levels. In such countries regulation will aim to improve the commercial and technical performance of utilities to allow the utility to recover its efficiently incurred costs, eliminating subsidy (or making it specific and transparent) and improving financial stability whilst enhancing the quality of supply.

In countries where the utilities have a reasonable overall technical and commercial performance, such as New Zealand, regulation can recognise the benefits of allowing the utility to balance quality of service and price. New Zealand is regulated on the basis that distribution companies are compared against each other in respect to 3 basic indices: price, rate of return, and service quality. Any company that consistently scores poorly is subject to a detailed regulatory review of its business.

In many countries where regulation is newly established, the regulator is faced with a number of conflicting objectives in a sector that is going through significant change. For example, the Government may have privatisation as a key objective, with a view to improved technical and commercial performance. However, investors will be wary of businesses where there is no or only a limited regulatory history and where there is a requirement for significant investment in order to reach satisfactory performance levels. In such circumstances, regulation will need to focus on establishing cost reflective tariffs and improving revenues so as to enhance the financial and operating performance of the utility. It is also vital that the regulatory processes have a high degree of transparency, and be free from political intervention. These practices have proven effective in many of the countries where IPA has worked, including the present work in Lesotho.

### Basic forms of regulation

There are two basic forms of regulation that can be applied to any business:

- Input based regulation; and
- Output based regulation.

The simplest form of input based regulation is rate of return regulation, where the business is permitted to make a specified rate of return on its assets. The company's investment plans and proposed prices are subjected to frequent and detailed reviews by the regulator, and the expenditure is subject to the approval of the regulator. At the other extreme, output based regulation is not specifically concerned with the investments and assets necessary for the company to achieve its ultimate result, which is the delivery of electricity to customers. Providing basic rules are adhered to, performance based regulation provides a return to the company based on the results achieved by the business.

Between these two extremes there are a multitude of variations that have been adopted in different countries, depending upon the specific needs of each sector. One common variation is the "incentive based" framework that was initiated in the UK, whereby performance that was more efficient than the regulator's projections would permit companies to earn a return greater than that nominally permitted, provided output did not deteriorate. In practice this scheme set specific efficiency improvement factors (by allowing future revenue to rise by a term "RPI-X", where RPI is inflation and X an efficiency factor) and hence it is sometimes known as RPI-X regulation. In the UK this scheme led to both significant reductions in prices improvements in output quality.

It should be noted that the form of regulation applied can change over time to reflect changes of emphasis in the objectives of the regulator (for example in the cost-quality trade-off) and the level of sophistication appropriate for the regulator and company, taking account especially of the granularity and quality of data available.

It should also perhaps be recognised that all regulation contains forms of incentives - some

explicit, others less so. In rate of return regulation the incentive is mainly concerned with capital investment. If the set rate of return is high, the regulatee will have incentives to invest more, and if the rate of return is low, the regulatee will wish to defer or reduce capital investment. In performance based regulation the incentive is to match (or beat) the specific performance targets, mainly associated with operating costs. Incentive based regulation allows the regulatee to retain the financial benefits from exceeding the target performance levels, until the next regulatory review when the gains can then be passed to the customer in the form of lower prices. This incentive works best when the period between reviews is not too short.

### Identification of targets for regulation

The identification and setting of targets for regulation schemes is a complex and controversial subject. Schemes that have been used in different countries can be compared but this is not always helpful, as there are many variables that can be adjusted to achieve the desired regulatory result. The setting of price control targets must also consider political implications as well as the economics of the regulated business.

In an incentive-based scheme like that used initially in the UK there are three main components of a regulatory price control for networks businesses:

- Rate of return on assets;
- Initial price reduction; and
- Efficiency improvement factor.

The regulator may be keen to use the control to emphasise either: the additional (incentivised) efficiency improvements achieved since the last control (tending to be reflected in the one-off reduction); the expected scope for future efficiency improvements (tending to be reflected in the annual X factor); or the relative attractiveness of investing in a utility company (reflected by adjusting the allowed return).

Ultimately, these elements are used to define the forward looking revenue that the utility is permitted to recover via its prices

In an extreme case the regulator may also consider it appropriate to revise the company's effective asset value (asset value or asset lives). This happened in the UK where Transco (gas pipeline business) had the asset lives extended, reducing the short term annualised depreciation value of the assets, but arguably more closely reflecting their actual economic lives. For performance-based regulation the selection of targets is generally more transparent. The base performance is normally set according to the outturn from previous years. The performance can be set with a deadband about the target point, with a defined scale of penalties and rewards dependant upon the outturn performance. Rewards and penalties are normally subject to a collar and cap arrangement to limit the financial exposure under the scheme. Statistical techniques can also be used to discount extreme values from the reported results. For example, for distribution system fault rates and customer interruptions, days when values fall outside two standard deviations from the mean can be considered to represent extreme events outside the normal operations of the business, and be excluded.

In setting regulatory targets and reviewing past performance benchmarking is often used to assess comparable businesses. In Britain there were strong cases made that some businesses were significantly different to others, and that benchmarking was of limited value and the same arguments are held across the World.

However, benchmarking is a favoured tool of regulators and, providing that high quality information is available, economists can devise increasingly sophisticated ways to compensate for differences between business. The process that led to the definition of the REDs in South Africa suggests that benchmarking will be a key tool in the future regulation of the sector.

| Country | Availability CML/SAIDI | Security CI/SAIFI per 100 customers | ROTA |
|---|---|---|---|
| Britain | | | |
| North of Scotland | 99 | 128 | 8 - 9 % [I] |
| South of Scotland | 69 | 68 | 8 - 9 % [II] |
| England and Wales (average) | 60 | 76 | 8 - 9 % [I] |
| London | 36 | 35 | 8 - 9 % [I] |
| *Republic of Ireland* | 255 | 162 | Not known, but thought to be about 8 % [I] |
| *Australia - all DBs* | 156 | 201 | |
| AGL | 86 | 143 | 12,3 % |
| CitiPower | 41 | 68 | 14,2 % |
| Powercor | 198 | 253 | 16,1 % |
| TXU | 204 | 311 | 12,4 % |
| United Energy | 66 | 131 | 12,5 % |
| *New Zealand* | | | |
| Dunedin | 56 | 96 | 11,5 % |
| PowerCo | 89 | 173 | 8,0 % |
| Vector | 54 | 99 | 9,9 % |
| United Networks | 81 | 153 | 10,0 % |
| *Singapore* | 4 | 7,3 | Circa 8,5 % |

[I] The allowable return set by the regulator was actually 6,5 %. The higher return demonstrates the ability of companies to respond to incentives

[II] The allowable return set by the regulator was actually 6,6 %. The higher return demonstrates the ability of companies to respond to incentives

*Table 1: Comparison of performance and returns of companies in different countries*

In the UK merger and acquisition have reduced the value of benchmarking and comparators to the regulator and this is something that will need to be carefully considered in South Africa. In other countries however, benchmarking exercises are still highly effective regulatory tools, especially where there are a large number of companies to be compared.

The electricity distribution sector in Finland for example has around 1000 small companies and in Germany there are around 800 companies. Interestingly, the scale of the challenge means that regulators in both countries have tended to favour ex-post regulation of charges rather than the ex-ante setting of allowed total revenues that rely on forward efficiency projections. There are a number of different methods available for benchmarking, and they are beyond the scope of this paper. However, the approaches basically consider either a form of averaging, or consider looking at the leading performers (frontier analysis).

It is perhaps worth commenting that however targets are set, it is important to recognise that they apply for one price control period only. Revenue targets are set according to a level of cost that an efficient business would expect to incur, and even very efficient businesses need an incentive to seek continued improvements in performance. If the regulator sets targets that become inappropriate with a change in circumstances, the regulator will be under pressure to take corrective action at the next control.

In extreme cases, it is important to ensure that if circumstances change dramatically, there is the possibility of an interim price control or price control adjustment mechanism, for example to ensure a company's financial stability.

### Examples of regulation used across the world

Regulation across the world takes different forms according to the legal frameworks established, but also the personality of the regulators employed. This results in variations in approach adopted to meet very similar objectives.

*United Kingdom*

Regulation in Europe was initially formed on the "incentive based" principles described above. This outwardly simple form of regulation was initially adopted in the UK as it provided investors and management of the companies with a clear indication of what was expected to be achieved in terms of the financial performance of the companies. It provided a clear forward track of revenues to allow investors and management confidence in the businesses. Since the regulatory environment was new to all parties, there was strong political and commercial pressure to demonstrate the success of privatisation. This meant that the early price controls were set in a manner that both encouraged efficiency improvements and reduced prices, but at the same time minimised the overall impact on the operation of the businesses.

The incentive clearly worked, and efficiency gains exceeded all expectations. While this led to high profits by the regulatees in the early years of the incentive scheme, these benefits were then passed to the customer in subsequent reviews. Arguably, had the initial incentives been weaker, through the setting of tighter targets, the same efficiency gains may not have materialised.

As all parties became more familiar with the regulatory environment, price controls became more targeted and forced greater efficiency improvements in the sector. In recent years the regulator in Britain has started to move towards regulation that links revenue to the outputs that are achieved rather than the inputs that are expected. The revenue for distribution businesses are now linked in part to a rate of return regulation and in part to a performance based scheme (see Box 1).

*Australia*

Regulation in Australia is performed on a state basis and is similar to the UK in that it combines incentive-based and performance based regulation. The price control formula used has a specific term linked to the quality of supply achieved by the distribution business. The trend in Australia is to move more towards performance-based regulation, with proposals being made recently for quality of supply measures to be included in the controls for transmission businesses.

*USA*

The form of regulation in the USA is generally straight Rate of Return. This requires annual hearings to be held to review and approve the company's investment plans and operational expenditure. At these hearings the regulator invites customers to challenge the proposals. Its advantage is a high degree of transparency. Its major disadvantage is its litigious nature which leads to high costs of regulation, and reduces scope for innovation. During the last 10 years many states have moved to incentive based systems on the grounds that Rate of Return regulation causes utility companies to opt for new investment rather than to ensure the best use of existing investments.

*New Zealand*

As mentioned above regulation of distribution businesses in New Zealand is based on a comparison of the performance relative to their peers. Companies are assessed according to 3 basic indices: price, rate of return, and service quality, and ranked for each index. A weighted score is applied to each index to derive a total score for each company. If a company consistently receives poor overall scores it is threatened with a price control, whereby the regulator will undertake a detailed investigation of the company's costs and business plans. It is the threat of a price control that ensures that distribution businesses balance their operations between quality of supply and price.

*Finland*

The approach to regulation in Finland is very similar to the approach adopted in New Zealand. The key difference between the New Zealand and Finland approach is that they use a retrospective, or ex-post form of regulation, whereas in other countries the price control is forward looking. Although there are increased company risks with the ex-post method (not knowing if revenue recovered will be later disallowed) the regulatory system is efficient and permits a team of less than 20 full time employees to regulate around 1000 companies.

*Mozambique*

Regulation in Mozambique is in its very early stages, and there is little to report on the actual activities of the regulator. However, historically EDM has planned its business operations with the Government and these plans have had to consider the tariffs that the Government will permit. These plans are formalised in the "Contrato Programma" and form a defacto price control, specifying key factors such as electrification targets.

*Former CIS*

In the former Soviet Union prices for electricity were set as part of economic planning and were usually far below cost. Since independence many of the countries have reformed their electricity sectors with poor results. The reforms have been initiated to resolve specific problems in the sector, on the assumption that an investor will solve all of the problems (despite the best advice of international experts). Private money has come in, but without the promised actions of Government and regulator the companies are unable to operate the businesses as they intended and are pulling out. Ukraine and Azerbaijan are two examples of where the reform process has delivered no real benefits, but which has incurred significant costs. Tariffs have not been increased to a level to allow cost recovery, and subsidies are not forthcoming. This means that sector income is far below cost and required investment levels.

*Germany*

At present, the electricity sector in Germany is not independently regulated. The Government carries out the regulation function directly, with companies subject to ex-ante appeal to the competition authority (the Bundeskartellamt) which conducts investigations of whether price levels are justifiable and has strong powers to fine offenders. The sector is characterised by high quality supplies, but with prices around double those of the UK. More recently Germany has announced plans for an independent, sector specific regulator to be introduced.

## Comparisons

Table 1 presents data for a number of utilities across the World. The table compares the network performance in terms of the quality of supply offered and the return on assets that distribution companies are allowed. The table shows that there is no hard and fast return on asset value that should be expected, and that even within countries (where the underlying economic conditions should be the same) there can be significant differences in the returns expected.

## Affordability

There is a balance to be made between the need for distribution businesses to recover their costs and the ability of customers to pay for the electricity they need. Affordability of the poor is often a key issue for Governments, and in some cases this is managed through a cross-subsidy from better off customers being provided on electricity tariffs. However, there is a growing recognition that cross-subsidies inevitably lead to price distortion in the market and allocative inefficiency. Cross subsidies are difficult to implement in competitive markets and act as a barrier to other reforms.

The industry does not have to recover all of its costs through customer charges; governments have intervened by providing subsidies to certain classes of customer that they believe must genuinely be protected from the need to pay the full cost of the services they use. This compromise is one that is being seen as being necessary for the wider benefits of reforms to be realised. Social protection is now recognised as an integral part of power sector reform, and research has shown that accurate targeting of vulnerable customers can be cost effective for Government, and need not adversely impact on the private sector, and quality of supply. Kyrgyzstan and Slovakia are currently designing effective social protection mechanisms which will provide support to those most in need based on ability to pay and willingness to pay. An ongoing project that IPA is completing in the Balkans is investigating the impact that poverty reduction mechanisms will have in the context of a regional electricity market.

Tariffs, and the need to increase them to allow the industry to be fully funded, form probably the single biggest issue for regulators and government when embarking on reform projects. Without tackling this at an early stage and solving the subsidy issues, reforms stagnate, or stall before they begin. Tariff design can be designed to minimise the impact on the poor: in Lesotho there is a very low rate for the first few units consumed (matched to the basic

**Box 1**

In the UK the regulator has moved from a relatively simple "RPI-X" incentive scheme to include additional schemes to incentivise technical performance improvements

Ofgem has recognised the importance of Distributor delivering an appropriate quality of supply, and initiated a project the Information and Incentives Project (IIP), following the conclusion of the last price control review in December 1999. This works to improve the level of service that distributors provide by linking certain quality of service measures to the revenue that they recover from customers.

Distributors have agreed to an incentive scheme that allows for financial rewards or penalties depending on the quality of supply performance in three key areas:

- number of interruptions to supply;
- duration of interruptions to supply; and
- the quality of telephone response

Distributors presently have 2 % of their revenue linked to this performance scheme.

In another scheme distributors are rewarded at 2,6 p/kWh for the marginal reduction in distribution losses below the average loss level over the past 10 years.

electricity requirements), which then increases with consumption. However, this implies cross subsidies and there is therefore a need to reconcile the conflicting interests of ensuring fair pricing, social protection and protecting the financial interests of the utility.

**Ensuring liquidity**

An issue that is closely linked to the protection of the poor is the protection of distribution system revenue. Liquidity is one of the most critical issues facing any business and has plagued most developing world distribution sector reforms. Without cash in the market, no reform will succeed.

Regulators have recognised the need for distribution businesses to protect their revenue through a number of different schemes. In the UK, there are a range of measures that companies are permitted to adopt, from the installation of prepayment meters through to disconnection. Of course the South African experience of prepayment meters shows that these devices are not infallible, but the combination of inspections, metering improvements and the use of legal action to punish theft of electricity has reduced the levels of non-payment in many countries.

In Argentina, where the electricity sector has a mixture of relatively sophisticated market mechanisms, multi-national corporations as customers, but also customers who have extreme poverty, innovative approaches have been adopted to revenue collection and allocation of subsidies.

In Buenos Aires, the provincial and national Government pays subsides to distributors to compensate for unmetered consumption in the shanty towns surrounding the city. Each shanty town is metered as a single unit and the total consumption is compensated through the taxes due from the companies. This arrangement has a revenue neutral effect on the private operators and has not impacted negatively on the sector. Separating the social support factors from energy sales is being recognised as a key aspect of sector reform.

Non-payment is a problem throughout the world and is linked to the history and culture of each country. In the UK there is a tradition of payment and a legal system that recognises non-payment and interference with meters and other equipment as serious offences. In other countries there are traditions of electricity being provided by a state owned organisation as a public good, so that certain customers (government departments, hospitals, army, police, war veterans, pensioners, etc.) have not traditionally been required to pay for their consumption. Solutions have been found in some cases, but there is no universal panacea to the problem.

**Asset value, and return on assets**

There is a widely held view amongst leaders in government and industry embarking upon reform that their power sectors are intrinsically valuable commodities, and that their disposal should only be considered if it generates substantial cash. But an industry's worth is not the book value of its physical assets. In most accounting conventions it is the lesser of the income generating capability of the asset, its replacement cost with a modern equivalent asset, or the depreciated historic cost. The income generating capability will depend upon the commercial environment in which the assets operate. The regulatory structure and the ability to predict future revenue is a key factor in determining the asset values. Regulators must be careful they do not make this argument circular in assessing asset values.

The individual assets may have little value despite the fact that they were installed at substantial cost. Their value comes from being operated together to provide a service in return for an income.

If the income stream is insufficient to cover the cost of operation, maintenance and refurbishment, then costly assets have minimal value.

Many companies will show examples of how to value assets and these models are reasonable tools for establishing a baseline. However, it is important that utilities recognise that asset values calculated by such models may not reflect the "market value" for the assets, and that the revenue resulting from a reasonable return on that value may not be realised in practice if leads to unacceptably high prices.

Put simply, asset valuations and return on assets are tools to assist the understanding of a utilities revenue earning requirements: the revenue allowed will be determined by market conditions; and if it comes to a sale, the assets are only truly worth what somebody will pay for them.

The physical value of the assets and the actual value are two different things - the later being dependant upon future earnings and therefore the regulatory framework.

On the other hand, if regulators consistently set asset values significantly below replacement cost, regulatees will have insufficient income and no incentive to replace life expired assets and quality of service will deteriorate. Once again there is a balance to be struck.

**Trends and implications for South Africa**

It is likely that regulation of distribution businesses in South Africa will contain specific incentives. However, we must learn from international experience that incentives are blunt instruments. When incentives are well structured and well aimed they work with sometimes startling effectiveness, but this virtue can also be a problem.

An incentive to cut costs that is not balanced by other duties - for instance to maintain security and quality of supply - can lead to a reduction in operational performance, albeit accompanied by an increase in financial performance.

A reasonable balance must be found between such possibly conflicting objectives for sector participants.

In the UK the incentive based regulation scheme delivered real reductions in distribution charges in the order of 10-12% over a 10 year period, with ongoing improvements in quality of supply.

However, in the early years a cautious approach was adopted and a similar approach should be considered for South Africa.

The problem of liquidity is as much as problem in South Africa as anywhere else in the world, if not more so. The regulator and Government must support REDs in combating non-payment and theft by giving the REDs the tools to tackle the problem, or alternatively give the REDs financial support.

Unless a coordinated approach is adopted, there is a risk that some of the failures of reform experienced in the CIS could be repeated.

In a South African context it will be important for the Government and regulator to work closely with the REDs to determine the steps that can be taken to protect the poor, and to link this with the broader Government strategy for the disadvantaged.

**Conclusions**

The benefits of market reform have been recognised across the world, and there has been a general move towards reform of the electricity sector. A key part of the reform process is the role of the regulator. The definition of the role of the regulator, his objectives and obligations are vital to the development of the reform process.

The regulator can set objectives through incentives that are placed on distribution companies.

These can be commercial incentives through rate of return regulation, or technical incentives through performance based regulation. Performance base regulation needs good data sources, and the more sophisticated the control the more complex the data requirements.

There is a move from basic rate regulation towards more performance regulation across the word as markets mature, but incentives must be considered carefully. The setting of a target for one performance index may have an unexpected consequence for another part of the business. It is therefore important that for each market the optimum form of control be considered carefully, so that an appropriate level of complexity is selected to match the ability of the market to respond against the overall Government and regulatory objectives.

Whilst the regulatory framework may be complex, and there be many factors that are used to drive the price controls, there are two basic factors that influence customers: quality and price.

Ultimately, it is these factors that also concern the regulator. Δ

# The corporatisation of the Central Electricity Board of Mauritius: lessons learnt

by PJS van Niekerk, general manager, CEB

**The corporatisation of a public service in any country is fraught with issues arising from government's obligations to the taxpayers. Electricity distribution is no exception and in spite of it being a tradeable commodity, it is perceived to be an "acquired right" and considered to be an essential service for modern living conditions.**

Electricity is, furthermore, essential to the commercial and industrial development of a country and the macro-economic effect of a continuous, reliable electricity supply of good quality has far reaching significance.

Consequently, irrespective of the most noble intentions of the corporate plan, the needs of the various shareholders must be very carefully balanced.

This paper is intended to give an overview of the corporatisation of the CEB and summarises the risks, advantages and disadvantages of major reforms.

This paper provides:

- an assessment of the key issues facing CEB in light of the power sector reform initiative;
- the strategic direction envisioned for successful business restructuring on commercial principles; and
- a look at the financial status of the organisation as well as strategies to improve financial results for the years ahead.
- an overview of problems encountered and lessons learnt during the process.

## Overview

*Electricity sector reform*

In meeting its social obligations as electricity provider to a rapidly growing island nation, the Central Electricity Board has not always been able to operate on commercial principles. This has contributed to a weak financial position for the utility over the years. Given that the country is now completely electrified and the standard of living has risen for the majority of the population, CEB can now begin to balance its social obligations with the need to operate as a commercial entity.

To realise its plans, the government of Mauritius committed to improve the financial condition of the sector through improvements in efficiency, reductions in system expansion costs, and injection of fresh capital through private participation by taking the following distinct steps:

- Corporatise the CEB as a vertically-integrated utility;
- Set up an independent, multi-sectoral regulator; and
- Invite a strategic partner to assist in the management of CEB.

*Organisational*

The Central Electricity Board is a parastatal body wholly owned by the government of Mauritius and reporting to the Ministry of Public Utilities. Established on 8th December 1952 and empowered by the Central Electricity Board Act of 25 January 1964, CEB's business is to "prepare and carry out development schemes with the general object of promoting, coordinating and improving the generation, transmission, distribution and sale of electricity" in Mauritius.

From a humble sales figure of 98 million kWh and a maximum demand of 31 MW at the time of the country's independence in 1968, the Central Electricity Board has focused its efforts on the supply of electricity to all sectors of our society, thereby contributing to the social and economic development of the country over the years. At the same time as we were completing the national rural electrification programme in 1981, we were also extending our networks to supply new industries following the setting up of the export processing zones and the needs of a growing tourism sector and textile industry.

Conscious of the country's heavy dependence on an uninterrupted and stable electricity supply, CEB has invested massively in building up generation capacity, mainly in heavy fuel oil-fired power stations. All hydro potential had been exploited as of 1983 when the Diamamouve Dam was completed, supplying water to the Champagne hydroelectric power station.

In 2002, electricity sales totalled 1 492 million kWh. CEB itself produced about 968 million kWh of energy - some 57 % of the country's requirements - from its four thermal power stations and eight hydroelectric plants, which have a combined capacity of 367 MW. The remaining 43 % of energy require-ments was purchased from independent power producers, which have a total firm capacity of 111 MW and produce electricity from coal and bagasse. With a workforce of approximately 1800 employees, CEB safely and dependably delivers electricity to more than 330 000 customers

## Our vision, mission and corporate values

*Vision*

We see ourselves as "a world class, commercial electricity utility enabling the social and economic development of the region"

*Mission*

We understand that the future of our business depends on delivering value and quality service to our customers and stakeholders, and that our business is to provide our customers, not with simply electricity, but with the benefits they want; in other words, comfort, security, entertainment, and the ability to carry on business and industry.

**Our mission**

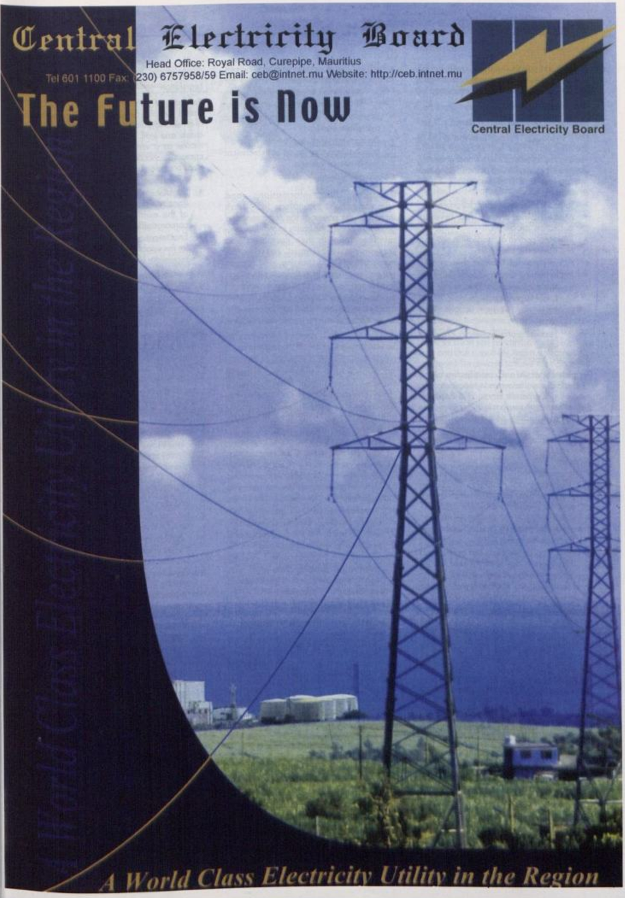
We meet the expectations of our customers and stakeholders by:

- Delivering prompt and efficient customer services
- Developing our employees and providing them with incentives
- Providing an affordable, safe and reliable electricity supply
- Undertaking our business in an environmentally responsible manner
- Being the preferred employer in the region.

*Values*

As we move forward with our corporate plan we will endeavour to have our people exhibit these values in their day-to-day work:

- Respect, honesty, and loyalty:
  We deal with our colleagues, customers and stakeholders on the basis of trust, honesty and respect for differing views and interests. We shall remain loyal to the ideals, ethics and values of the company
- Pride and ownership:
  We shall act responsibly and participate actively in building pride and ownership of our corporate values.
- Courteous, excellent service:
  The nation is our client. We shall always endeavour to provide a courteous and excellent service in satisfying the electricity service needs of the Mauritian public.
- Superior performance:
  We perform our tasks in a professional manner and produce our outputs to the best of our ability, with optimum utilisation of resources and with a focus on continuously improving the quality and reliability of the electricity supply.
- Team culture:
  We involve our people in the success of our organization. We value initiative, cooperation, innovation, communication and flexibility in our work. We encourage,


Central Electricity Board
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The Future is Now
Central Electricity Board
A World Class Electricity Utility in the Region

support, and involve staff in the mechanisms and processes through which we make decisions in our organization.

**Corporate goals**

*Financial soundness and efficiency*

Our strategies to achieve the goal of financial soundness and efficiency include making improvements to a number of existing internal processes as well as introducing new procedures and staff functions. These strategies embody:

- Improving internal financial processes;
- Modernising billing and revenue collection processes;
- Ensuring capital authorisation requests are business-case driven.
- Actively manage financial risks; and
- Implementing a path to profitability by:
  - Minimising capital borrowings;
  - Reducing bank overdraft;
  - Reducing production and other costs;
  - Sustaining and growing our revenue base.

*Integrated planning*

To ensure a secure and cost-effective supply of electricity for customers in Mauritius, CEB created a Corporate Planning & Research Department with responsibility for long-term planning including demand forecasting, generation planning, transmission and distribution planning, and strategic projects. The strategies of this planning group embody:

- Implementing integrated planning processes to improve business preparedness, reduce overall system expansion costs, and reduce risks;
- Identifying and developing initiatives to meet and manage current and future electricity demand;
- Reviewing power purchase agreements and identifying areas where future agreements can be refined; and
- Maximising the profitability of existing and new assets.

*Desirable employer*

The path to becoming a world class electricity utility depends on our ability to attract, retain, and motivate people. With an ageing work force and an external environment of evolving social, lifestyle, and demographic trends, CEB recognises that it must not only build up a more diverse base of in-house skills, it must also establish a more modern employer-employee relationship.

Strategies to assist in the achievement of this goal include:

- Completing an employee profile;
- Preparing a comprehensive Human Resources Plan to:
  - Attract and retain individuals with critical skills;
  - Foster knowledge transfer from retiring employees;
  - Provide succession plans; and
  - Introduce a performance appraisal and remuneration system, which includes performance-based compensation and incentives for employees to achieve corporate and personal development goals.
- Implementing a change management pro-gram; and
- Designing and implementing staff training programmes on both technical and business subjects.

*Information systems*

Advances in information and communications technology (ICT) have increased the power of the consumer and given companies the ability to redefine their relationships with their customers and stakeholders. CEB must invest in ICT infrastructure, tools, training, and support not only to provide its customers with a high level of service, but also to improve internal processes and efficiency. CEB has already made progress toward this goal by preparing a comprehensive Information System Plan in late 2002.

*Service delivery*

Improving the quality of our service delivery will improve our customer relationships at the same time as it contributes to revenue growth and cost reduction. Both the electricity delivery backbone and staff will be developed and strengthened. Strategies to address these areas include:

- Restructuring the Distribution Department and creating three Customer Service Areas-Area North, Area Centre, and Area West-with responsibility for providing "one-stop" customer service needs in each Area;
- Developing and implementing a comprehensive, integrated protection plan to minimise the frequency and severity of power outages; and
- Introducing a customer service orientation among field staff and highlighting areas where performance improvement is necessary.

**Corporatisation**

*Overview*

One of the mechanisms Government intends to use to achieve the objectives of power sector reform is to corporatise the Central Electricity Board into a new company.

A series of legal framework, corporate governance, financial, technical, market, tariff and human resource issues require immediate attention as part of the process of corporatisation and CEB - along with Government - has begun to systematically address these issues through a series of steps and plans as described in the following sections.

*Communications Plan*

In order to be as open as possible and thereby gain the cooperation of all stakeholders, communication plans are being developed to address the information needs of the public, employee unions, and donor/lender institutions.

*Legislation*

As a new, corporatised entity, CEB would be vested with the powers and responsibilities of an electricity undertaking and entrusted with assets and staff to operate in a regulated market as a vertically integrated electricity company. Accordingly, the following legal steps are being undertaken:

- Amendment of the Electricity Act of 1939.
- Establishment of the CEB Transfer Act to transfer assets, rights, and obligations of the existing company to the new corporatised company.
- Enactment of the Utility Regulatory Bill for the establishment of the independent regulatory body.

*Regulatory body*

An independent regulator will have a pivotal role in the restructured electricity sector. Not only will it provide a forum for the regulation of utility undertakings and the regulation of the utilities' operating environment, it will ensure that utilities under its jurisdiction operate in a manner consistent with consumers' interests. Government, in conjunction with its legal advisers, is currently drafting the conditions under which the regulatory body will be set up and operate.

*CEB successor company*

The steps and terms under which the successor company to CEB will be established are as follows:

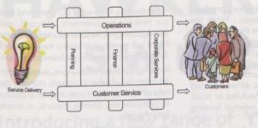
- Drawing up a memorandum and articles of association.
- Registering the new company.
- Issuing a licence to take over and carry on CEB's business.
- Confirming the financial conditions of the successor company on Day One; i.e. after transfer from CEB.
- Confirming the conditions under which existing CEB staff and pensioners will be transferred to the new company.

*CEB business transformation*

Our business - today and tomorrow - is all about service delivery to our customers. The following diagram illustrates the concept using the analogy of a railway.

Service is what we are delivering by means of the two railway tracks i.e. through excellent operations and customer service. These tracks are supported by corporate functions and shared business services, namely, planning, finance, and other corporate services. The tracks and their support illustrate the interactions of the various organisational units as we go about our business of electricity service delivery.

CEB is not, however, currently well structured to fit this picture nor to operate on commercial principles. For the successful restructuring of its business, CEB embraced the new strategic direction outlined in this corporate plan in 2002 and has already begun to implement several business enhancement measures to transform




operational and business processes in different departments, as discussed next.

**Restructuring**

*Corporate planning and research*

This department is developing a comprehensive forecasting process, not only to secure adequate supplies of electricity but also to provide an outlook for CEB's revenues. Volatility in the energy sector globally-whether from oil prices or other economic trends-and in the Mauritius economy affect both demand for electricity services and the price volatility CEB must manage. Preparing and tracking demand and sales forecasts will give CEB the ability to recognise risks and take mitigative action.

Another key area of activity for the department is the development of a revised tariff structure and five-year tariff strategy. Working with demand forecasts, system expansion needs, and financial projections, the department is using a newly developed model to assist in the setting of tariffs that provide CEB with reasonable revenues to cover its costs of supplying electricity services and, at the same time, are fair to all classes of electricity consumers both in terms of pricing and equity among the various customer classes.

*Information technology and management information systems*

An information technology and management information system (IT/MIS) Department was set up in 2002 with the objective to integrate the activities of our various administrative, commercial, financial and engineering sections and to meet the information needs of our customer service, operations, and strategic management processes. The department also prepared an information systems plan whereby CEB would obtain an adequate level of information technology and systems in a phased approach over the next three to five years.

*Transmission and distribution department*

The Transmission and Distribution Department is structured around three, decentralised customer service areas with the objective of improving operational efficiency and at the same time instilling better responsiveness to customer needs. The areas are set up on a geographic basis covering the island of Mauritius in terms of Area North, Area Centre, and Area West, with an area manager heading up each area. The areas are responsible for providing "one-stop" customer service; that is, responsibility for both the operational and financial performance of each Area is entrusted to each area manager.

*Finance department*

In late 2002 CEB carried out a business process review of the Finance department, encompassing all areas of activity within the current department as well as the organisation and structure of the department. The review included procurement procedures, billing and collection processes, and business case formulation for capital authorization requests. At the same time, a financial forecast model-a critical strategic tool for decision-making which will also assist in long-term financial planning and budgeting-was developed. Also included in the review was an assessment of the need for dedicated staff to handle foreign exchange and risk management.

As a result of the review, CEB will be making a number of structural and procedural changes in the department. Some external recruiting is now taking place, in accordance with identified needs; a new format for budget reporting to monthly board meetings is being introduced; an accounting exercise is being carried out to update the asset register and restate the value of our assets; and a new charter for the finance committee of the board is being developed.

*Production*

Several enhancements in spare parts holdings and the inventory management system are being investigated, in light of improved global communication and transportation facilities as well as supplier-buyer networks. A strategic generation availability plan is currently being developed, as is a least cost generation dispatch model, in collaboration with the Corporate Planning & Research Department.

Fuel costs are one of the key contributors to CEB's financial position. A strategic fuel holding plan is under study to optimise fuel ordering and holding and to safeguard against any force majeure such as shortage of fuel supply-line availability. Reward incentives at the level of power stations are under review in an effort to increase operational effectiveness.

The operating conditions and constraints at our older power stations are under review, as is the impact of recent water resource developments on our existing hydroelectric resources. These constraints may lead to a downrating of the capacity and energy potential from existing generation sources. The long-term outlook for replacement of aging plant by new and additional generation plant is under study by the Corporate Planning and Research Department.

*Internal audit*

The business process review of the Finance Department also included the audit function. As a result of this review, an audit charter is being drawn up for the board's Audit Committee, audit objectives are being prioritized, and a company risk profile is being prepared.

*Corporate administration*

The Corporate Administration Department was formed in 2002, taking in functions of the previous Administration Department as well as functions of the company secretary.

This Department is managing the legal, communications, and administrative aspects involved in sector reforms, such as setting up of a CEB successor company, the legal framework for the corporatisation process, and registration of the new company under the Companies Act, and transfer of all existing assets as well as contracts binding CEB to third parties.

*Human resources*

The Human Resources Department is challenged with providing the strategic fit i.e. having the required skills to support the business strategies and realize the goals and objectives of the organization. A human resource audit will be carried out to identify skills and staff capability, and a staff planning system will be devised to have the right skills in the right place. The HR department is currently working on several levers of change, which will encompass the following:

- Job evaluation and training.
- Conditions of service and industrial relations.
- Change management programme
- Communication programme to welcome change
- Man power planning
- Training and development
- Overcoming resistance to change
- Managing culture and commitment
- Reward and performance management.

**Financial outlook**

*Sales and revenues*

After many years of double-digit growth, energy sales increased in 2002 over 2001 by about 3 % to reach 1 492 GWh. Lower sales could be attributed to a slightly lower GDP growth rate caused by a slowdown in the economy, deferment of certain projects coupled with the closure for renovation of several major hotels. Sales decreased slightly with the passage of Cyclone Dina in early 2002. Total revenue from sales of electricity in 2002 increased to Rs 4 538-million, representing an increase of Rs 607-million, or 15 % percent, over the previous year. This increase arose, mainly as a consequence of the 10 % increase in electricity tariffs and the revision of meter rents from Rs 2 to Rs 5.

*Costs*

The major sources of costs for CEB are shown in the figure below for fiscal years 2003 and 2004, and comprise the following four elements:

- Purchase of electricity from independent power producers and continuous power producers, accounting for about 30 % of annual turnover;

- Interest charges and servicing of loans and overdraft, accounting for about 24 % of annual turnover;
- Purchase of fuel and lube oil, accounting for about 23 %;
- Operations, maintenance, and salaries and general administrative expenses for the organization as a whole accounted for about 18 % of annual turnover.

Only the remaining 5 % could be used to meet other costs and/or make allowance for minor but essential capital expenditures.

### Financial plans, years 2003 and 2004

CEB's fiscal year runs from January 1 to December 31 each year. The current financial plan and 2003 Budget were developed in late 2002 based on current levels of business activity and a business-as-usual approach. The budgeting process will be revamped in 2003, in line with the goals and objectives of this corporate plan. A longer-term outlook with key performance indicators and targets identified will be presented as part of CEB's financial outlook in future business service plans.

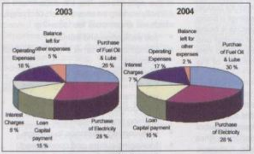



Fig. 1

The outlook for fiscal years 2003 and 2004 was based on the key assumptions outlined in Table 1.

Based on a forecast of electricity sales of 1 606 GWh in 2003, and 1 784 GWh in 2004, and assuming no upward revision in tariffs, we forecast the corresponding turnover to be Rs 4 855-million and Rs 5 394-million, respectively. Major expenditures as a fraction of those revenues are shown in the diagrams above.

In 2003, the business-as-usual budget requirement for investing in capital projects is estimated at Rs 1,168-million, or about 24 % of expected turnover. From the preceding diagrams we see that only about 5 % of expected turnover would be available for other expenses, including capital expenditure. In other words, in order for CEB to finance the refurbishment and renewal of its capital assets, either expected loan repayments are rescheduled or more funds are borrowed from external funding sources.

In 2004, notwithstanding the forecast 11 % increase in turnover, which in itself is subject to uncertainty, the balance for other expenses is projected to drop to 2 % of turnover. Moreover, we project an amount of about Rs 455-million, i.e. over 8 % of forecast turnover, will be required for financing capital projects. Clearly CEB will be looking for the participation of private capital in key infrastructure investments in the coming years at the same time as we seek to balance our own financial outlook.

### Strategies to manage key parameters

Fluctuations in the global price of fossil fuels and currency exchange rates are dominant determinants of both the purchase price of fuel oil and of electricity purchased from independent power producers in Mauritius. For instance, the price of fuel oil used for the Fort George generating station - which produces about 40 % of the energy generated in Mauritius - has varied from US$ 129 to US$ 178 per metric tonne during the course of 2002 alone. The IPP purchase price is indexed on the exchange rates of both the Euro and US Dollar. Over the last three years, the Mauritian rupee has lost approximately 20 % and 15 % of its value against each of these currencies, respectively. In addition, most of our loans and procurement expenses are denominated in foreign currencies yet all our revenues are in Mauritian rupees. This leaves CEB with the management of foreign exchange risk.

The business process re-engineering planned for the CEB Finance Department aims to address this challenge using a two-pronged approach. First, the financial forecast model will enable us to forecast our costs and thus our revenue requirements. Second, risk management policies to be adopted in the near future will permit us to assess the impacts of these key parameters on our financial position.

In the light of these evaluations, decisions can be taken on whether to actively manage the risks-which has its own costs-take other actions to attenuate any adverse impacts, or simply bear the risks.

| Assumptions | Year 2003 | Year 2004 |
|---|---|---|
| Demand Growth | 7,6 % | 11,3 % |
| Customer growth | 3,0 % | 3,0 % |
| Price for Electricity Purchases | 2002 prices | 3,0 % increase |
| Heavy Fuel Oil Price | 8 % increase | 8 % increase |
| Hydro Availability | Normal Rainfall | Normal Rainfall |
| Foreign Exchange Rates | 5% decline in MUR | 5% decline in MUR |
| Inflation Rates on local costs | 3 % increase | 3 % increase |
| Electricity Tariffs | Same as at 01.01.2002 | Increase of 6% |

Table 1

### Electricity tariffs

One of the root causes of CEB's unfavourable financial situation can be traced back to an eight-year period between 1992 and 2000 where electricity rates were held constant during a period of massive capital investment to meet rapidly growing electricity demands in Mauritius and where the average annual inflation rate was 6,6 %.

As a joint UNDP/World Bank energy sector review in 1994 concluded, CEB's tariff structure and price levels were not appropriately set in such a way that electricity consumers would be charged the real costs they impose upon the electricity system.

While this policy of subsidizing electricity prices has been beneficial to the annual growth rate of our national gross domestic product and to socially vulnerable groups in the population, it has dramatically worsened the financial situation of the organisation.

In real terms, that is net of inflation, the average selling price of one unit of electricity has decreased steadily from just over Rs 2 per kWh in 1992 to approximately Rs 1,30 per kWh in 1999, as depicted in Fig. 2.

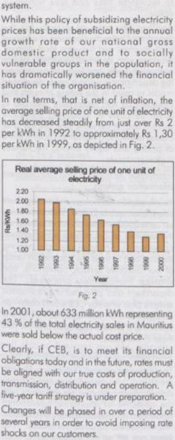



Fig. 2

In 2001, about 633 million kWh representing 43 % of the total electricity sales in Mauritius were sold below the actual cost price.

Clearly, if CEB, is to meet its financial obligations today and in the future, rates must be aligned with our true costs of production, transmission, distribution and operation. A five-year tariff strategy is under preparation.

Changes will be phased in over a period of several years in order to avoid imposing rate shocks on our customers.

The 5-year tariff strategy will also enable the organisation to more systematically forecast its revenues and thereby plan its resource allocation programme for the various business units in a more rational manner.

### Major issues

*Shareholder's requirements*

The shareholders/owners should be very clear in it's ultimate objectives for the utility.

*Political ideology*

The shareholders should be very clear regarding the financial objectives of the utility. It is not possible for example to provide social services from a commercialised company.

*Change management*

To ensure that stakeholders are fully aware of the effects of corporatisation on vested interests, It is essential to launch an effective communication and change management campaign.

*Organised labour*

Trade unions inevitably see the process of corporatisation as being detrimental to job security.

*Macro-economics*

Invariably the utility will still rely on Government guarantees to acquire loans for major capital investment.

### Conclusions

- Start the process of corporatisation with a clear vision of the end state. Have a clearly defined set of concise objectives that have been agreed to by all stakeholders e.g. should the final outcome be a vertical integrated, single buyer company or provide for a measure of horizontal disagregation.
- Establish a planning program which should include the following:
  - A corporate plan
  - An integrated electricity plan
  - A communication plan
  - A business plan
  - A staff transfer plan
- Make sure that all activities are effectively ring-fenced.
  - Draw up an accurate asset register
  - Asset valuation
  - Clearly identify current staff obligations in terms of actuarial valuation of the pension fund and sick leave staff obligations
- Communication

  Set up a communication strategy very early in the process, in order to obtain buy-in and acceptance of the ultimate goals.

The communication strategy must include:

- Owner/shareholders

  Although initial agreement has been obtained, electricity sector reform is a very complication process and consequently the shareholders have to be continually reminded of the ultimate objectives.
- Staff and unions

  The primary stakeholders in the process are the members of staff who will be directly affected by the establishment of a new company.

  The trade unions could participate and assist in the process of change management, but could also be a showstopper if not properly managed.
- Customers

  In order to maintain shareholders' confidence, customers must be kept fully informed of the process. It is advisable to establish customer forums and appoint key customer executives early in the process.

The media can assist in the communication plan, and should be kept informed. Δ

# The role of integrated development plans for grid and non-grid technologies

by A Theron, regional manager, NETGroup Solutions

**The National Electrification Program (NEP) started in 1994. Since then significant achievements have been made and more than 3,2-million households have gained access to electricity services throughout the country.**

In their White Paper on energy policy the South African Government has stated their vision and goal of universal household access to electricity. The backlog on electricity services is still significant and most households who do not yet have access are generally located in the rural areas of the country. These areas are sparsely settled and remote from established backbone infrastructure and reticulation costs are expected to be higher. The challenge now lies in taking the NEP further and achieving the goal set by government. There are many obstacles but a well-structured integrated planning process at local level will contribute significantly towards this goal.

This paper outlines the recent change in the governance of the NEP which has coincided with local government restructuring and initiation of the non-grid programme. The paper then identifies planning challenges that have since become apparent at local and district municipality level in rural areas and closes off with a proposed solution as already implemented at two district municipalities in kwaZulu-Natal.

## Background

The South African Government's white paper on energy policy released in 1998 states their goal of universal household access to electricity. The white paper broadly separates the energy sector into demand and supply sub-sectors. The demand side is generally analysed in terms of the energy requirements of households, industry, commerce, mining, transport and agriculture. Supply sub-sectors include the electricity, nuclear, oil, liquid fuels, gas, coal, renewable energy sources and transitional fuel (low smoke) industries. The white paper also states recognition to the fact that universal access to electricity will include non-grid options i.e. solar home systems (SHS) and mini-grid using distributed generation.

Until 2000, governance of the NEP was carried out by Eskom and transitional local councils (TLCs). Their task included electrification planning, design, construction and operation and maintenance. At that stage Eskom was also responsible for financing the NEP in their licensed areas. In 2000 government assumed responsibility for the NEP through the Department of Minerals & Energy (DME). An Integrated National Electrification Program (INEP) was announced and DME set out to establish the INEP Business Planning Unit (INEP BPU) who would be responsible for the planning, allocation of funding and programme control. This unit has since engaged all licensed electricity distributors with requests for 3-year rolling plans to be submitted.

This change in NEP governance coincided with the final restructuring stage of local government. TLC's were redefined as Metro's and district or local municipalities. In some cases complete new Local and District Municipalities had to be established in the rural areas. Soon after the restructure a legal obligation was placed on these new local government structures to prepare integrated development plans (IDPs) for the areas under their jurisdiction.

In 2001 DME approved the non-grid programme and concessions were allocated to public private partnerships to deliver rural non-grid electricity supplies in South Africa. Pilot projects were then initiated in 2002. DME are now in the process of establishing a central planning mechanism through a national electrification modelling tool designed to link with IDPs.

## Problems and Challenges

*Planning void*

The above sequence of events led to a situation where there are now a number of players involved in the planning and delivery process of electricity services in rural areas. These are:

- Community - Legislation requires that a consultative process must be followed when planning delivery of services;
- Local Government - District and local municipalities obliged through legislation to plan and establish basic services within its area of jurisdiction (electricity and community lighting services included);
- Eskom - Licensed distributor of grid electricity in most the rural areas and are therefore mandated to submit applications to the INEP Business Planning Unit for grid electricity on behalf of the local and district municipalities (there are exceptions where local municipalities are also licensed by the NER to distribute electricity in the rural areas). Eskom are also contracted in by DME to execute the construction of electrification projects in Local and District Municipalities which do not have the capacity.
- Non-grid concessionaires - Mandated to apply for non-grid electrification grant funding and also implement SHS projects on the ground.
- DME - responsible for macro planning and funding on a national level.

Eskom have engaged the new local and district municipalities and included their participation in the planning process through their IDPs.

Local and district municipalities in the rural areas are relatively young entities. In most cases they do not have the capacity or expertise to prepare detailed integrated plans for the delivery of electricity services. The IDPs completed recently generally deal with electricity services at a high level and do not adequately co-ordinate or integrate with other projects and service sectors. They do not scope electrification projects properly and have little or inaccurate budgeting detail. They are usually politically driven plans with little consideration given to technical and financial constraints. They also do not make provision for non-grid electrification.

DME have initiated a national centralised planning process which will engage with the IDPs of the local and district municipalities. This process is not yet in place but this planning approach will probably not be able to take into account the detail of electrification dynamics at local and district municipality level.

*Conflict between grid & non-grid electrification*

Non-grid concessionaires have no technical constraints when installing their services. Also, their installation cost is fixed regardless of settlement density. However, they are expected to operate along commercial lines after the service has been established. From a business point of view it is also in their interest to target densely populated settlements, including settlements which are close to their energy centres.

Since the initiation of non-grid electrification cases have been cited where non-grid electrification installations have been made in close proximity to grid electrification. Other cases have been reported where non-grid electrification has been installed in settlements planned for grid electrification the following year.

This un-coordinated planning and contesting of customers between grid and non-grid electrification jeopardises the INEP initiative and leads to wasted resources. Clear rules or areas need to be established where grid and non-grid electrification can be marketed. However, these must not be too rigid leaving marginal customers without a choice.

*Connection costs*

The remaining areas which are not electrified are generally sparsely settled and remote from bulk infrastructure - most of the "low hanging fruit" has been picked. The average cost per connection limit of R3500 set for grid electrification will rule out many of the remaining settlements if considered in isolation.

The challenge now lies in carefully co-ordinating electrification with electricity requirements of all the other service sectors and leveraging available funding for these projects into establishing bulk electricity infrastructure to discount the average cost per rural connection within the set limits.

*Future grid planning*

In the absence of integrated long term electrification planning including time-phased spatial load forecasts, network operators (typically Eskom) have no forewarning of the implications on their distribution and sub-transmission networks. As result network expansion plans are not timeously identified and actioned which can again impact on electrification delivery. This uncoordinated approach also leads to cases of sub-optimal network expansion planning where these potential loads are not factored into other regional developments.

*Information*

Accurate information is possibly the single most important enabler towards good planning. Demographic information for rural areas has become outdated over the past couple of years. The information that is available is not well co-ordinated or freely shared, leading to a situation where duplication of data acquisition occurs among sectors. Not only does this result in unnecessary expenditure but it also leads to 'various versions of the truth'.

*Communication*

The many stakeholders in the electricity sector for rural areas emphasises the importance of having a means or mechanism of clearly communicating details of the electricity services plan. This is currently not happening and vital information is not being communicated i.e.:

- Electrification priorities (sequence of electrification - in what order will villages and settlement areas be connected and approximately when);
- Areas where grid and non-grid electrification is required;
- Preferred routes of future power lines;
- Funding sources (not limited to DME but also other service sectors as well as possible donor funding)

## A solution

Although not fully operational, macro planning of the national electrification program is currently underway at DME. This is important to ensure equity on a national basis. However, macro planning will not be able to effectively deal with the problems and challenges as pointed out above. A bottom-up planning approach at regional level which must slot in below and support the macro plan is also needed. This is illustrated below.

Micro planning at ward, local municipality and district municipality level is key towards achieving the goals set out by Government and compliance with legislation. This micro planning must focus on the dynamics of all service sectors at the lowest level possible, the rural villages.

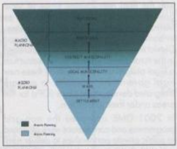


Fig. 1: Respective roles of macro and micro planning

Micro plans must then aggregate upwards to local municipality and district municipality levels. At district municipality level these micro plans must interface with the national macro plan. Overlap at this interface is necessary as targets and criteria must be communicated from the macro plan to the micro plan. The micro plan for electricity, electricity sector development plan (ESDP) should support the IDP as illustrated in Fig. 2.

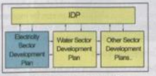



Fig. 2: Sector support to IDP

## Benefits of an ESDP

*Demand versus supply side planning*

An ESDP focuses on demand side planning. It establishes an accurate electrification plan which can be cross linked with other services sectors. It also establishes load forecasts and high level reticulation requirements i.e. preferred line routes which can be incorporated into Eskom's network development plans (NDP's). This load and reticulation information is then communicated to Eskom who in turn focus on the supply side planning as illustrated in Fig. 3

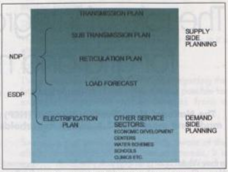



Fig. 3: Interface and overlap between Energy Sector Development and Network Development Plans

*Holistic planning and leveraging of savings*

A shortcoming of the current electrification funding methodology is that strict application of a per unit subsidy (e.g. R3 500 per connection) does not allow for holistic development planning of a geographic area or electrical network over time. Evaluating electrification potential at a fine-grained level and on an annual basis will preclude the grid-electrification of certain areas which in the greater context, would be electrifiable within the allowed financial parameters.

One way of overcoming this limitation is the careful grouping of settlements within a project to achieve the benefit of cross-subsidisation. This is illustrated below where villages A & B as isolated projects will result in village B being excluded due its cost exceeding the limit. On the other hand grouping villages A & B as a single project will result in village B also qualifying for grid electrification. Reducing the average cost per connection in this manner makes marginal villages and settlement areas viable for grid electrification.

Another approach to leverage available funding is to establish backbone network and bulk infrastructure through funding available for other service sectors and priority areas such as schools, clinics, commercial loads and others. For this reason it is also important to

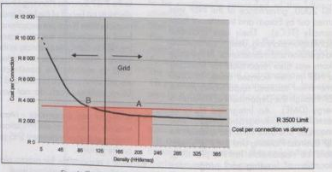



Fig. 4: Illustration of cross-subsidization between settlements

regularly update regional electrification plans also taking into consideration other network expansion as the impact on the viability of marginal settlements can be dramatic.

*Prioritisation between grid and non-grid technologies*

By modelling feasible network expansion over a number of years, areas not suitable for grid-electrification under the current funding regimen can clearly be defined.

The identification of these areas enable non-grid concessionaires to plan for integrated energy solutions comprising renewable and non-grid technologies supplemented by other fuel sources.

*ESDP funding and resources*

ESDPs should be established at district municipality level. Establishing ESDPs at local municipality level will create too many linkage points with the national program and create an unnecessarily complicated structure which would probably fail.

The district municipality should take responsibility for the ESDP and ensure that participation is carried out to the lowest level as practically possible beyond the level of local municipality. The district municipality should also be the linkage point between all stakeholders.

Funding for ESDPs is currently problematical as district municipality budgets are generally under pressure and this work falls outside the scope of most funding institutions.

As the availability of locally integrated electrification plans is critical to the successful implementation of the INEP and optimal application of funds, the logical conclusion is that DME should make such funding available to district municipalities out of the national electrification budget.

The amount could be based on a percentage of the estimated value of electrification backlog in the order of 0,5 - 1% of this amount.

The national electrification program will probably be completed within the next 10 years (assuming the current rate of progress) with the bulk of the planning to be done within the first years.

Also taking into consideration anticipated developments within the EDI it would probably not be practical for district municipalities to staff up for the compilation of ESDP's.

The private sector, particularly locally based consultants active in the power sector, are ideally suited to be engaged to carry out this work as they would be familiar with the requirements of the regional stakeholders. These plans should be reviewed at least every 5 years along with the IDP.

However due to the dynamic nature of electrification and the ever changing need and priorities, reviews should be at shorter intervals i.e. 2 - 3 years.

ESDPs must be prepared in electronic format to make the updating process easy and cost effective.

**Conclusion**

Two ESDPs have already been established for nodal areas in KwaZulu-Natal and the third is currently underway. These plans have been well received by stakeholders.

Non-grid electrification adds a further dimension to micro planning in that all SHS installations must be supplemented with cooking and space heating energy sources such as LPG and paraffin.

These energy sources must be distributed through energy centres located within the communities they serve.

Taking this factor into account the micro planning process proposed in this paper should be taken to the next level and expanded into a "Energy Sector Development Plan" which also plans for all the energy requirements of the community. In closing, it is important to note the following:

Development of the energy sector is a pre-requisite for growth in all other sectors;

Access to electricity is important not only as a medium for delivering energy but also a medium to access the digital and communication world.

If we are serious about improving the lives and opportunities of our people in the rural areas we must strive to maximise access to clean and safe sources of energy through a well coordinated and detailed planning process. Δ

# Municipal Systems Act section 78 process and the challenges therein

by Fay Cranmer, electricity restructuring consultant, and At van der Merwe, city electrical engineer, Manguaung

**The South African electricity distribution industry (EDI) is currently the subject of a significant restructuring process. As part of the restructuring exercise, all elements of the EDI, including the municipal electricity undertakings, will be required to reorganise the mechanisms of service delivery in preparation for the formation of the Regional Electricity Distributors (REDs), in line with the guidelines set out by the EDI Restructuring Project Office (EDIRPO).**

## Introduction

The Local Government Municipal Systems Act (Act 32 of 2000) (the MSA) sets out a process that must be followed by all municipalities contemplating a change to their service delivery mechanisms, whether internal or external. This process, known as the section 78 process, is considered by some to be an unnecessary, time-consuming and costly step in the restructuring of the EDI. However, experience has shown that if carried out in a pragmatic manner, the section 78 process can provide a very valuable platform for the effective restructuring of the EDI, by understanding its impact at a local government, economy and community level. Bearing in mind the constitutional issues and obligations relating to electricity service delivery by local municipalities, the importance of considering the local as well as the national implications of the EDI restructuring initiative should not be underestimated.

## The legislation

Section 76 of the MSA outlines the possible service delivery mechanisms available to municipalities:

Section 77 sets out occasions when municipalities must review and decide on mechanisms to provide municipal services:

A municipality must review and decide on the appropriate mechanism to provide a municipal service when:

- preparing or reviewing its integrated development plan;
- a new municipal service is to be provided;
- an existing municipal service is to be significantly upgraded, extended or improved;
- a performance evaluation in terms of Chapter 6 requires a review of the delivery mechanism;
- the municipality is restructured or reorganised in terms of the Municipal Structures Act;
- requested by the local community through mechanisms, processes and procedures established in terms of Chapter 4; or
- instructed to do so by the provincial executive acting in terms of section 139 (1) (a) of the Constitution

A number of these occasions may be relevant to the EDI restructuring process, particularly when viewed in conjunction with the municipal restructuring taking place as a result of the Municipal Structures Act and the Demarcation Act. However, it would be surprising if many, if any, local municipalities, when reviewing the requirements of section 77 of the MSA, would not find that at least one of these conditions applied to their circumstances. Any such occasion should be seen as a perfect opportunity toreview electricity service delivery in relation to the impending establishment of the REDs and thereby fully understand the impact of the EDI restructuring on the local economy and community.

The MSA section 78 process comprises four components: an internal assessment, followed by a decision to remain with an internal mechanism or investigate an external mechanism, an external mechanism assessment, followed by a decision to pursue the internal or the external mechanism and in which format. The internal assessment requires that the municipality

- First assess:
  - the direct and indirect costs and benefits associated with the project if the service is provided by the municipality through an internal mechanism, including the expected effect on the environment and on human health, well-being and safety;
  - the municipality's capacity and otential future capacity to furnish the skills, expertise and resources necessary for the provision of the service through an internal mechanism mentioned in section 76 (a);
  - the extent to which the re-organisation of its administration and the development of the human resource capacity within that administration, as provided for in sections 51 and 68, respectively, could be utilised to provide a service through an internal mechanism mentioned in section 76 (a);
  - the likely impact on development, job creation and employment patterns in the municipality, and
  - the views of organised labour; and
- It may take into account any developing trends in the sustainable provision of municipal services generally. If a municipality decides in terms of subsection (2) (b) to explore the possibility of providing the service through an external mechanism it must:
  - give notice to the local community of its intention to explore the provision of the service through an external mechanism; and
  - assess the different service delivery options in terms of section 76 (b), taking into account:
    - the direct and indirect costs and benefits associated with the project, including the expected effect of any service delivery mechanism on the environment and on human health, well-being and safety;
    - the capacity and potential future capacity of prospective service providers to furnish the skills, expertise and resources necessary for the provision of the service;
    - the views of the local community;
    - the likely impact on development and employment patterns in the municipality, and
    - the views of organised labour.As can be seen from the above extracts from the MSA, both the internal and the external assessments are very similar in their extent and analytical requirements. It should certainly be noted that the external assessment

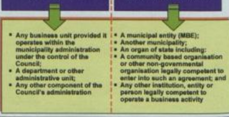



Fig. 1

could and should be instigated as a matter of course to ensure that all options are fully investigated prior to a final decision being made, thereby limiting any need for a further investigation at a later stage. The full section 78 process is depicted in Fig. 2.

Once the external assessment (section 78(3)) has been completed, a key decision will need to be made regarding the type of mechanism, either internal or external and in addition, which of the section 76 options will be pursued. It is most helpful at this stage for a comparative study to be presented to allow for a fair analysis of the different options. Whilst the MSA sets out the requirements for analysis from a local government viewpoint, any section 78 process in relation to the electricity service delivery cannot ignore the EDI restructuring process and intended key steps to the creation of the REDs.

### The EDI restructuring process

The EDIRPO has set out guidelines for the ringfencing and separation of the electricity distribution businesses, both of municipalities and Eskom, prior to their incorporation into the REDs. There are four identified steps to the creation of the REDs that include Accounting separation, Operational separation, legal separation and finally ownership separation. Each step effectively results in a different type of entity being created, namely a separated operational entity (SOE), a municipal entity (ME) and finally a RED. The move to create any one of these entities would require the completion of an MSA section 78 process in order to assess their suitability to any local municipality. All steps are ultimately required to be undertaken to reach the REDs, and importantly can only be performed in the sequence as set out in Fig. 3.

As a result of these guidelines, there are two clear options that any local municipality should analyse through a section 78 process, namely a separated operational entity (SOE), which represents an internal mechanism, and a municipal entity (ME), which represents an external mechanism in terms of the MSA. Since it is a requirement of any local municipality to at the least perform the steps that would lead to an SOE, in terms of the cooperative agreement. Given that an ME simply represents a legally separated SOE, it is advisable that all local municipalities review both options prior to committing further resources to the restructuring process. Such a review would also clearly identify the specific needs of the local municipality, its community, economy and its workforce. In terms of the guidelines set out by the EDIRPO, it should be noted that the separation required with respect to both accounting/financial and operational issues, is extensive. The cost and timeframes to achieve an SOE through following the accounting and operational separation guidelines constitute by far the bulk of the effort in terms of the journey towards the REDs.

Though, in order to reach the REDs, it is still necessary to legally separate the municipal electricity businesses from the local municipalities. Whilst this extra step of legal separation often constitutes a significant shift in the mindsets of local municipal councils, it is not a timeconsuming or costly exercise to execute, particularly as it mostly involves creating a 100% municipal-owned corporate entity. The advantages to be gained by taking the extra step of legal separation may in many instances outweigh the relatively small additional cost and timeframe.

### The benefits of following a section 78 investigation

A number of benefits therefore result from the successful completion of a section 78 process investigation with relation to the electricity service delivery in any local municipality. From experience, it is not unusual for local municipalities to misunderstand the importance and value of their electricity undertakings to the financial and economic health of the council. In addition, resources, both human and financial, are often misallocated in relation to the value addition equation, sometimes resulting in an erosion of value at a time when local municipalities should be seeking to improve the value of their electricity businesses ahead of the creation of the REDs.

Therefore, the section 78 investigation allows any municipality to:

- Understand the state of the electricity business in each municipality in terms of capacity and financial resources;
- Build a local, as well as contribute to the national, platform on which to restructure the EDI, including customer and labour interaction;
- Create awareness and buy-in between senior officials and politicians of the importance of the EDI to the local economy;
- Increase/commence appreciation of the value and associated funding requirements of the electricity business; and
- Clarify extent of "true" surpluses/rates relief.

In addition, the investigations, when performed on a comparative basis, allow a decision to be made regarding the preferred change path, i.e. SOE or ME, in preparation for the REDs. Any ringfencing of staff and functions as required by the EDIRPO guidelines would not be legally possible without the completion of the process, since this ringfencing would most definitely constitute a change as defined by the MSA section 77. It should also be noted that in terms of the Constitution and the latest draft of the Electricity Restructuring Bill, a continued role for municipalities as service authorities with respect to electricity service delivery in the EDI is envisaged into the future. As a service authority, it would be incumbent on any municipality to fully understand all stakeholders' requirements, in order for it to fulfill its role effectively. The section 78 investigation would assist in defining and clarifying many of these matters.

### A proposed approach

As discussed above on the legislation, the section 78 investigation has four components. However, the analytical requirements of both the internal (78(1)) and the external (78(3)) assessments are remarkably similar. In order to apply a pragmatic and cost-effective approach to the investigations, it is proposed that elements of the analysis are performed using a comparative basis, such that the SOE and ME can be assessed alongside each other. Such a comparative process would need to include both a qualitative and a quantitative assessment, taking into consideration all of the requirements of the MSA. The qualitative assessment is largely focussed on the non-financial aspects of the analysis and may include a view on the alignment with the strategic aims of the council, the integrated development plan, an assessment of the overall transformation initiatives and the socio-economic impact of staff migration. It is always difficult to objectively assess qualitative aspects in such an investigation. A method involving a questionnaire that not only examines which qualitative factors are worthy of assessment, but also weights and ranks each factor in an objective manner is recommended. Although the relative scores for each factor may vary considerably, the cumulative total of all scores will give a fair assessment of the qualitative factors with respect to the SOE and ME.

The quantitative assessment would necessarily focus on the more financial aspects of the assessment and business case generation. In order to perform an effective comparative financial analysis it is important to

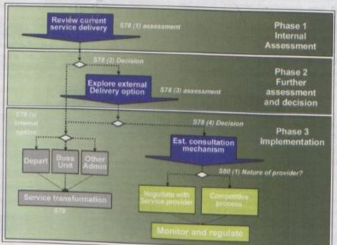



Fig 2

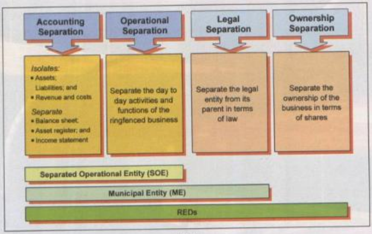



Fig. 3

- Identify all of the ringfencing and transformation initiatives to create both the SOE and the MBE;
- Quantify the financial investments and associated value creation for each individual initiative;
- Quantify improvements and value gains to be achieved through the change initiatives; and consolidate financial investments and value for the entire change journey.

Such an assessment would result in the generation of a present value calculation for a series of events into the future. This assessment for both the SOE and the ME, viewed in comparison to each other, allows a local municipality to place a value on the costs and benefits of each option and determine the most effective and beneficial option for them. Importantly, the absolute values are less meaningful than the relative values and the trend in values when viewed on a comparative basis.

The option that demonstrates the most positive trend of present value into the future is the most beneficial in terms of value creation for the municipality.



## Evidence from Mangaung

The techniques described above have all been utilised during the MSA section 78 investigations at Mangaung Local Municipality with respect to the municipal electricity department. These techniques have not only resulted in the first successful completion of a section 78 process in the South African electricity domain, but have also assisted the municipality in determining the importance of the electricity business to the local economy and the financial stability and viability of the council. Following the section 78 investigation, Mangaung Local Municipality made a decision to implement an external service delivery option in the form of a municipal entity. The rationale for creating a municipal entity was to:

- Demonstrate capacity and competency in service delivery in order to become a Metro;
- Give leadership in the area and the Province in order to optimise service delivery;
- Ensure a definite future revenue stream for the municipality;
- Obtain experience in such governance and service authority processes pertinent to the future RED;
- Cooperate with other local municipalities to strengthen the definition of the municipal position in terms of the RED's to come;
- Restructure the local government as a result of the Demarcation Act and the Municipal Structures Act; and
- Organise as a commercially-oriented business for greater efficiency and optimum delivery.

## Conclusion

The legislation provides for the in-depth investigation into service delivery mechanisms of local authorities through the MSA section 78 process and the associated sections relating to the occasions on which such investigations are necessary. Guidelines have been developed to determine the necessary steps towards the creation of the REDs within the EDI restructuring blueprint framework. These steps indicate that there are two key options for consideration in the realm of the municipal electricity service delivery, namely the SOE and the ME. In order to fully appreciate the benefits of either of these options with respect to the local environment, it is beneficial to conduct both a qualitative and a quantitative assessment, on a comparative basis.Following an MSA section 78 process allows municipalities and their electricity undertakings to:

- Assess the status quo in a uniform and consistent basis across the country;
- Create buy-in, both political and administrative, to ensure movement in the direction of the REDs;
- Commence the long, hard walk to customer awareness, which can be managed by the local authority, rather than a less empowering national initiative; and
- Assess the true impact of ringfencing and separation in order to develop an implementable plan, both locally and nationally.

Most notably, if performed in a pragmatic and cost-effective way, the section 78 process need not be a hindrance to the restructuring of both the EDI and the local municipality, and can result in the successful implementation of an SOE or an ME, as has been the case in Mangaung. Δ

# Multi-market model for the introduction of IPPs and PSPs in the ESI

by Dr. Elsa du Toit, Department of Minerals and Energy

**Government recognises that significant opportunities and need exist to increase the efficiency of the Electricity Supply Industry (ESI). The principal objective of the restructuring agenda should be seen as improving efficiency in the industry and the economy as a whole.**

This is not primarily in relation to short-term efficiency related to operating costs (although gains here may be stimulated), but more to investment - improving the allocation of capital and increasing the efficiency of the use of capital received from capital markets.

The restructuring of the ESI is a complex process. International experience has shown that poor implementation and the establishment of inappropriate wholesale electricity markets and a lack of demand side participation can lead to failures in the supply of electricity. The Government has therefore directed that a managed liberalisation approach will be used for the ESI restructuring process that addresses some of the positive developments arising out of a competitive multi-market model and ensuring Eskom plays a role in the development of Africa. This will be done on a phased basis, with the programme designed to accommodate South Africa's unique circumstances and its timing in line with Government's policies for the sector.

This paper gives an overview of the multi market model and summarises the work done by a consortium appointed by government and guided by a stakeholder steering committee namely the Multi-Market Model Workgroup.

### Background

The Department of Minerals and Energy in close cooperation with the Department of Public Enterprises and other relevant government departments and stakeholders have embarked on a study to develop the following three outputs:

- Phase 1: The design of a multi-market model specifically for South Africa
- Phase 2: Investigation of the current facilities e.g. Eskom Power Pool to ascertain whether it would be a good basis to start off from.
- Phase 3: The detailed functional market description, transitional plan and governance arrangements for the proposed multi market model for the electricity supply industry in South Africa. (Note: This does not include the actual market code.)

Process

The project commenced on 4 November 2002 and was successfully completed on 11 July 2003 after a number of stakeholder consultations.

After the completion of the project an independent international reviewer was appointed to review the work done by the consortium and this paper will also present the findings of that report.

The aim of the restructuring of the sector is to be:

- Encouraging competition within energy markets.
- Strengthening the ability of the National Electricity Regulator (NER) to regulate private players and a competitive market.
- Making energy prices as cost-reflective as possible.
- Unbundling Eskom's generation and transmission groups and in the long term Eskom restructured into separate generation and transmission and distribution companies.
- Providing open access to the transmission lines.
- Implementing integrated resource planning methodologies in evaluating further electricity supply investments and the decommissioning of older power stations.
- Further development of the Southern African Power Pool (SAPP).
- Increasing non-utility generation.
- Increasing transparency of subsidies, where required.

### Governance framework

The multi-market model will be a hybrid of private and public governance and will be governed by the following bodies:

- National Electricity Regulator - the regulator retains the responsibility to ensure that the market complies with Government policy. It must have appropriate tools to exercise this role over the electricity market, but also needs to be mindful when is the appropriate time to utilise these tools (as over-regulation of markets will compromise their effective operation and will impact on investor confidence). The NER plays key roles in both the monopolistic and competitive components of the multi-market model.
- Market Governance Body (MGB) - this body has primary oversight for ensuring that the market rules remains relevant to the needs of market participants and stakeholders. A market must have the capacity to evolve to continue to meet the changing needs of its stakeholders and to take advantage of new technologies as they become available. The MGB also oversees the performance of the service providers (Market Operator and Systems Operator) and the market's surveillance regime.
- Market Surveillance Panel (MSP) - a panel of independent experts appointed by the NER and overseen by the MGB. This body acts as a quasi-judicial panel for the market (analogous to a panel of judges in a court system). The responsibility of the MSP is to ensure that where market participants do not comply with the market rules they are identified and appropriately disciplined.
- Market Surveillance Unit (MSU) - a team that sits as part of the Market Operator who provide support to the MSP. The MSU

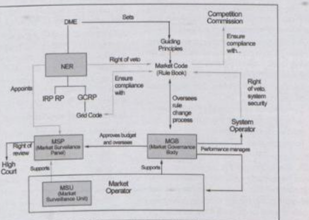



*Fig. 1: Governance bodies in relationships*

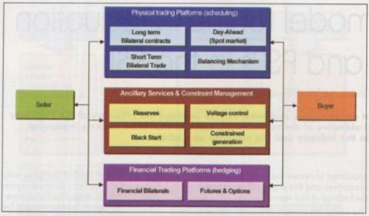



*Fig. 2: Schematic representation of the multi-market model*

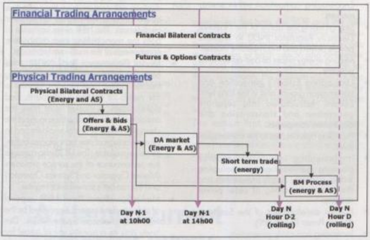



*Fig. 3: Timing and linkages of multi-market model platforms*

will implement surveillance processes outlined by the MSP, investigate alleged rule breaches within the market and prepare reports for the MSP to decide what further action is required. In the event that an alleged rule breach progresses to a formal MSP hearing then the MSU will act as prosecutor.

The key governance issues faced by an electricity market can be broken down into four areas or processes as follows:

- Admission and exit procedures - making sure people can join and be bound by the rules
- Rulemaking processes - making sure the rules can evolve to meet changing needs of the market
- Surveillance and compliance - making sure people obey the rules and can resolve disputes; and
- Administration - of each of the above.

The consortium recommended that the MGB, the MSP and the service providers should be created as soon as possible during the implementation process, and certainly well in advance of the market opening. Naturally, the government and the NER has to maintain overall oversight and responsibility for market implementation and must make the decision on when it is prepared to let the market go live. However, the existence of the MGB, the MSP and the two service providers will create focal points for accountability for key parts of the market build and implementation project. International experience suggests that these projects are fraught with risk. However, this risk could be mitigated by the creation and early establishment of these institutions.

An additional benefit of this is that is allows pre-market experience, learning and training to take place, making the transition to the competitive market substantially easier. For the service providers, it also allows them time to employ new people and upskill existing staff to be prepared for new roles.

### Transitional mechanisms

In the transitional the following will have to be dealt with:

- *Stranded Assets:* There is a risk that introduction of competition and a market will undermine the viability of certain assets. In a similar way, certain existing contracts in the industry may be "stranded" in that their value under a new market environment will change.

  There are three topics under this area: stranded generation assets which could be dealt with by the following: low return on public assets, debt restructuring and allocation, asset clustering, vesting contracts or a stranded asset levy. Existing fuel procurement contracts which could be dealt with by the following: allocation of contracts to Eskom clusters as the loss of bargaining power should not be severe, security of supply and coal stockpiles are also addressed. Existing special pricing agreements - a set of bilateral contracts that would be honoured in the new trading arrangements. This could be administered by KSACS.
- *Stranded Benefits:* Market reform may also result in certain beneficial activities being curtailed or at least influenced by new market conditions. Broadly termed "stranded benefits", this includes support for research and development, demand side management, environmental programmes, and low-income support programmes (e.g. free basic electricity).
- *Transitional price mechanisms:* Competitive markets bring new risks to participants, including new price and volume risks. Government will want to ensure that participants' exposure to these new risks are phased in over time, thereby facilitating a transition from a market to a competitive environment. The use of vesting contracts is proposed as a means to manage risks during the transition.
- *Facilitating investment during the transition:* While competitive markets are expected to deliver an efficient level of investment in the long-term, there may be difficulties during a transition period when risks are high due to the nature of transition. During this period, Government may want to put in place special mechanisms to ensure that sufficient investment takes place.
- *Regulating the transition:* The regulator has a role to play in the market, and during the transition period it is important that the basis for this longer-term role is developed. There is a need for new network tariffs in a market, regulation of cross-subisdy mechanisms, regulation of energy charges for captive customers, and regulatory involvement in long-term planning.

### Multi-market model

The multi market model allows participants the freedom to contract bilaterally, as well as to make use of various administered energy trading arrangements to meet their electricity needs. In addition, the trading arrangements will allow both demand side and intermediaries to become active participants in the market.

Under the multi-market model, the following opportunities for transactions shall exist:

- *Long Term Bilateral Trade* - for physical contracts: over-the-counter or facilitated through dealers or brokers. This market is essential to allow participants to hedge their risks through physical contracts;
- *Day Ahead Market* - a coordinated power trade mechanism whereby

# Electrical and Mechanical Consulting Engineers

Plantech Associates as an electrical and mechanical consulting engineering concern started its practice in 1982 and celebrated its 21st year of existence on 18 September 2003.

The "Electrical" wing of the business is active in a very wide spectrum of electrical engineering, from building services (inclusive of sophisticated electronic access control and surveillance systems), township reticulation and industrial installations, to HV and EHV master planning and project design, documentation and implementation work.

Over its entire life span the HV and EHV department has been particulalry active in the power system distribution field and has rendered services to many utilities such as Eskom, Lesotho Electricity Corporation, Central Electricity Board Mauritius, Swaziland Electricity Board, many South African Municipalities, as well as industries such as Sasol, Anglo American and JCI.

As a high voltage specialist, Plantech has over the years played an active and constructive role in innovative research and development, an activity headed by senior director Hein Schuld, who also started the concern in 1982. Through Hein's enthusiastic R&D, the concept of the now well-known "Through Wall Isolator System" led to the cellular indoor substation concept and design approach. This concept made indoor HV substations possible at a cost of only 55 % to 60 % of the equivalent gas insulated substation at voltages of 44 kV up to 132 kV. In addition, Plantech also designs low profile compact outdoor HV substations at very competitive costs with the use of locally developed and manufactured vertical break isolators. Several of these developments have been awarded with prestigious design awards by the industry at large. The company plays an active role in AMEU proceedings, and is an affiliate member of the AMEU. Since Plantech's birth in 1982, all AMEU conventions and technical meetings have been attended by either or both of Hein Schuld and Johan Stapelberg, who jointly head the HV and EHV department. Hein has also delivered several papers on high voltage substation design and innovative reticulation at the AMEU, CIGRÉ and other international conventions.

Plantech offers its mature experience and expert engineering skills to utilities, industries and private customers and developers in the following disciplines and fields:

ELECTRICAL ENGINEERING

- HV and EHV master planning
- HV and EHV turnkey substations, power lines, sophisticated cable feeder systems, etc.
- Power system protection, metering and SCADA systems
- Reticulation and distribution services
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participants can trade physical contracts on a daily basis prior to real-time. The market provides an avenue to trade power not contracted bilaterally at low transaction costs. It also provides a public and transparent price signal;

- *Short Term Bilateral Trades* - opportunity for bilateral trading and adjustment of physical positions after the closure of the day ahead market will exist, subject to SO approval on the basis of maintaining reliability and security. This option will allow participants to adjust their positions after closure of the day ahead without being exposed to real-time prices. It also allows a portfolio of generators to optimise production within the portfolio;
- *Balancing Mechanism* - enables the SO to balance the system on a real-time basis. This market platform is required to provide a market based mechanism to balance supply and demand in real-time;
- *Ancillary Services Markets* - arrangements whereby the SO can produce ancillary services essential for system operation, security and reliability from market participants, making use of competitive mechanisms where possible; and
- *Financial Markets* - arrangements whereby market participants can hedge risks through a variety of financial products. These may include both bilateral arrangements (e.g. contracts for differences) as well as trade in standardised products (e.g. futures and option contracts) offered through an exchange. Financial markets are necessary to provide participants with opportunities to hedge their market risks.

*Service providers*

The MGB will appoint the Market Operator and System Operator as service providers to perform the necessary functions to operate a multi market. In addition the NER will issue licenses to both the MO and the SO to facilitate the market. Additional service providers (e.g. metering service providers) may be appointed to facilitate certain aspects of market operation.

*The role of the Market Operator*

The MO is responsible to implement and adhere to the market rules. The MO's responsibilities will include amongst others the following:

- Receive offers and bids for the DA and BM
- Determine the unconstrained hourly production and consumption schedule for each participant for the following day;
- Calculate the DA electricity prices for each hour based on the unconstrained schedule (role as Pricing Manager);
- Publish a constrained hourly production and consumption schedule for the following day, based on constrained information provided by the SO;
- Hand over pre-dispatch information to SO and receive post dispatch information;
- Perform reconciliation activities (role as Reconciliation Manager), etc.

*The role of the System Operator*

In addition to its traditional role (i.e. overseeing of system operations, security and reliability) the SO will be responsible for the amongst others the following:

- Perform various planning activities in short medium and long term. These include load forecasts, outage management, reserve requirements and network flows;
- Determine constraint requirements necessary to prepare the constraint schedule;
- Define, procure and call off ancillary services;
- Balance the system using valid BM bids and offers and AS contracts;
- Be responsible for buying and selling Inadvertent Energy Flow;
- Record all instructions to producers and consumers, etc.

*Market participants*

The design of the multi market model is premised on a competitive ESI structure being in place comprising multiple sellers, multiple buyers and service providers. The following organisations are assumed to participate in the market:

- Competing generating companies including Eskom generation clusters, IPP's as well as municipalities with own generation facilities;
- Distribution companies (distributors) comprising of Regional Electricity Distributors (REDs) municipalities and Eskom Distribution (at least during a transition stage to a future EDI structure)
- Retailers (including brokers and aggregators) trading on behalf of other entities
- SO purchasing and selling ancillary services, balancing energy (including inadvertent international energy flows) and the determination of losses to be purchased;
- Traders; and
- Between 100 and 150 contestable customers (users over 100 GWh per annum consumption from a single metering point). Contestable customers could buy their electricity from a distributor, a retailer, a generator, through participation in the DA or BM, or any combination of the various trading arrangement described.

A market participator must obtain a license from the NER, be registered with the MGB, and be certified by the MO and SO before he or she is allowed to trade in the multi market.

### Market code

From the detailed functional description of the market, the market code with the market rules for each of the participants in the market is currently being drafted and this will take place with regular stakeholder interaction to ensure that stakeholders are abreast of the developments and to ensure that the quality of the rule book is to the satisfaction of all players involved.

### Independent review

The Department of Minerals and Energy appointed an independent international reviewer to review the market design in order for government to be more certain that the design for the multi market model is practical and feasible.

The overall opinion of the reviewer is that the proposed design for the multi market model described in the consortium's reports, represents a firm basis for implementing a wholesale electricity market in South Africa. The proposals are generally considered to be effective and practical in the context of the South African market.

However, there are a number of areas where the reviewer has identified the need for additional clarity and a few areas were it is the reviewer's opinion that a different alternative might be preferable. However, there reservations do not detract from the basic conclusion that the design is fundamentally soundly based. Furthermore, there is no reason why the planned implementation plan to investigate such details further and to provide the degree of clarity that will be necessary for practical purposes.

Where the reviewer has recommended that an alternative approach be considered, this again can be part of the implementation process. The main area of concern is with the proposals for market governance, which are viewed as being unnecessarily complex. In particular, it is recommended that the need for a Market Surveillance Panel should be re-considered.

A simpler rule change system may be requird in the early development stages where it is expected that numerous changes will be needed, many of which could be non-contentious. It is also suggested that clarity is required in the mechanisms to prevent any one party from dominating the representation on the board of the Market Governance Body (MGB).

The proposal to adopt the existing Eskom Power Pool (EPP) as the basis for developing the market operations is supported thoroughly, as this has shown to be an effective mechanism to provide a day-ahead market. It is recommended however, that the planned enhancements should be incremental and reversible as for as possible in order to mitigate the risks of failure to achieve the required functionality within the expected time and costs. There is also a need for the existing entities in the EDI (i.e. municipalities, large customers, Eskom Distribution) to be involved in the development of the market at the earliest possible stage.

The overall design whilst not "proven" in the sense of having a previous track-record, is built upon a practical working mechanism. However, there are significant enhancements required, which will require careful planning. To mitigate the risks of cost escalation and failure, the implementation process should:

- Be carefully planned to a detailed process level;
- Be carried out in incremental, reversible stages; and
- Include suitable periods of system trials and shadow running with market participants.

The proposed use of a separate Market Operator (MO) and System Operator (SO), as opposed to a combined MO/SO, as used in many other markets, is constrained by the decision to retain ownership of the SO with Eskom transmission. This will require a very clear division of responsibilities between the two entities and suggests the need for separation of the EPP from the SO at the earliest opportunity, in order to establish the separate identity of the MO. This would also provide an opportunity for the EPP to be exposed to a wider participation.

It is agreed fully that some form of "vesting" contracts will be required as part of the transition process towards a competitive market. The structure, term, conditions and price levels of these contracts will affect the price trend of customers and, as such, is possibly the most important aspect of the transition mechanisms. It is therefore recommended that work on the proposals for the vesting contracts should begin as soon as possible. This should also include considerations of trading liquidity in the long-term bilateral markets.

Dealing in power purchase contracts is outside the existing experience of most Distributors and it is therefore recommended that there is a need to ensure that the municipalities develop the necessary capabilities with regard to trading. This is not something that can wait for the establishment of the Regional Electricity Distributors (REDs) as the trading capability will need to be established at an early stage.

Cross subsidies require a full analysis to understand the extent of the existing cross subsidies and how any unintended cross-subsidies (i.e. apart from subsidies specifically intended as part of government policy) may be phased out commensurate with the need to manage the price impact over the period of transition.

As noted in the report it is particularly important to ensure that new contracts for special pricing agreements do not sell long-term at the current low prices when it is already known that capacity will have to be enhanced with higher-cost generation in order to meet demand. It is likely that some degree of regulatory oversight will be required to ensure that the market prices are, as far as possible, least cost. However, this should not take the form of an intrusive regulation of offer and bid prices.

Rather regulation should ensure that the correct incentives are provided to the regulated entities, consistent with the objective of achieving least cost.

The need for a regulated approach to ensure security of supply in the medium term, via a call for proposals, is fully supported. This will require oversight by DME /NER. With regard to the legal and regulatory framework, it is suggested that an assurance process to continually check that draft legislation and license conditions and the MMM design proposals are in line, should be part of the implementation process.

The next step is to proceed with the implementation plan, under a suitable initial governance process. A steering committee, consisting of representatives from major stakeholders, would appear to be a suitable arrangement. There does not appear to be any reason for further analysis or review before proceeding with implementation.

## Conclusion

The implementation of the multi market model must be approved by Cabinet and then the implementation will commence with the establishment of the Market Governance Body. This Body will then also further assist to ensure that the rest of the institutional structures are established and to drive the process forward. At this stage it is not sure whether Cabinet will make such decisions before or after the election period.

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# Internet based energy trading in southern Africa

by Dr. G van Harmelen and RM Surtees, Enerweb

**With deregulated and cross-border electricity markets opening up worldwide and the imminent establishment of the Multi-Market-Model in South Africa, the mechanisms enabling the trade of electricity have become a topic of great interest. Predictably, the Internet has become the worldwide de-facto standard platform for energy trading.**

The reasons are compelling for both buyers and sellers. Buyers are assured that the competitive bidding process uncovers the true market value of the contracts. The seller is also assured of getting the best price for the contract, as maximum exposure is achieved. Internet-based trading positively contributes to liquidity, wide exposure for many potential contract partners, lower transactional costs, anonymous trading, real-time speed of execution and trading after-hours. The barriers to entry are low due to the relative familiarity with the Internet, the use of expensive technology seldom being required and the feasibility of back-office integration with existing systems.

In Eskom, the internal power pool has been in existence for some years and while it has not been fully opened to external participants due to the prevailing regulatory environment, there has, however, been much activity in the trading arena, some larger customers and self-generating entities having been given exposure to Real-Time Pricing, Demand Side Participation via a product called DMP (Demand Market Participation), a Reserve Market and a Forward Energy Market (based on week-ahead trades contracted via an Internet enabled financial exchange). Regionally, there has also been trade activity on the Southern African Power Pool (SAPP) for many years, with Internet- based systems being gradually introduced as well. These systems have not only resulted in substantial additional sales for the utilities concerned, but have also served to improve information flows and supply chain efficiencies.

Future participation in local multi-markets is likely to be Internet-based. This paper will cover existing case studies and demonstrate some of the functionality likely to be present in a new Multi-Market-Model.

### Multi-Market-Model (MMM)

Most developed electricity markets cater for the trade of electricity in three basic market areas, viz. the physical market, ancillary market and financial markets, as pictured below (Fig. 1).

The Multi-Market-Model components shown above consist of:

- A platform for long-term (fixed) bilateral agreements between electricity suppliers and a defined category of consumers will be specifically suited to traders who prefer consistency of volume and price.
- The day ahead Spot Market (24 hour ahead) is where the actual product (electrical energy measured in kWh's) is bought and sold on a day-ahead basis. It has a fluctuating compulsory price dictated by demand and imbalances peculiar to electricity consumption characteristics.
- The balancing mechanism is used to resolve the discrepancies between contracts and what is actually consumed and typically occurs within the hour.
- The ancillary market will assist the systems operator to ensure security of supply, primarily from a system contingency perspective.
- The financial trading platform enables the forward buying of power in much the same way as risk hedging in the commodities markets.

### Current trading activities in Southern Africa

The Southern African Power Pool (SAPP) was created in 1995 when twelve countries within the southern half of the African continent (Fig. 2) decided to pool their electricity supply resources for their mutual benefit.

The early years of operation in this mode provided the participants with a relatively low risk environment for trading. It also enabled them to gain enough experience (and motivation) to ultimately move to a competitive environment as and when appropriate. The advantages being increased trading opportunities, particularly in a short-term market where demand / supply shortages and surpluses can be matched to the benefit of all participants.

In terms of exchange requirements, little sophistication was initially required. Participants were able to enter into bilateral contracts with wholesale generators (Utilities) for their long-term and medium-term requirements. This ensured that most of their predictable needs could be secured at reasonable prices and also provided the generating utilities with some assurances on investment return. The short-term energy market (STEM) was subsequently established in 1999 to take advantage of gaps between day-to-day demand and contracted supply (i.e. bilaterals). While it was possible to initiate this market using faxes, e-mails and telephonic communication, as the volumes increased, an electronic Internet-based system became essential.

These systems require that information such as hourly energy forecasts, confirmations and schedules (often accompanied by the previous day's load measurements) are exchanged (called the daily bilateral operations). The value of the energy traded in these bilateral agreements (using Enerweb hosted platforms) is currently in excess of R1-


Fig. 1: MMM components [1]

billion per annum. Due to the relative infancy of the trading environment, operational and rule changes have been frequent. The platforms are thus required to be flexible enough to be configured by the users themselves, whilst also being capable of automating and monitoring operations. Detailed reports covering bid parameters, contract data, load data, pricing and settlement data, etc. have been made available online. While the communication infrastructure may not be of the same standard as the European and American markets, all available communication networks (the Internet, SMS, e-mail and even fax machines) are utilised to ensure reliability and high-speed delivery of information. Connectivity to date has been more than adequate within the region to support electronic trading platforms.

Once the MMM is established in SA, the SAPP licensed participants may be granted access to the local market under the same rules and obligations as the local participants, subject to transmission constraints etc. In the opinion of the authors, the higher liquidity levels likely to be experienced in the MMM will result in the SAPP short-term energy market being gradually combined with the local market initiatives.

*Trading activities on Eskom's power pool*

While the MMM has yet to be implemented, an internal Eskom power pool has been operational for over five years. Although its intent was to optimally schedule (on an economic basis) the various power stations, it was also useful in developing the skills and some of the technologies required in the new electricity market place.

*Real time pricing*

The first exposure to dynamic pool prices for SA Electricity Consumers was in 1998, with the introduction of the Real-Time-Pricing (RTP) tariff. Large customers who could demonstrate that their marginal consumption would increase or decrease in response to variable day-ahead energy prices were given access to this specialised pricing regime. This has developed to the extent where now over R 1-billion is transacted on this mechanism on a yearly basis. The administration is highly dependent on web-based systems to enable secure viewing and delivery of bills, settlements, reports and pricing statistics. Customer interfacing is easily facilitated via the Internet through a web browser, email, auto-fax or even a cell phone. The system architecture is specifically designed to integrate with existing systems and user interfaces and checks and balances are included to ensure that any possible erroneous data is highlighted before price posting, or final billing and settlement is produced. Account executive interaction and acceptance prior to bill processing and dispatching is facilitated.

*Power exchange simulation*

The establishment of power pools, deregulation and cross-border electricity trading make the establishment of various exchange-traded electricity trading instruments inevitable. The area of derivatives, historically the domain of commodity traders and speculators, can be complicated. Eskom's Research group therefore deemed it important to establish a real-world simulation environment in order to gain an understanding of the dynamics and risks associated with this environment, particularly in light of the harsh lessons learned elsewhere in the world (e.g. the Californian disaster, and more recently the Enron debacle).

The (Internet-based) South African Power Exchange simulation game, based on Enerweb's enerXchange platform, was customised to replicate local market conditions as closely as possible, and run over a six-month period. Participants included all prospective Eskom energy traders as well as a number of selected external participants. The market rules were modelled primarily on the Nordpool financial market (similar to the prospective SA MMM).

The interactive trading game was transparently interfaced with the financial exchange, also incorporating actual SA weather and operational constraints thus providing real-world volatility. Over 120 participants were involved in the trading simulation, resulting in excellent liquidity. Each player was given a R1m balance to start with and had to assume the role of either a Generator (producer), Trader (speculator) or Distributor (consumer). The exercise proved highly successful, not only from a training perspective but also from a technology implementation perspective, with the lessons learned being implemented in a real Forward Energy Market as described in the next section.

In technology terms, Straight Through Processing (STP) principles using XML messaging standards were applied in the development of the platform (enerXchange). This ensured that data could be transferred in a way that is compatible (and understandable) to all interconnected systems, eliminating all human transferring of data and human interactions.

*Forward energy market*

The Forward Energy Market is an Internet-enabled electronic exchange platform where Eskom's "surplus energy" is traded with customers who have their own generating capacity but would be able to take advantage of lower cost Eskom energy in periods when demand is low. In order to hedge risks and to provide sufficient incentive for the customer and for Eskom Generation to participate, a method was required which would enable weekly surplus energy to be obtained from the Generation Energy Management Department (EMD), acting as wholesaler, and where the Eskom Distribution group customer executives would act as the retailer. The

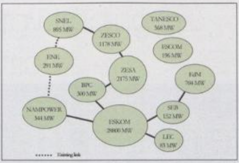


*Fig. 2: SAPP Participants [2]*

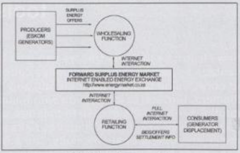


*Fig. 3: Forward energy market*

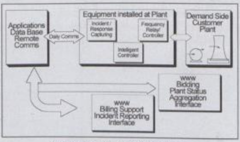


*Fig. 4: Generic Reserve Market Infrastructure*

electronic trading of the contracts (volumes, prices and hedges) was required to be made available to the customer in an on-line, efficient and electronically secure environment. Furthermore, as weekly forward energy contracts were being negotiated, the customer also needed to contract electronically on a weekly basis for the following weeks, where these contracts would then also become part of the settling and billing procedures for that specific customer.

An Internet browser-based energy exchange application allowing open access was implemented as illustrated in Fig. 3. The web-based standardisation for user/trader interaction shortened the learning curve, reduced the set up cost and had quick user acceptance. Eskom branded the product as Dynamic Surplus Pricing (DSP), with the self-generating municipalities and Sasol being the primary customers. More than R250-million is being transacted on the market on a yearly basis, resulting in the benefits of lower cost marginal energy sales to be derived by all parties.

Apart from the improved supply chain efficiency benefits, other positive spin-offs were improved Eskom customer information flows and real world experience through being able to demonstrate successfull participation in a wholesaling, retailing and customer trading environment, all via a secure Internet-based contracting system.

*Ancilliary services market*

Participation in the Eskom Power Pool Reserve Markets has traditionally been the preserve of the Generators. In line with international market developments however, Demand Side Participation in this area has been found to be extremely viable and the Internal Eskom Ancilliary Service Market was opened on a limited scale (albeit via Eskom Distribution as the trading entity) to customers having existing interruptible or under-frequency load shedding agreements in place.

The Eskom Reserve Energy Market is split into four categories:

- Regulating Reserve (Automated Generator Control) 4 sec response time required
- Instantaneous Reserve - 10 sec response
- 10-min Reserve
- Emergency Reserve Markets - 2 hour response

The Generator's participation in the markets was through the existing energy market mechanisms, where the system administrator interfaces are also web-based. Entirely new demand-side infrastructure however had to be established in order to cater for this new type of participant as outlined in Fig. 4.

The Ancilliary Services or Reserve Market comprises of generating capacity (synchronised or not) or Demand Side Managed load that can respond within a pre-determined time period when required. A one day ahead bidding process for available capacity is managed through a system operations web interface. Payments are made to the lowest cost bidders for being available (capacity payments). Additional payments are made if loads are dispatched (utilised), thus providing "insurence" for the system operator in case of system contingencies. In the first year of operation, almost a third of Eskom's reserve capacity (other than regulating reserve) was supplied by the demand side using this mechanism.

### Electronic trading - lessons learned

The web platforms introduced were easily able to handle the required transaction volumes, the negotiatiation complexities of multiple bids and bid matching. Deal closure also occurred in almost real-time. The requirements of scalability to handle volumes, robustness and reliability to ensure performance were also successfully demonstrated. The utilised platforms were able to support the full range of trading-types for assignments and allocations, making it easy to change transaction/auction types which enable the energy trading community to use the best options depending on their specific needs. "Rules of the game" with parameters, were also easily managed and configured, including among others:

- Who can access which markets
- Who can bid/offer
- What bidding information should be revealed, and to whom
- How winning bidders are selected (not necessarily the highest bidder)
- How bidding is structured across time
- Any special treatments that should be extended to some bidders, and under what conditions

The following themes were considered essential (and verified by customer requirements) in the high-level system design [4,5]:

- Low transactional cost
- Ease of use
- Ease of monitoring
- Transparency of price
- Quick transactions
- Highly customisable
- Private
- Audit trails available

Utility managers were also able to use the provided platforms to collect data regarding each trading partner's bidding and buying behaviour, demand for power under various market conditions, specific price resistance points, etc. This data being extremely valuable when fed into an analytics system for revenue forecasting and management.

*Secondary systems integration*

Integration with adjacent technology applications such as finance, revenue, credit and risk management systems was essential. With the prevalence of SAP and other ERP type sytems in the industry, this integration was one of the primary design requirements [3].

### Conclusion

There can be no doubt that the Internet (e.g. electronic exchanges) will continue to play a key role in the future of energy trading in developed, as well as developing countries. In this regard, Eskom has already, in anticipation of the new MMM, successfully deployed various platforms, systems, simulations and products. Of fundamental importance, however, remains an evaluation of the current state of cross border energy trade, the potential local and regional liquidity, as well as the state of industry liberalisation in Africa. It is expected that in Southern Africa, while the SAPP and MMM would run in parallel, they will ultimately merge as a result of the benefits of increased liquidity, lower transaction costs and the use of more efficient technologies.

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# How the newly restructured Eskom tariffs were developed

by A J de Kok, senior consultant: pricing analysis, Eskom Distribution Division

**This paper describes the major steps taken in the development of tariff structures and tariff methodologies for Eskom. With the publishing of the White Paper on Energy Policy in 1998 and several other driving forces such as the unbundling of Eskom into separate divisions it has become possible to restructure legacy rates.**

Eskom has a long standing tariff history and some tariffs were developed decades ago. The current tariff methodology is a response to the current utility environment where cost based tariffs, effective customer behaviour and the efficient investment are of the utmost importance. In the light of restructuring it has also become necessary to restructure tariffs into new sets of tariff that could weather the "storm" and will form a foundation for the tariff structures of future Distribution companies.

The steps taken in the tariff design methodology are described as well as the overall outcomes at different stages of the design process. There are two conflicting concepts in tariff design that make this process one that is often described as art rather than science: On one hand is the desire of the utility to reach its financial objective and earn a fair return and on the other hand, is the desire of the end-user or customer to receive fair tariffs at the lowest possible level. The major thrust of the tariff design philosophy is to achieve a realistic balance between these two often conflicting concepts within the realm of a regulated environment.

### Attributes of rate structures

There are several attributes that sound rate structures should adhere to. These attributes can be separated into revenue-related attributes, cost-related attributes and implementation-related attributes.

### Revenue-related attributes

The tariffs should yield the total revenue requirement including a fair return. This would require that all designed tariff structures should be tested for adequate recovery of revenue and scaled to levels that would ensure recovery.

The revenue should be stable and predictable with minimal unexpected changes to the utility. This should allow the utility to gradually grow its base of customers and revenue. There could be no revenue shocks (i.e. losses in revenue) that would jeopardize the sustainability of utilities.

The tariff structures should be stable and predictable with minimal unexpected changes and with some sense of historical continuity. This might sound conflicting in the light of restructuring tariffs but major changes towards future tariff structures should be brought about to ensure as small an impact as possible on customers. The fact that several utilities are still marred by legacy tariff structures will make this attribute difficult to adhere to in the time leading into the future RED dispensation.

### Cost-Related Attributes

Tariff structures and tariff groupings should be designed to discourage wasteful use of the service while promoting efficient use:

- Increased overall usage for existing infrastructure should be encouraged and
- Time variant or relative usage should be encouraged (Off peak usage vs. peak usage or summer usage vs. winter usage).

Tariffs should reflect all present costs and portray the structure of costs to the utility.

There should be fairness in the apportionment of total costs of service among the different customer classes so as to avoid arbitrariness. This would imply the adoption of accepted cost of service methodologies that is used to allocate cost to defined customer classes.

Undue discrimination in tariff levels should be avoided and where possible subsidies should be shown and phased out in accordance with government objectives. In this are Eskom has engaged government to provide direction as this issue touches on the distribution of resources in the larger economy and the effects should be known to government.

### Implementation-related atributes

The tariffs should be kept as simple as possible while providing adequate information to the customer. The introduction of additional tariff components might be seen as contradictory to this statement. There is however an element of being able to clearly express the services that the customer is paying for by having tariff components for the most significant services such as energy and networks.

Tariff structures should be implementable and free from controversies. The interpretation of tariff structures should be clear. Inconsistencies should therefore be eradicated as to promote understanding. The elimination of the consumption based rebate is one such inconsistency that Eskom will eliminate by introducing more consistent pricing signals across all tariffs in the form of the network charge.

### Recent tariff structure changes

Eskom has made significant progress over the past few years to implement rate structures that are in coherence with principles laid down in the White Paper on Energy Policy published by Government in 1998. There has also been several changes that was brought about to ensure that Eskom tariffs have attributes that are acceptable for utility tariffs as discussed in the prior paragraph on Attributes of Rate Structures.

The most significant changes that have been brought about can be summarized as follows:

The introduction of unbundled network charges started with rural customers in 2002 and will also be extended to urban customers in 2004. The attribute of reflecting the cost structure and ensuring adequate revenue for the utility is satisfied by the introduction of these charges. This also provides for efficient usage of resources by customers and Eskom being able to provide additional service on existing networks. As mentioned before the necessity for providing consumption based incentives for utilizing supplies optimally through the connection charge rebates have been done away with. This has been replaced by a more significant incentive by charging for network costs based on the utilized capacity of a customer that is the higher of the actual for the previous 12 months and the Notified Demand.

The introduction of a shorter high demand season and more pronounced price differentiation in the time of use periods. This satisfies the attribute of encouraging overall usage of infrastructure and encouraging time-variant usage.

### The tariff design process

The process of calculating tariff structures for electricity can be broadly broken into 3 steps:

- Identifying and calculating costs
- Allocation of the costs to defined tariff classes and
- Tariff structure and rate determination

Identifying and allocating costs is done based on the cost of supply methodology as set out in NRS 058. This methodology has been accepted by the industry. Eskom has implemented this method to allocate cost to its existing tariffs classes. It is envisaged that tariff classes in future will reflect usage patterns. Thereafter the calculation and logic used to determine the structure and rates of the tariffs is described.

There is often confusion around the words "price and cost", price is not cost. Cost is the amount incurred to obtain or deliver a specific service whereas price is an amount charged to a customer for that service.


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In a regulated and monopoly environment, the price paid is regulated based on certain criteria, such as cost which includes an allowed return on investment, or even on affordability levels as judged by the regulatory authorities.

Irrespective of what type of market environment there might be, the basis (or the floor) for determining the price to be charged is the costs. The market or regulator determines the price ceiling. Costing information is a vital element of management information and is a useful tool in the following areas:

- Product pricing
- Make/buy decision making
- Breakeven and investment analysis
- Transfer pricing
- Scenario planning
- Process optimisation

All of the above are important for Eskom. The basis for Eskom's tariffs is cost; a good understanding of what these costs are and how they are allocated to customers is required in order to set tariff levels, and subsequently to determine project viabilities, investment decisions, technology strategies and, ultimately, how to keep prices low and profitability up.

Once the costs have been determined and adjusted to ensure that revenue requirement is met, the tariff design process moves to the allocation of costs amongst various customer categories. The allocation process is based on the customer categories' degree of association with the energy, demand and customer related functions. Eskom's customer categories used for this tariff design process are based on the existing tariff classes.

Once the cost of energy, demand and customer-related functions are allocated, these costs are used to determine the initial average cost reflective price, and do not take adjustments (e.g. voltage surcharge and subsidies) into account.

There is a cost differentiation from higher voltages to lower voltages that should be reflected in the tariff structures. Eskom is currently operating with a specific set of pre-defined voltage differentiation factors. These factors will be under scrutiny in future but will only be changed or increased as more data is available to model all voltage levels. In the next step the adjustments are included, which is a reconciliation and scaling process to ensure that revenue requirement is met.

There are inherent subsidies in the current Eskom tariffs that should be rationalized and phased out as Government gives direction to re-balance tariffs to those customers that receive the subsidies. In the next step of the design process the subsidies are clearly identified and levies are added to the costs of those customers contributing to the subsidy pool and given to customers that receive the subsidies. These levies and subsidies impact the tariff structures and once again the tariffs should be applied to the customer data to ensure that revenue requirement is met.

The final tariff structures and rates are applied to customer data and analysis is done on each point of deliver of large customers and groups of small customers to determine the impact of the changes in tariff structure.

This analysis is then used to make further adjustments to the tariff structures if the impact of the proposed changes is too severe such as phasing-in of fixed charges.

Each step of Fig. 1 is described in more detail as follows:

*Revenue requirements*

Eskom's revenue requirement consists of Distribution purchase costs (energy and transmission network services) and other distribution costs such as the cost of Distribution networks and customer service. A tariff design exercise should always use a test year as close as possible to the present financial year to ensure that rates reflect as far as possible the current level of service and mix of customers. The tariffs are therefore designed using the budgeted revenue requirement for the year when the design is done and using the forecasted customer data for the same year. The tariff structures for 2004 are therefore designed by using the 2003 budgeted revenue requirement and the 2003 customer forecasts. This would result in tariff structures with rates in 2003 rand value. Once the overall price increase is determined these rates are increased by a percentage to reflect the revenue requirement for 2004. The revenue requirement is broken down into the major cost categories according to the NRS 058 cost of supply methodology whereafter each component will be allocated.

The tariff design process has, as one of its main objectives, to recover the revenue requirement. All rates applied to the customers' forecasted profiles should therefore balance to the revenue requirement.

*Tariff class average load profiles*

The load profiles of the defined customer categories should be determined to allocate costs based on the way a customer or customer category uses electricity in the hours of the day and in the seasons of the year. This information is used to determine the costs of purchasing energy and the capacity required on the networks. Eskom currently uses the defined tariffs as customer classes as these categories are well established and a migration to new classes that are more load factor related for larger customers will probably only occur after the formation of REDs. For many of the existing tariffs this categorisation is adequate as it reflects 3 levels of pooling: urban and rural is separated, residential customers are treated separately from other urban customers and customers are pooled according to size.

The tariff class average load profiles are determined at the 275 kV level per tariff class.

*Allocate costs NRS 058*

One of the fundamental criteria in allocating costs is to classify costs according to their nature. Costs can be broadly classified into the natures of:

- fixed or variable costs, and
- direct and indirect costs.

Fixed costs are costs that are fixed regardless of consumption and relate in particular to capital investments for infrastructure development. An example would be the cost incurred in building an electricity network to supply a customer.

Variable costs are those that vary directly related to output or consumption, such as the cost of raw material. An example for an electrical utility would be the cost of the coal or the water, which is used to generate the electricity consumed. Direct costs are those costs are costs that are directly associated with providing service related to a product or service. An example would be the cost of metering or billing a customer and providing customer service.

Indirect costs are shared or common costs that are allocated to a number of different products or customer categories as there is no direct cost causation responsibility. An example is overheads related to building rentals or head office staff costs. The costs are allocated to the defined customer categories according to the NRS 058 methodology. Each tariff class (subdivided by size) becomes virtual customer groupings that share in the allocated costs. The costs allocated to each of the virtual customers is captured in a cost matrix reflecting each major cost category that can be used in a tariff structure ie. kVA related costs, kWh related costs and customer or account related costs. Once these costs categories have been determined average tariff rates will be designed for each tariff.

The energy costs (for peak, standard and off-peak time periods in both the high and low seasons ) are allocated directly, with an addition for losses, while network costs are allocated using the Average and Excess methodology, as described in NRS 058. Energy costs are allocated on the basis of volume (c/kWh) whereas network costs are allocated based on capacity (R/kVA).

Other distribution costs are categorized with cost drivers being volumetric (kWh), capacity (kVA) and number of customers (Customer; Account; POD). Customers are differentiated on size and the costs are allocated accordingly.

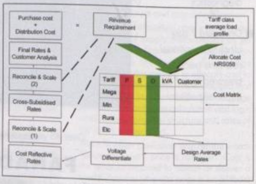



Fig. 1: Rate Design Process Overview

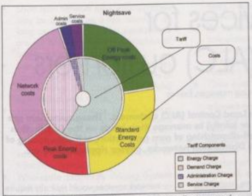



*Fig. 2: Difference between cost components and tariff components for Nightsave (Urban) tariff.*

The above steps yield a cost matrix, reflecting per unit and total costs, for each tariff class for energy, capacity and customer costs. This matrix can be seen in Fig. 1.

*Design average rates*

The cost matrix contains a cost component for each identified cost, for each tariff. The tariff structures are limited by the ability to meter certain cost drivers and by simplicity. As an example the Homelight tariff cannot have separate network costs and customer costs reflected in the tariff, as the capacity is not measured and the meter is not capable of raising a fixed charge. In this case certain cost components of the cost matrix should be added together (bundled) to determine average rates.

The purpose of this step in the tariff design process is therefore to add different cost components together to match appropriate rate structures and to convert those bundled costs into unit rates (c/kWh, R/kVA, R/Customer; R/Account; R/POD).

The costs are put together in accordance to the unbundling of energy and wires costs. Therefore all tariffs that allow for the separation of these costs see separate energy costs and separate network costs. The energy costs can be reflected on a time of use basis exactly like the input costs or converted to more equalized energy charges for the small customer tariffs. The network costs are charged based on utilized capacity where possible as the network costs are not caused by the variant demand of a customer but the maximum required by the customer for a specific year.

Fig. 2 expains the relationship between costs and tariff structure components for the Nightsave tariff. This tariff re-packages the costs into tariff components that are more suitable to customers that manage their load on a daily and seasonal cycle rather that an hourly cycle. This tariff design converts standard and off-peak energy costs into a non time-variant energy price and converts some of the energy costs into a demand charge to ensure demand side management when energy rates are flat. Network costs are recovered as a demand related charge (R/kVA).

*Voltage differentiation*

The rates at this point are average rates designed by using the average profile of a tariff class as seen at the purchasing point of Distribution. These rates still require differentiation for voltage to reflect the true cost of supplying different customers at the various voltage levels. This is achieved by calculating the volume weighted differentiated rates for each component per tariff class and per voltage level. The resultant rates will reflect cost differences between higher and lower voltages. The existing voltage differentials will be applied.

*Reconcile and scale (1)*

Once the voltage differentials have been applied the rates are deemed to be close to cost reflective. These rates are applied to customers' profiles to determine Eskom's total revenue.

A difference between the calculated revenue and Eskom's total revenue requirement occurs due to a combination of the following reasons:

- Certain assumptions are made regarding load profile where no actual data exists.
- Adjustments due to Transmission surcharge.

This difference is eliminated by scaling the cost reflective rates to ensure revenue requirement within an accepted margin of error (0,1%).

*Cross subsidised Rates*

The cost reflective rates for some tariffs are significantly different from the existing rates which may require huge increases/decreases to the rates, which may be unaffordable for some customer classes. These rates are adjusted based on tariff rebalancing direction approved by the regulator. The cross-subsidisation is based on reducing the capacity related (network) costs allocated to the subsidised tariffs, and recovering this cost on a volumetric (c/kWh) basis from customers contributing to the subsidies.

*Reconcile and scale (2)*

Once the subsidies have been included the rates it is necessary to ensure that revenue requirement is obtained from these subsidised rates. The subsidised rates are applied to customers' profiles to determine Eskom's total revenue.

A difference between the calculated revenue and Eskom's total revenue requirement occurs due to a combination of the following reasons:

- Adding a flat c/kWh subsidy rate to rates and then applying voltage and geographical differentials.

This difference is again eliminated by scaling the subsidised rates to ensure revenue requirement within an accepted margin of error (0,1%).

*Final rates and customer analysis*

The re-designed tariffs are now structurally different and have different tariff rates from existing tariffs. Due to these changes, individual customer bills will be impacted differently, depending on their load profile and tariff. The impact can range from significant savings for the customer to substantial increases in the customer's bill. Such impact is unavoidable when there is a re-design of tariffs, however due to affordability constraints, there should be a minimum negative impact to the majority of customers. The quantification of "minimum" and "majority" is at the discretion of the National Electricity Regulator.

To be able to quantify the revenue impact on each individual customer, the customer's bill needs to be modeled on the existing tariff and the new re-designed tariff. Comparisons between existing and new tariff revenue is compiled for each customer (LPU) or customer grouping (SPU) by tariff and portrayed in the form of histograms. Automatic savings made by customers without shifting any load, is regarded as a loss to Eskom. This places risk of not meeting the revenue requirement. Further analysis based on new rates is very important to quantify the risk of automatic savings.

## Conclusion

There is a need within the Electricity Supply Industry (ESI) to have substantiated tariff structures that are based on costs with some changes to allow for socio-economic subsidies. A prerequisite of this is a standard procedure of allocating and deriving costs, which is considered to be fair and equitable which is as broadly acceptable as possible to all stakeholders. In the costing process the unit costs for all functions of electricity supply to customers (purchase, network and support costs) are calculated as described. The cost-of-supply methodology on its own is not enough to allow for the restructuring of retail tariffs towards sound cost-reflective tariffs. It is necessary to have a tariff design methodology that guides the process of moving from costs to tariffs.

Eskom has followed such a tariff design methodology and has brought about significant changes in the legacy tariff structures to reflect more accurately, current-day pricing objectives and cost structures. These structural changes have brought about a certain level of instability in tariff structures. This is however a transitional phase that will stabilise as the tariff structures are founded on the longer term cost structure. If these changes are implemented there will be longer term tariff structure stability.

The tariff restructuring has brought about several of the objectives for sound pricing. Eskom has seen better usage of infrastructure due to the introduction of network charges and the charging of required capacity as opposed to actual variant demand. There is also a close reflection of the purchase cost time of use ratios in the retail tariffs that has been followed by the rescheduling of electricity consumption to times and seasons that are most cost-effective to the customer. This will bring about longer term savings as it would postpone the requirement for new capacity if this signal is followed by customers. Δ

# Network services for active load control (ALC) customers

by Johann Crous, large customer pricing manager, Eskom

**Customers with active load control capability are known as Active Load Control (ALC) customers. These customers are able to apply any number of real time technologies (individually or jointly) to manage their loads on the Distribution (Dx) system. These technologies include, but are not limited to, self-dispatching of own generation, self-dispatching of alternative energy sources that do not flow through the Eskom Distribution networks, geyser ripple control, etc.**

## Background

- Customers practicing active load control often have network capacity and generation reserve requirements that are different from other customers. Furthermore, some ALC customers (typically customers with alternative energy sources) may contract for the sale of electricity to another customer or may want to supply his own facilities located elsewhere. Such an ALC customer will be charged for network services rendered by Eskom.
- Until now the pricing of network services and generation standby charges was contained in Eskom's non-scheduled tariffs in accordance with approved Eskom directives. Eskom has now promulgated the pricing of energy sales, network and generation standby charges for ALC customers for 2003 and this will be implemented for all customers in this category once approved by the National Electricity Regulator (NER).

## Scope

- Network services for ALC customers will be applicable to Eskom customers with active load control schemes and who may consequently have non-standard requirements for network capacity and generation reserves.

## Definitions and abbreviations (Refer to Fig. 1)

- Additional Energy is energy consumed over and above the customer's notified normal load (NNL). This is expected to happen when the customer's load control scheme is out of order and the customer elects not to reduce load to NNL.
- Additional Capacity is network capacity specifically contracted for by the customer to ensure that outages of his load control schemes can be met with back-up capacity from Eskom Distribution.
  - Long-term Capacity refers to network or generation capacity reserved for the customer to supply his regular load (i.e. NNL) as well as any capacity specifically contracted to be available in the event of the customers' ALC systems being inoperative. (Also see Reserved Capacity).
  - Short-term Capacity is network or generation capacity that the customer may from time to time need over and above his long-term capacity in order to meet short-term increased capacity requirements that result from the in-operability of the customer's ALC equipment.
- Firm network service in this instance does not refer to N-1 planning standard or premium supplies as defined in Eskom Distribution's Recovery of Capital Costs Policy, but implies that a required amount of network capacity is reserved on Eskom's network. Firm network service may only be interrupted for system emergencies. For firm transactions, network service charges shall cover the full-embedded cost of Eskom.
- Long-term network service transactions take place over a period of one year to several years. The duration could allow for the building of new infrastructure.
- Network charge is a fixed charge payable every month, whether electricity is consumed or not, and is a contribution towards Eskom's fixed network capital costs. Where applicable, this charge is based on the utilised capacity, which is the greater of the customer's reserved capacity or actual maximum demand registered during the previous 12 months, but excluding usage of un-firm network services.
- Non-Eskom Generator (NEG) is a customer connected to the networks of the Distribution Group who has his own on site generation or who has access to generation from a party other than Eskom, e.g. an Independent Power Producer (IPP). Customers who operate embedded generation (including IPPs connected to the customer's networks) must comply with the latest version of Eskom Directive ESKAGAAG2: "Minimum requirements for the connection of non-Eskom generating plant to the Eskom electrical networks".
- Non-Firm network service, having less priority than a firm network service, will be interruptible based on system conditions and Eskom's ability to meet the load requirements of its full service customers. Non-Firm network services would typically require the expansion/strengthening of networks to convert to a firm network service. This means that no guarantee can be given that the load will be supplied, even under healthy network conditions.
- Normal Load - see Notified Normal Load (NNL)
- Notified Maximum Demand (NMD) is the peak demand that could possibly be imposed on the Distribution system when the ALC customer's load control scheme is inoperative and without the customer taking any other measures (such as load shedding) to attempt keeping the load to within NNL.
- Notified Normal Load (NNL) is the maximum load that the customer expects to purchase from Eskom after allowance for the customer's normal ALC operation. This load can be specified either as a half-hourly load profile, for Real Time Pricing (RTP) customers, or as a notified annual demand for other customers.
- Real Time Energy Price is the price determined daily from the pool price and is applicable to Real Time Pricing (RTP) customers.
- Reserved Capacity
  - Reserved Generation Capacity is long-term generation capacity that Distribution specifically reserves on Eskom's generation system, in addition to NNL, to be available to the customer under system healthy conditions.
  - Reserved Network Capacity is the sum of NNL and long-term network capacity and is reserved on the Distribution and Transmission (Tx) systems for the exclusive use of the customer under system healthy conditions.

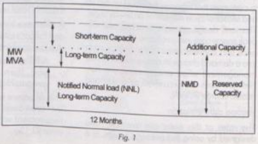



Fig. 1

- Short-term network service transactions may be as short as a few hours to as long as one year. These transactions are not associated with the creation of additional infrastructure.
- Standard charges are a set of charges used throughout Eskom with the aim of recovering the cost of standard operational work done.
- Transaction voltage is the lowest voltage at which Eskom's networks interface either with the ALC customer or the energy source (i.e. the lowest voltage of either the take-off point or injection point).
- Wholesale Electricity Pricing System (WEPS) This is a pricing system that unbundles most of the cost components of electricity supply, in particular the cost of energy generation (by Eskom's Generation Division) and transmission network services (by Eskom's Transmission division).
- Wheeling is the term used for the transportation of energy from one party to another over the networks of a third party. The owner of the networks is entitled to compensation for the use of his assets. The Wheelee is defined as the owner of the energy transported and the Wheelor is defined as the party over whose network the wheeling transaction will take place.

**Load contract for ALC customers**

When negotiating the supply of electricity to an ALC customer, the following parameters shall be contracted for (over and above the normal contract conditions), as illustrated in Fig.1.

- The customer's notified normal load (NNL), based on normal active load control system being in operation, e.g. normal self-generation output, ripple control in use, etc.
- The customer's additional capacity requirements. (The increased load expected when the customer's generation or ALC system fails or is taken out of service for planned maintenance should be included in the additional requirements). Customers may choose to specify long-term capacity of zero, in which case the customer must take steps to limit his load to the NNL during ALC system outages.
- The customer's notified maximum demand (NMD) which is the greater of the sum of:
  - NNL plus
  - long-term capacity plus
  - short-term capacity or
  - peak generation injected into the Eskom system.

The NNL plus long-term capacity (i.e. reserved network capacity) will determine the ultimate sizing of the network and can only be increased by further capital investment with the associated project lead times to be considered.

- The NNL may be changed on an annual basis, subject to project lead times where network strengthening may be required. An increase in NNL may require the re-calculation of capital payments. The recovery of such capital expenditure will be in accordance with Eskom Distribution's Recovery of Capital Costs Policy.
- Only customers who are on a 2-part Real Time Pricing (RTP) tariff may be allowed to specify their normal load and standby requirements in the form of an hourly load profile. The load profile shall be contracted for a period equal to the profile required in terms of the customer's RTP contract, which is normally one calendar year.

**Pricing of energy sales, network and generation standby charges for ALC customers**

*Standard charges*

- ALC customers are required to pay the connection charges that would normally be applicable for any other customer in terms of Eskom Distribution's Recovery of Capital Costs Policy.
- The cost of upgrading existing meters shall be for the customer's account on a cash up-front basis.

*Energy charges*

- One of Eskom's promulgated retail tariffs will be applicable for the NNL of the customer, unless a Special Pricing Agreement (SPA) has been negotiated and approved. Energy supplied with respect to NNL will be charged for at the applicable tariff rates, which implies that:
  - For RTP customers this is all energy supplied up to the hourly load profile (called the customer baseline load or CBL for these customers).
  - For non-RTP customers this is all energy supplied up to the NNL, which is a straight-line profile for the year.
  - For bundled tariffs, all the normal tariff components will be applicable up to the NNL.
  - For tariffs unbundled into network and energy charges, the network charges will be applicable up to the NNL capacity.
- Energy sales to an ALC customer, over and above NNL, will be priced to reflect the cost of energy only. This additional energy supplied in excess of the CBL for 2-part RTP customers or the NNL for other customers shall be charged for in one of the following two ways:
  - The Real Time Energy Price for 2-part RTP customers.
  - Eskom's Distribution's bulk energy purchase price from Generation, adjusted for system losses, plus a retail mark-up.
- Customers with plant capable of controlling power factor (e.g. generation or capacitor banks) shall ensure that the power factor shall under no circumstances be leading. Reactive energy shall be charged for in terms of Distribution's standard tariffs. Reactive energy consumed as part of additional energy shall be charged at the rate applicable to Megaflex.

*Charges associated with Distribution (Dx) network services:*

- The cost of network capacity to supply NNL is recovered through the normal Eskom retail tariff rates. This includes the cost of transmission network capacity that Distribution has to reserve on behalf of the customer.
- The network cost associated with additional capacity requirements (in excess of the NNL) is separated into short-term and long-term network capacity requirements.
  - The cost of short-term network apacity is derived from the short run orginal cost of this capacity, which is deemed to be equal to zero. Distribution shall not be under any obligation to make this capacity available or to include this capacity requirement into the long-term network planning. Short-term network capacity, at zero cost, will therefore only be made available if and when that happens to be available on the system. Customers who wish to include their short-term capacity requirements into the network planning base, can do so by contracting for it as part of reserved network capacity.
  - Long-term network capacity will be charged to customers at full embedded cost. The charge for long term network capacity will depend on the customer's normal tariff structure:

    i. Where the tariff is unbundled into a cost-reflective network and energy charge, the long-term network capacity charges will be equal to the regular network charges in accordance with Eskom's Schedule of Standard Prices.

    ii. Where the tariffs are still bundled, or the network charge introduced is being phased in, the reserved network capacity has to be differentiated into capacity to meet NNL and long-term network capacity. The charge for network capacity up to NNL is recovered through the regular bundled tariff.

    The cost for long-term network capacity is recovered through a Dx network services charge which is a voltage differentiated capacity based charge (R/kVA), based on the ALC customer's reserved network capacity. The Dx network services charge will include the cost of refurbishment, operations and maintenance. The customer will therefore not be required to make additional capital contributions in the event of the networks being refurbished.

| Voltage | < 500 V | ≥ 500 V - < 66 kV | ≥ 66 kV - ≤ 132 kV | > 132 kV |
|---|---|---|---|---|
| Urban (R/kVA) | 7,17 | 6,72 | 6,57 | 6,11 |
| Rural (R/kVA) | 16.83 | 15.79 | N/A | N/A |

*Table 1: Dx network services charges*

| Voltage | Loss Factor (Urban) | Loss Factor (Rural) |
|---|---|---|
| < 500 V | 1,0912 | 1,1189 |
| ≥ 500 V - < 66 kV | 1,056 | 1,090 |
| ≥ 66 kV - ≤ 132 kV | 1,0174 | NA |
| > 132 kV | 1,0000 | NA |

*Table 2: Dx loss factors*

| Distance from Johannesburg | Zone | TxNC (R/kVA) | Loss Factor | RS (c/kWh) |
|---|---|---|---|---|
| 0 to 300 km | 1 | 2,11 | 1,0107 | 0,1379c/kWh |
| 301 to 600 km | 2 | 2,13 | 1,0207 | 0,1379c/kWh |
| 601 to 900 km | 3 | 2,15 | 1,0307 | 0,1379c/kWh |
| > 900 km | 4 | 2,18 | 1,0407 | 0,1379c/kWh |

*Table 3: Transmission Network Charges (TxNC) and Loss Factors*

| Tx Supply Voltage | Transmission Connection Charge |
|---|---|
| ≥ 400 kV | R 0,00 |
| 220 kV to 275 kV | R 0,00 |
| 88 kV to 132 kV | R 0,00 |
| < 88 kV | R 0,00 |

** Charges are still bundled with the Network Charges.

*Table 4: Transmission connection charges (TxCC)***

| Season | Peak (c/kWh) | Standard (c/kWh) | Off-peak (c/kWh) |
|---|---|---|---|
| High (June - August) | 49,274 | 12,345 | 6,304 |
| Low (September - May) | 13,307 | 7,910 | 5,344 |

*Table 6: Dx energy purchase price for 2003 (WEPS rates)*

| Charge Type | Rate |
|---|---|
| Electrification levy | 1,16c/kWh |
| Rural Network Levy | 0,54c/kWh |
| Service Charge | R1 455,07 |
| Administration Charge | R1 099,96 |
| Retail Mark-up | 0,569 c/kWh |

*Table 5:Other charges and values*

- Should any new Distribution network investment be required to support the non-standard requirements for network capacity, the cost of that investment will be recovered in terms of Eskom Distribution's Recovery of Capital Costs Policy. Any capital charges levied by Transmission with regard to their networks will be passed to the ALC customer.

*Charges associated with Transmission (Tx) network services:*

- Eskom Distribution reserves a certain capacity at each Main Transmission Station (MTS) and pays for this reserved network capacity as a Transmission network services charge. The Transmission network services charge is differentiated into two components:
  - A Tx network charge (TxNC), which is a geographically differentiated charge aimed at recovering the cost of the transmission system, 220 kV and higher. The geographic differentiation will follow the geographic differentiation during the phasing in of WEPS (Wholesale Electricity Pricing System).
  - A Tx connection charge (TxCC), which is a voltage-differentiated charge aimed at recovering the cost of the substation equipment where the customer is connected (i.e. line and transformer bays and transformers).
- The cost incurred by Eskom Distribution to reserve capacity on the transmission system will be recovered from the ALC customers. The Transmission network services charges are currently still bundled and will be recovered from the ALC customers on a R/kVA basis through the Tx network charge.
  - The cost of reserved Tx network capacity up to the level of the customer's NNL is recovered through the normal Eskom retail tariff rates.
  - The cost of reserved Tx network capacity to cover the customer's long-term capacity requirements (in addition to NNL) is recovered through a separate Tx network charge.
  - Short-term network capacity requirements of the customer will be made available at zero cost, following the same principles as for distribution network services
- The effect of system losses increases the customer's reserved network capacity as seen at MTS level, where Distribution will purchase the Transmission services on behalf of the ALC customer. The customer's reserved network capacity must therefore be increased by the Distribution loss factor for the appropriate transaction voltage.
- The Transmission network cost applicable to the customer will therefore be:

Tx Network Cost =
LTC (kVA) x Dx Loss Factor x TxNC (R/kVA)

Tx Connection Cost =
RC (kVA) x Dx Loss Factor x TxCC (R/kVA)

where:

LTC = Customer's long term reserved capacity (in addition to NNL)

RC = Customer's reserved capacity which is the greater of NMD or actual recorded demand in the previous 12 months.

TxNC = Transmission network charge

TxCC = Transmission connection charge determined at the voltage level of the MTS from where the ALC customer is supplied and not the POD voltage.

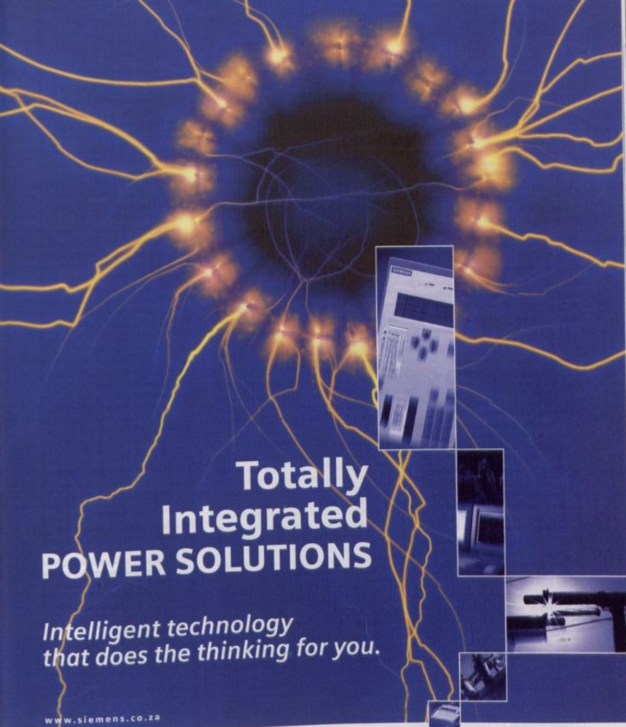
*Standby charges for generation reserve*

- The cost incurred by Eskom Distribution to reserve generation capacity will be recovered from the ALC customers.
  - The cost of long-term generation reserves to meet NNL is recovered through the normal Eskom retail tariffs.
  - The cost of reserved Generation capacity to meet the customer's long term generation capacity requirement is recovered through the Generation standby charge that is passed to the customer from Generation through Distribution.
  - Short-term generation reserves to meet the customer's short-term capacity requirements, will initially be made available at zero cost. This cost will ultimately be reflected through the market for ancillary services/reliability services, where customers with own generation could in fact be a supplier of short-term reserves.
- Customers can specify short-term and long-term capacity requirements for networks and generation reserves independently of each other. Therefore, a customer can specify a certain quantity of long-term network capacity and at the same time specify zero long-term generation capacity. It all depends on how the customer views the risks associated with the possible unavailability of the different services. It stands to reason, therefore, that short-term generation reserve capacity will be fully interruptible if there is a short-term generation capacity shortage, even if long-term network capacity has been reserved and paid for.

### Cost of losses

*Cost of losses in the Distribution system*

- Distribution will recover the cost of the losses resulting from the supply of additional energy.
- Distribution will effectively purchase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from Generation the energy lost in its networks while transporting this energy to the ALC customer. This cost will be recovered by determining the amount of energy losses, multiplied by the WEPS energy purchasing rates of Distribution.

- The energy losses in the Distribution system will be determined by measuring the energy imported by the customer (i.e. delivered energy). This energy, multiplied by the Distribution loss factor for the appropriate transaction voltage, will be the calculated energy losses in the Distribution system.

  i.e. Losses = Delivered energy x (Loss-factor - 1)

Since the WEPS rates are time-of-use differentiated, it stands to reason that these measurements and calculations have to follow the same time-of-use periods.

The cost of these losses will be charged at the regular WEPS energy rates.

Cost of Losses =
$\Sigma$ cost of $losses_t$ = $\Sigma$ $Losses_t$ x $P_t$

$\therefore$Cost of Losses =
$\Sigma$\{Delivered $Energy_t$ x (Loss factor -1)\} x $P_t$

where

t = the appropriate peak, standard or off peak time period and

$P_t$ = WEPS energy price for peak, standard or off peak time periods

- If the ALC customer both imports and exports energy (for example some seasonal non-Eskom generators), it should be determined which of these energy flows contribute to losses.
  - If only imports contribute to losses,exports should be ignored for the purpose of calculating the cost of losses (i.e. losses resulting from exports will be zero).
  - If only exports contribute to losses, imports should be ignored for the purpose of calculating the cost of losses (i.e. losses resulting from imports will be zero).
  - If both imports and exports contribute to losses, the absolute value of imports and exports should be added for the calculation of the cost of losses. (I.e. imports may not be subtracted from exports (or vice versa) to obtain a net value.)

*Cost of losses in the Transmission system and Reliability Services*

- The cost of losses in the Transmission system will be recovered on exactly the same basis as for Distribution losses, except that the appropriate Transmission loss factors will be used, as per the WEPS directive.

  i.e.: Total Losses = Delivered Energy x (Dx Loss Factor x Tx Loss Factor - 1)

  The same time-of use differentiated formula used for Distribution would be used to calculate the cost of transmission losses.
- Distribution purchase reliability services (RS) from Transmission at MTS level, based on the energy flow at that level. To recover this cost from embedded ALC customers, the measured additional energy at the customer's POD will be increased by the loss percentage for the applicable transaction voltage. The cost of reliability services will be equal to the reliability services rate (in WEPS) multiplied by the energy and increased for losses.

  RS Cost = Delivered Additional Energy x Dx Loss Factor x RS Rate

  For the purpose of this charge, only the additional energy delivered to the customer will be considered (i.e. exports to Eskom will be ignored).

**Levies**

*Electrification levy*

- ALC customers purchasing additional energy at WEPS rates need to continue their fair contribution to the cross-subsidisation of electrification customers. These customers will therefore be subject to a volumetric c/kWh levy to cover this cost. The levy will be determined by Eskom Distribution Group Finance.
- Unless and until otherwise directed by the NER, energy wheeled from a non-Eskom generator (i.e. energy exported into the Eskom system) will not be subject to this levy.

*Rural network cross-subsidisation*

- ALC customers purchasing additional energy at WEPS rates need to continue their fair contribution to the cross-subsidisation of rural customers.

  These customers will therefore be subject to a volumetric (c/kWh) rural network cross-subsidation levy at the same average rate applied to Eskom Distribution's regular customers.
- Unless and until otherwise directed by the NER, energy wheeled from a non-Eskom generator (i.e. energy exported into the Eskom system) will not be subject to this levy.

**Billing**

Customers' bills shall, in addition to the usual billing components for NNL, have the following additional components.

- Dx network services charge for long-term firm network capacity and based on RC minus NNL.
- Tx network charge for long-term firm network capacity and based on RC minus NNL.
- Generation standby charge for long term firm generation reserve capacity
- Charge for short-term generation reserve (only when the ancillary and reliability services market is introduced)
- Active energy charge for energy sold in excess of NNL, at WEPS rates, plus retail mark-up.
- Cost of losses on Transmission and Distribution systems
- Electrification and Rural Levy on additional energy
- Reliability services charge
- Reactive energy charge billed as follows:
  - Where the customer's normal load is supplied on Megaflex, the reactive energy payment shall be calculated on total reactive energy supply, exactly as for any other Megaflex customer.
  - Where the customer's normal load is supplied on RTP, the reactive energy payment shall be calculated exactly as for Megaflex.
  - Where the customer's normal load is supplied on Nightsave, billing for reactive energy is more complex and shall be done as follows:

    i. No reactive energy charge is applicable to those half-hours where the actual demand was less than NNL or during off-peak periods.

    ii. Determine the active and reactive energy for every half-hour where the actual load exceeded the NNL.

    iii. Apportion the reactive energy to (a) normal load and (b) energy in excess of NNL in the same ratio as active energy.

    iv. The reactive energy in excess of 30% of active energy of the excess energy component is accumulated for every half-hour to derive the monthly total.

**Proposed charges for 2003**

All prices quoted in this notice are in 2003 Rand value and exclusive of VAT.

*Network services charges*

The following network services charges (in the Rand value as indicated) will be applicable during 2003. These rates will escalate annually at Eskom's average annual price increase, until the rates are superseded by new rates, calculated on a later version of the cost of supply study.

- Dx Network Services Charges
  Refer to Table 1
- Dx Loss Factors
  Refer to Table 2
- Transmission Network Charges (TxNC) and loss factors
  Refer to Table 3
- Transmission Connection Charges (TxCC)
  These charges are still bundled with the network charges.
  Refer to Table 4.

*Other charges and values*

Refer to Table 5.

*Dx energy purchase price for 2003 (WEPS reates)*

Refer to Table 6.

*Standby charges for generation reserve*

This charge is currently set at R2,50 per kW per month, but may be revised by the NER as the multi-market competitive energy market unfolds. Δ

# An overview of the Norwegian regulation and tariff system

by Lisbeth Anita Vingås, Norwegian Water Resources and Energy Directorate (NVE)

**The Norwegian Electricity market is organized with the Ministry of Petroleum and Energy as the highest authority. NVE is a directorate directly under this ministry. NVE is the regulation authority in Norway. Most of the regulation is done in the department for Energy and Regulation.**

The departments area of responsibility includes mapping of energy resources, administer power systems planning, technical and economic analyses, monitor and ensure that network companies construct and operate power networks efficiently, economic regulation of network companies, regulation of the tariff structure and to ensures that the energy market functions as efficiently as possible.

## Backround on Norway

Norway is a small country with only 4,5 million people. Norway is a widespread country where climate, topography and demography vary a lot throughout the country. This of course influences the costs for the network companies that are operating in the different parts of the country. Norwegian production is 99 % hydro power. Norway has interconnections with thermal-power system in neighbouring countries. Norway has around 600 power stations. Several generators own more than one power station. The capacity of these power stations is around 27 500 MW.

Before 1990 we had a central regulation in Norway with political determined energy prices. In January 1991 Norway got a new Energy Act. With this Act came unbundling of supply and transmission/distribution and supply was opened for competition. All customers have since that day had access to a competitive market where they can choose among several suppliers. All customers are free to negotiate bilateral physical contracts. But trades in the futures market is increasing rapidly.

From 1991-1996 we had a cost plus regulation. All costs where covered and we had a fixed rate of return on capital. From 1997 Norway have had an income cap regulation which I will come back to in greater detail later in this paper. Norway has around 200 network companies. Public ownership is dominant, and many of these utilities is still vertically integrated, meaning that they own both production and network.

Only 20 % of production is private.

## Legal framework in the Norwegian regulatory system

- Energy Act (1991)
- Regulations – level 1: given out by the ministry of petroleum and energy.
- Regulations – level 2: given out by NVE (Norwegian Water Resources and Energy Directorate) as the regulating authority. These regulations are the most detailed. These can be found on our web-site: www.nve.no press English/energy regulations

NVE have issued several regulations under the Energy Act:

- Financial and technical reporting, income-cap and tariffs
- Metering and settlement
- System responsibility (new)
- Rationing (new)
- Quality of supply (start 2005)
- Safety and contingency (planned)
- Energy - and power system planning (planned)

## The Norwegian electricity market

As mentioned, in Norway we have had unbundling of supply and transmission/distribution since 1990. The tariffs are set completely independent of trading agreements.

When you buy electric energy in Norway you pay for two products. You pay an energy price for the energy that you want, to the supplier of your choice. You pay a tariff for transmission/distribution to the network company that have a monopoly in the area where you live. If you change to another supplier you will still pay the same price for transmission/distribution to the monopolist in your area. Tariffs are non-transaction based, and as mentioned completely independent of trading agreements. NVE as the regulator only regulate the tariff – the price paid for transmission/distribution. The energy price is decided where demand equals supply in a competitive market.

The cost structure in the network is what we in economic theory characterize as a natural monopoly. The short definition of a natural monopoly connected to a transmission/distribution network is that this is a cost structure where the average cost will fall as more units (kWh) is transferred through the network (high fixed costs and increasing returns to scale). A monopolist can take the price he wants for his products if he is not regulated, and this is the main reason why NVE regulate the network companies. The main objective for NVE as a regulator is to:

- regulate the network as a "natural monopoly".
- promote competition in generation and supply.

## Income cap regulation

As mentioned we have practiced income cap regulation in Norway since 1997. NVE regulate the network company by giving them an income cap every year that says how much income the company can have from their network activities. NVE also set a maximum and minimum rate of return.

The income cap is set based on data from economic and technical reporting that the lincensees are obligated to do to NVE each year. All licensees have to submit annual financial and technical data to NVE and Statistics Norway (SSB). The reporting is to be separated on segment/activities. The reports have to be validated by the companies' CPA, and be in accordance with the companies' annual reports. The licensees are required by the Energy Act to provide separate information concerning the monopoly activities in their annual reports. The economic and technical reporting has been internet based since 2000, and the program for this reporting, which costs should be reported and how, has been developed by NVE. NVE has collected financial and technical data from the licensees since 1993. Until 2000 reporting we have used Access database, floppy-disk or CD "runtime" version, e-mail, etc. for transfer.

One regulation period is for five years. This period is from 2002-2006. The income cap for this period is set based on average operating costs in the years 1996-1999, average technical losses 1996-1999, depreciation in 1999 and the income cap also includes a reasonable rate of return on capital for the network companies. Annual updates are done according to inflation, efficiency, value of technical losses, increase in energy demand nationally and new connections.

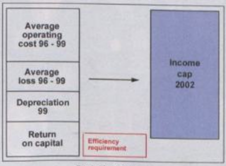


Fig. 1: The income cap


where's Wally?!
who's who at the
AMEU

An efficiency requirement is set for each network company. The requirement consists of a general component of 1,5 % which all companies get and an individual component that can be vary from 0 - 5,2 %. So the total requirement can vary from 1,5 % to 6,7 %. The requirements are set based on an efficiency analysis called Data Envelopment Analysis. (DEA) The companies' efficiency is measured by how near the company are the companies that is 100% efficient.

We find the companies efficiency potential and by giving them an efficiency requirement we force them to bring in 50% of their potential during the regulation period of five years. If a company for instance is measured to be 90% efficient, their potential is 10% and we want them to bring in 5% during the current regulation period. It means that this company get an efficiency requirement on 2,5% (1,5% general and 1% individual).

If the network company is more efficient than the requirement set for them, they are allowed to increase their profit. If the company is less efficient than their requirement – profits will decrease.

If a network company has higher income one year than the income cap, regulations state that the company is obligated to pay this excess income back to the customers through lower tariffs the following years. If the company has a deficit income, the company can cover this through higher tariffs the following year. NVE annually determine the company's excess/deficit income through individual decisions (legal).

## Regulation of the tariff structure

As already mentioned NVE as the regulation authority sets the allowed level of revenue for the network companies. Than NVE regulate the tariff structure. NVE does not set the tariffs. Through legal regulations NVE set rules/guidelines that the network companies have to stay within when working out tariffs for their network area.

The network companies themselves are than responsible for working out tariffs for their area that is not in variance with the rules in the regulation.

NVE does not approve tariffs. There are around 200 network companies in Norway that all have different tariffs for different voltage levels, customer groups and so on. We do not have the capacity to approve each tariff. We do however each year control that the income for each network company does not exceed their income cap.

NVE also handle disputed concerning tariffs. If an end user, another network company, generator or someone else have a complaint on a tariff; NVE is given the authority to handle such disputed. If NVE find that the network company in question is practicing tariffs that are in variance with the rules in the regulation, NVE has the authority to impose that company to change their tariffs.

The main principles for the tariffs:

- tariffs are referred to connection points. Paying a price in one connection point gives excess to the entire interconnected network and all sub systems including low voltage.
- tariffs should give signals of efficient use and development of the network
- tariffs shall give non-discriminated access to the power market
- tariffs shall be independent of power purchase contracts
- tariffs shall give the network companies income to cover their permitted income cap

The Norwegian network has three network levels.

- Central grid (420 kV – 132 kV)
- Regional network (132 kV – 30 kV)
- Distribution network (22 kV and below)

The customers connected to the Central grid are power intensive industry, aluminium works, wood processing industry and more. End users in the Regional network are mainly larger industrial customers. 50 % of production is connected to this level. Most end users are connected to the Distribution network as well as 40 % of production. The tariff for taking out energy will increase with decreasing voltage level.

The main objective for regulation of the tariff structure in Norway is to achieve economic efficient prices. The optimal price for use of the electric network will be a price equal to the value of marginal losses (technical) in the network plus costs of constraint measure at any node in the network system. With increasing returns to scale, marginal cost pricing will not cover all production costs.

A pragmatic way of solving this problem is to introduce a tariff that consists of several components; one covering the value of marginal losses and other components (fixed components, load components) that will ensure cost recovery for the network owners. As fare as possible these "other components" are to be neutral, meaning that they should not give price signals that will influence the use of the network in the short run.

As already mentioned tariffs are independent of power purchase contracts, so the costs associated with the use of the network do not depend upon the physical distance between the parties involved in commercial power trading.

The costs are solely dependent on how much power the individual generators and end users put in or take out of the network at any time. Tariffs are paid in both entry and exit points.

Tariff structure in general consists of an energy component (øre/kWh) whose main purpose is to cover the cost of marginal losses (technical). For voltage above 22 kV the energy component is point related. This means that the marginal losses are calculated in each connection point. The network companies are using their own load flow models for finding these losses. The losses are to be symmetrical around zero, meaning that if the value of losses is 2 øre/kWh to take out energy in one point; you get paid 2 øre/kWh to feed into this point of connection.

In the central grid the loss factors for each node is calculated up front for an eight week period multiplied with the system price (energy price) and volume hour by hour. For voltage lower than 22 kV the most common is to use average technical losses plus 2 øre to find the marginal losses.

The energy component is also to be time differentiated. For voltage < 22 kV the differentiation is to as a minimum reflect the differences in marginal losses between summer and winter. For voltage > 22 kV time differentiation of losses should be winter day, winter night/weekend and summer.

Other components are different for generators and customers taking out energy from the network. Generators in addition to the energy component pay a component which is based on average annual production. Most common is an average of the last ten years. "Other components" for generators are to be the same (structure and level) for all network (voltage) levels.

Regulation says that Central grid shall serve as a reference. When Statnett as the Central grid operator, has worked out this component in their tariff for generators, the other network companies has to adopt this component for their networks.

"Other components" for customers taking out energy from the network will be different for different network levels. These components can consist of:

- fixed component (kr/year)
- Load component (kr/kW)
- Capacity component (øre/kWh)

The most common is to practice a fixed component and an energy component for residential customers, cabins (cottage) and small commercial customers, while a load component together with the energy component is more commonly used for industrial customers.

Load components are based on customer's maximum load in defined hours/periods. Hours for those customers that is measured hour by hour. In Norway the network companies are obligated to have hourly metering of customers that use more than

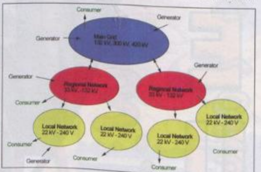


Fig. 2

400 000 kWh/year (100 000 kWh/year from 1. January 2005).

The capacity component mentioned is a component that the companies can use to balance the need between transmission and capacity in the network.

This component can be used when the need for transmission oversees the capacity in the network.

**Connection charges – one time payments**

In Norway we also have to kinds of connection charges. Investment contribution is the most common connection charge used in Norway. The reason is mainly that an investment contribution is a source of income that is partly in addition to the income cap.

The network companies in Norway may calculate and charge an investment contribution to cover the cost of connecting new customers to the network and/or reinforcing the network for already existing customers. The network companies are not obligated to charge an investment contribution.

They decide themselves if they want to charge an Investment Contribution, and also if they want to charge 100 % of the installation/investment costs or less.

The network owners are however entitled to cost recovery, so if the cost of connection is not covered through the Investment Contribution or the Connection Fee it can be covered through the general tariff.

An Investment Contribution must be charged based on objective and non-discriminatory conditions. In general this means that if a network company charges a new connection 100 % Investment Contribution, this shall apply for all similar connections.

The other connection charge that is practiced in Norway is what we call a Connection Fee. Connection Fee is a source of income for the network companies within the income cap.

This means that the network companies have relatively smaller incentives to use a connection fee than an Investment Contribution, because charging a Connection Fee will not influence their income. Using the Connection Fee will in principle only influence the allocation of costs between the customers in the network.

The Connection Fee will not give any location signals.

Regulations say that the connection fee can be differentiated after fuse size. Customers will than be charged a higher Connection Fee for choosing higher fuse size.

This gives an incentive for a new customer to think through how large a fuse size is necessary in his/her case.

Especially environmental organisations in Norway have argued that a Connection Fee differentiated after fuse size can give an incentive for consumers to consider alternative energy sources. Δ

# State-of-the-art time-of-use metering issues

by Dr. R Billiet, Strike Technologies

**This paper discusses some issues encountered with time-of-use metering and more notably the world wide phenomenon of the convergence of Information Technology (IT) and metering equipment. We will conclude that higher data speeds are possible than what is currently used in Time-of-Use (TOU) meters and by implementing this, one can get maximum use of the meter and new possibilities are opened.**

I will first of all discuss some of the current and potential uses of TOU meters. The current data speeds will then be discussed and then we will look at the potential benefits of using a very high data transfer rate.

## Time-of-use meters current and some future possibilities

*Current applications*

TOU meters are mostly used to perform more or less complex billing and load profile functions. The company which I represent also has a quality-of-supply feature built in to the NRS 048(A) specifications. It is still quite normal to send a meter reader to these meters armed with a paper note book. Reading billing information is kind of feasible provided the number of registers is not too big. Reading load profile information implies the use of a Hand Held Unit or a laptop computer. The risks and complexities of using these can be considerable.

More and more companies and utilities resort to automatic meter reading (AMR). In this respect, I note Drakenstein Municipality who is busy upgrading their meters to cellular enabled meters and Vaal Reefs Goldmine who has taken this step already successfully. Slow data speed however implies a relatively higher cost in reading these meters as well as the potential risk of data corruption over the transmission medium due to the long transmission times required.

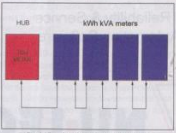


*Fig 1: Simple meters pulsing to "HUB"*

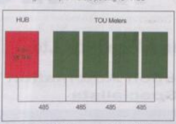


*Fig. 2: RS485 Meters connected to "HUB"*

*Some future possibilities of TOU meter functions*

Given the state-of-the-art of the current micro-processors, digital signal processor (DSP) chips and the emergence of low cost bulk memory, we can anticipate more uses for the TOU meter. As the meter is connected to the relevant voltage and current transformers any way, we can contemplate the following uses of the meter:

- Remote monitoring of instantaneous voltages, currents, frequency, apparent power, real power, reactive power, power factor
- The full spectrum of quality-of-supply information, inclusive of harmonics and flicker statistics
- Energy management features
- Network analysis
- Statistical metering
- Measurement of power outages and reconnection times
- The meter as a transducer using pulse outputs, mA loops and RS 232 and RS 485 serial links
- Control via the meter of over or under voltage, over or under current, etc. for reporting purposes or to be fed into a PLC via an Ethernet link

The above propositions each operate in a different time domain. For example, energy management typically requires a 1 - 3 minute response whereas the instantaneous voltages, etc. are required on a second or sub-second refresh time. Profile data may be required on a shift or daily time span. Billing is only needed on a monthly basis! These various uses are entirely feasible in a meter provided one can access, deploy and utilize this information in a timeous manner

*The meter as a "Hub" concept*

So far, we have been looking at the TOU meter as a stand alone unit. In many cases, notably in industrial settings, we can see many meters in close proximity. This opens up the concept of a metering "hub". Some examples will clarify this as shown in Figs. 1, 2, 3 and 4.

*Implications*

All these various meter combinations and permutations, combined with all the data as discussed above and noting that data may need to be combined from the various meters such as the synchronous peaks and synchronous profiles including combined currents and energy management parameters, poses a huge data transfer requirement.

The current specification for the IEC 62056-21 draft states under 5.2 (p. 33) states:

"Initial baud rate - 300 (only required for the optical head communications. Fixed port communications can initiate at the operating baud rate)

Standard baud rates - 300, 600, 1200, 2400, 4800, 9600, 19200

Special baud rate - as desired"

In view of the above discussion, we will have to operate in the "special baud rate" range in order to transmit this potentially huge amount of data and processed data. How is the meter coping with such a high data transfer rate and is it feasible?

## Solutions

*The meter infrastructure solution*

The meters can be equipped with dedicated expansion modules to provide for inter alia:

- RS 232 serial links point-to-point communication and these days short end multi-drop as well
- RS 485 serial links daisy-chained communications
- GSM communications
- GPRS communications
- Via an Ethernet connection onto a LAN or WAN
- Radio links
- Internet enablement of the meter (see Fig. 5)
- "Blue tooth" environment
- Satellite links (future)

All these methods are well understood and can be implemented forthwith.

*The world infrastructure solution*

GSM, GPRS, Ethernet and satellites (although the latter is expensive) are available in more and more places and the

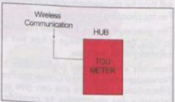


*Fig. 3: HUB with wireless communication*

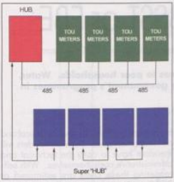

*Fig. 4: Simple and low cost meters pulsing to the "hub"*

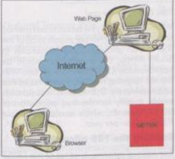

*Fig. 5: Internet enablement of the meter*

benefit of their increased availability is a massive cost reduction. Indeed, the increased level of these services makes now possible the new applications as we have contemplated above. There is an emerging synergistic relationship in that the decreasing costs open new possibilities which in turn generate adequate profits for the operators of these services.

The prerequisites are that guaranteed connectability and very high baud rates are available at affordable cost AND that the traffic thus generated is returning an adequate profit for the service providers.

*Some benefits*

Various benefits emerge from this scenario:

- The meter hub cluster can perform all the various meter functions in a location
- Lower cost of data acquisition as no "traditional" meter readers are required
- Metering bureaus can read and bill plants
- Specialists can monitor plants remotely
- The various parameters thus generated can be read, interpreted and used by the relevant user i.e. the billing can be sent directly to the billing computer, the profile data can be read by the energy engineer, the instantaneous data can be fed into a PLC
- The users can be geographically separated, i.e. the mine manager can look at one set of data while the consulting engineer in London is interested in a different bundle of information
- Low cost data acquisition and access to data that is normally not easily available to a particular user
- World wide billing becomes possible across borders
- Web enablement does away with all sorts of special software in cases such as viewing billing data, as the standard web browser could be sufficient to access the data specialist requirements would still necessitate proprietary software
- Data of various regional or global plants can be combined in a seamless way
- Energy management can be undertaken on a regional, national or even global scale with this infrastructure

## Conclusions

The emergence of economical high speed links provided by the world infrastructure opens up totally new opportunities in TOU metering. The possibilities and advantages will increase with the data speed. Metering of this kind can now combine all types of metering functions that were not easily possible before. The "hub" concept can further increase the viability of this paradigm

The condition is that these meters are equipped with high speed data links in order to make the huge amounts of data available to the relevant end-users in a timeous manner. The current IEC proposal on data speed will have to be seen in this light. Our company has taken cognizance of world trends in technological development and is working towards offering cost effective solutions that will make many of these possibilities a reality in the foreseeable future, to the ultimate benefit for the end user. Δ

# Implementation of the EBSST or FBE

by Danie Potgieter, manager: electrical services, Polokwane Municipality, and SALGA representative on EBSST task team

**In 2000 Government announced a policy intent to provide free basic services to poor households. Water, sanitation and energy were identified as basic services to be supported by government's programmes in respect of poor households.**

## Background

An EBSST Task Team was established by the Department of Minerals and Energy (DME) in February 2001 to formulate policy guidelines for the free allocation of a basic amount of electricity to poor households.

On 5 December 2002, Cabinet approved the following principles of a national policy:

- The free allocation of electricity to qualifying households is set at 50 kWh per month;
- Recipients of the free allocation are to be identified by means of "self-targeting";
- Funds will be provided in the fiscus to pay for the operating cost of the free allocation.

The EBSST policy guideline document which was developed by the Task Team, was published in the Government Gazette no 25088 of 4 July 2003 (notice 1693 of 2003).

## Implementation guidelines

Main issues influencing the implementation of the free basic electricity allocation to poor households were:

- Level of the FBE allocation
- Identification of recipients of the allocation
- Cost implications of such an allocation
- Sustainable source of funding

## Level of free electricity allocation

Grid connected poor households should receive an allocation 50 kWh per month.

Motivation:

- Of 6,8 million households in South Africa connected to the national grid, 3,1 million live in rural areas of which 56 % consume on average less than 50 kWh per month.
- 50 kWh per month is adequate for lighting, media access and basic water heating and ironing. Not sufficient for cooking and refrigeration, however.
- 50 kWh has achieved widespread political and community acceptance.

*Non-grid households will receive* a subsidy of up to 80 % of the monthly service fee, which is currently R58 i.e. 80 % of R58 = R46,40

## Identification of recipients

*Broad based approach*

With this method of identification all legal connected households would receive a subsidy.

This approach would ensure that the allocation reaches all the poor. However, to provide 50 kWh per month to all households in South Africa, would cost approximately R1,4-billion per annum.

*Targeted approach*

An alternative to the broad based approach would be to target the poor households in South Africa, thus supporting poverty alleviation.

Most municipalities, however, would not have resources to identify indigent households and monitor this status. Eskom definitely would not have such resources either. It was therefore deemed more practical for the indigent to identify themselves by means of one of the following two self-targeting methods.

*Self-targeting with current-limiting*

A 10 A current limited supply.

A household wishing to receive the 50 kWh per month free allocation would apply to the Service Provider to restrict the supply to 10 A. Consumption in excess of 50 kWh per month would have to be paid for at the normal domestic tariff.

This is the ideal method for prepayment meters (Eskom's preference). The inconvenience of 10 A restriction will deter the non-poor customer to take advantage of the allocation, which is meant for the poor only.

*Self-targeting without current limiting*

This method involves households using on average, less than a pre-determined amount of electricity (up to 150 kWh) per month applying for the free basic electricity allocation.

This method is ideal for conventional credit meters and will probably be more suitable for implementation by municipal electricity distributors.

To deter non-indigent customers from receiving or applying for the allocation, a municipality can introduce a special tariff for qualifying EBSST customers. The tariff for these customers for each unit above the free allocation would be greater than the normal domestic tariff with the breakeven point occurring at the level of consumption used for identifying the indigent (say 125 kWh per month). Consumption in excess of this level would cost more, which factor should deter misusing of the EBSST. The tariff graph in Fig 1. explains it better.

## Cost of free basic electricity allocation

Cost of the programme can be separated into:

- Technical and administration cost
- Free basic energy cost

*Technical and administration cost*

In terms of the gazetted guidelines, Service Providers may receive limited capital support subject to the availability of capital grant. We are all aware that no capital support has been made available to cover technical and administration costs. Service Providers will therefore have to carry the technical and administrative costs themselves. With self-targeting these costs are estimated at R200-million compared to about R600-million, had the broad-based approach been followed.

*Free basic energy cost*

When implementing the broad-based method of allocating 50 kWh per month to all of the 6,8 million grid-electrified households in South Africa, the energy cost would be approximately R1,4-million per annum. With the self-targeting method, it is estimated that approximately 2,5-million households would qualify for the free allocation of 50 kWh/month, which would cost about R525-million per year.

## Funding the FBE allocation

For various reasons, funding of the EBSST will be funded through the national budget

- The Department of Provincial and Local Government (DPLG) shall be responsible for the EBSST funding through a conditional grant allocation from the fiscus to Service Authorities (municipalities). Such funds shall be disbursed to the Service Providers.
- The 2003/04 conditional grant for the EBSST was R300-million which leaves a shortage of about R225-million if the full 50 kWh per month allocation were to be implemented and funded from the conditional grant only. (R300-million will only cover 30 kWh per month).
- The equitable share to municipalities has risen this year with 12,2 % in real terms, and also includes a Free Basic Services Grant of R822-million.
- Municipalities will have to respond to Government's request for full implementation of the EBSST (50 kWh per month) by funding the shortfall from their own resources or from the Free Basic Services Grant which they received this year.

## Service delivery agreement between service authorities and service providers

Section 8 of the Division of Revenue Act (DORA) deals with transfers to entities.

Funds from the Fiscus for municipal services may only be provided to relevant municipalities. Municipalities, in turn, transfer funds to public entities, such as Eskom, where the entities render a service on behalf of municipalities.

The public entity must not later than 30 June 2003, or such other date determined by

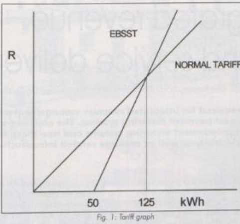


*Fig. 1: Tariff graph*

National Treasury (NT), certify to NT that it complies as an external mechanism as contemplated in Chapter 8 of the Municipal Systems Act (MSA). NT has extended the deadline to 30 September 2003. When a municipality provides a municipal service through an external mechanism (public entity), the municipality must enter into a service delivery agreement with such an entity (Section 76 of the MSA).

A pro-forma service delivery (funding) agreement which was drawn up by DPLG, have been supplied to all municipalities which can be used as a basis for municipalities to draw up their own agreements.

Paragraph 6 of the pro-forma agreement requires Service Authorities to compensate Service Providers for the actual cost of providing the free basic electricity. It is suggested that the paragraph be amended to make provision for the payment of the actual cost to provide the FBE or for the loss of income (forgone revenue) from the selling of 50 kWh to the now, recipients of the FBE, whichever is the smallest. (In most instances the cost of supplying electricity to a low consumption customer is more than the income received from such customers. The FBE allocation is surely not meant to balance Service Providers' books).

### Reporting in terms of Division of Revenue Act (DORA)

The National Treasury can delay or withhold installments of equitable share on the grounds of a municipality's breach of uniform treasury norms and standards. A public entity that provides a municipal service on behalf of a municipality, must report to that municipality, on a monthly basis in order to access funds for the service rendered. Municipalities must report their spending of funds in terms of the Quarterly Reporting Framework. The quarterly report consists of seven sections which require details of the municipality, the Service Providers, the recipients of the free basic services and financial information.

### Communication

Government departments DME, DPLG and NT held provincial workshops to inform Provincial departments and municipalities about the administrative requirements to implement the EBSST.

Municipalities together with Service Providers must take it on themselves to inform the wider community about the free basic electricity. The community have great expectations about the EBSST and they will have to be informed who will qualify to receive the free allocation and in particular how they will have to identify themselves for the allocation. Service Providers on the other hand will have to inform qualifying customers about the process to be followed to be registered as a qualifying customer.

### Roll out of EBSST

Roll out of the EBSST was discussed at a meeting of ministers of DPLG and DME, MECs for Local Government and District and Metropolitan Mayors, on 16 July 2003.

At the meeting it was resolved that:

- The roll out of free basic electricity in the whole of South Africa, should be done by 30 September 2003.
- Municipalities be urged to supply 50 kWh per month (even though the conditional equitable grant for free basic electricity is not enough)
- The self-targeting approach be followed to identify qualifying households to receive the FBE.

### Conclusion

- Free basic electricity is a social service and is funded from the fiscus;
- The focus on FBE is to the poor;
- Implementation of the FBE is a multi-stakeholder engagement process;
- No cross-subsidation for the FBE is envisaged from the EDI, (which would have been in conflict with provisions of the Electricity Act).
- There will be a need for establishment of performance, monitoring and evaluation instruments to be put in place.
- Although there will be teething problems initially, the successful implementation of the EBSST is accepted by the EDI as a challenge. Δ

# Towards integrated revenue management and service delivery

by J Groenewald, Actaris Metering Systems, studying under Prof. DG Kourie, School of Information Technology, University of Pretoria

**The paper will discuss the conceptual data model required for integrated revenue management and service delivery within the domain of prepayment as well as post payment metering systems. The objective of the paper is to create an awareness of different generations of prepayment metering systems and how these address the reality of the environment in which we sell electricity as well as manage related infrastructure.**

The need for integrated revenue management and service delivery will briefly be re-iterated, however previous papers presented at AMEU Conventions have motivated this. Finally the paper will propose a conceptual data model that can be used to benchmark existing metering systems and assist the utility in procuring or developing future metering systems. This paper forms part of a mini dissertation for the School of IT, University of Pretoria. The mini dissertation will cover this subject in greater detail, which was omitted from this paper.

## Introduction to a metering system

In South Africa water and electricity is supplied to end-users by utilities. These utilities are either government owned or regulated by government bodies, and should deliver these services in accordance with national legislation. The Municipal Systems Act, the Constitution and other forms of legislation prescribe the standard of service to be delivered as well as rights of the utility to receive payment for such services. The term service delivery will be used to refer to a utility delivering water, electricity as well as other services to end-users. Other services include the removal of sewage and household refuge and the levy of taxes to provide and maintain municipal infrastructure such as roads, public open space etc.

The term, revenue management will be used to refer to the process of collecting revenue for the services provided. In order to manage service delivery and revenue management, the utility requires a metering system of some sort. This metering system must be:

- an inventory of all points of delivery (POD), associated metering devices, addresses, tariffs and end-users, and
- keep and be able to report on the transactions generated between the utility and its end-users.

The conventional method of metering resource consumption is by using a metering device that is read once per billing cycle. The tariff for the specific POD is then applied to the consumption and a bill is generated and sent to the end-user for payment. This is referred to as a post-payment metering system.

In the South African environment there is also a very large component of prepayment metering devices. The principle here is that the end-user has a resource-dispensing device rather than a conventional meter installed at the POD, and needs to first pay the utility in order to obtain credit on the metering device. The advantage of prepayment over post-payment metering systems is an improved cash flow for the utility as well as negating the need for meter reading and credit control actions for non-payment. The disadvantage however is that the prepayment metering device requires more intense meter management as well as purchase pattern analysis in order to identify possible cases of tampering.

In the South African environment both post- and prepayment metering devices are used and metering systems must be capable of facilitating both types. This is often achieved by integrating existing billing systems with the prepayment metering systems. The level of integration varies, however the aim is always to at least achieve integrated management information reporting.

## The reality of our metering environment

In South Africa the metering environment refers to metered points of service delivery, with the services delivered mainly consisting of electricity and water that are used as resources. A previous section has provided an introduction to utilities in South Africa and how they measure the resources consumed by consumers. In the ideal world the concept of a metered resource makes perfect sense and billing the client for consumed resources seems elementary. However, should the client not pay the bill or tamper with the installation at the resource consuming location (RCL) one would expect that credit control policies and procedures will solve the problem. For a resource such as airtime on a cell phone, one expects to be simply cut off from the network if payment has not been made. In the case of water and electricity, the situation is somewhat more complex.

*Reality of the South African metering environment: Macro-level*

In order to understand the reality of the South African metering environment, it is necessary to look at aspects that affect the metering environment on a macro-, meso- and micro level. The delivery of basic water and electricity services is politically driven in South Africa and every South African is considered to have a right to basic access of these resources.

Gaunt [15] explained how this, more complex situation regarding service delivery came about for electricity and it can be applied for water as well. According to Gaunt electricity started off as being a resource driven by industry, i.e. industry had the economic need to have access to electricity. With time the need became expanded to business in general and it became a necessity to have access to electricity in order to function efficiently as a business. Access to electricity then became a socio-economic driven resource where private legal entities wanted to have access to electricity to better their lifestyle. Ultimately electricity became a political driven resource where it was seen as a basic service that every legal entity in South Africa is entitled to. The fact that certain legal entities cannot afford electricity lead to the Electricity Basic Service Support Tariff (EBSST) which imply that households that cannot afford access to electricity will receive a certain amount of free electricity per month.

The fact that electricity (and water) became a politically driven resource implies that credit control procedures are not as simple as denying access to the service in the case of non-payment. The problem of non-payment was then addressed in 1990 by the introduction of the one-way prepayment meter. It was believed that if the consumer will buy electricity upfront and that an electricity-dispensing device will then dispense the resource only when credit is available on the device.

These devices were installed in great numbers and Eskom alone has installed over 2,9-million of these one-way prepayment meters in South Africa to date. The reality that struck the metering industry was that this technology alone was not the answer to non-payment of services, as meter installations were tampered with to get unmetered access to the distribution network. The issue of non-payment required a management intervention rather than a technology intervention. Today one will find that well managed metering systems have management procedures in place that monitor the purchase patterns of one-way prepayment meters in order to detect possible cases of tamper. This is followed up by field inspections to determine why a particular point of delivery is not purchasing electricity according to its historic purchase pattern.

If one would then look at conventional and one-way prepayment meters, one would find that there are two primary aspects to these meter installations that need to be managed. In both conventional and one-way prepayment meter installations one needs to manage the revenue derived from the installation as well as the delivery of the actual service.

*Reality of the South African metering environment: Meso-level*

South African utilities are currently undergoing a restructuring process, which is prescribed by the Municipal Systems Act (2000). There are many debates on this subject that will not be discussed here. The effect, however, is that restructuring has had an impact on the delivery of services that is significant to metering systems in utilities. The lack of proper knowledge management and skills transfer has led to the loss of expertise of people who are no longer in the service of utilities. This has left a void in the people domain of our system that is still in the process of being improved. Unfortunately the wheel of service delivery cannot be stopped to accommodate these changes and it is feared that integrity of metering system data may suffer from this.

The introduction of prepayment meters in 1990 has introduced with it prepayment vending systems. The existing billing systems of utilities were not equipped to vend prepayment tokens and stand-alone vending systems entered the metering system. The entire meter configuration database is most of the time totally separate from the billing system. This segregation of revenue systems introduced a challenge to utilities when it came to revenue management and service delivery. Billing systems in South African utilities are also not equipped to address the need for service delivery. A billing system is typically account driven and aims to generate a bill that can be delivered to a legal entity responsible for paying it. One would find that in most cases a legal entity's postal address is properly captured on billing systems, but that the physical address of the point of delivery is absent or not adequate for service delivery.

In order to deliver an effective service one needs to be able to locate the point of delivery for various reasons such as meter reading, installation inspection, maintenance etc. One would find that in most utilities the revenue management of a metering system is administered by the treasury department and service delivery by the engineering department and that communication or data flow between the two departments is not what it should or can be. The billing system is also procured and managed by the treasury department and has little to offer the engineering department in terms of meter management and other service delivery functionality. The engineering department may try and fill this void with an array of meter management systems that range from 'Oom Piet and his bakkie' addressing random maintenance calls to more sophisticated metering systems that integrate with billing systems.

One may ask if enterprise resource planning (ERP) systems will not bridge this gap. However, on the one hand, the reality is that only a select few utilities in South Africa can afford the luxury of such systems. On the other hand, these systems may lack the required functionality. In addition to the problem of fragmented systems there is also a lack of data warehousing on metering systems. This is necessary to not only benchmark the integrity of the data, but also to produce good quality information to management that should influence decision-making.

*Reality of the South African metering environment: Micro-level*

In South Africa there is a wide variety of points of distribution in the water and electricity distribution networks. These range from very large consumers that require specialised metering devices to measure consumption and demand to informal housing in rural areas. The challenges posed by our metering environment on the micro-level relates to the variations of addressing systems used for meter installations. One may find that the conventional street address will get you to a formalised part of a city or town, but that the same addressing specification is totally inadequate in informal housing areas and rural areas such as farms.

Brand [9] has identified five different addressing specifications pertaining to a point of delivery (POD) or resource consuming locations (RCL).

- The Surveyor General's (SG) number for a registered parcel of land, also called a cadastre. The definition of this number does not necessarily point to a single polygon in South Africa. However in most cases it will be sufficient to locate an RCL in a formal residential development.
- The 'city planner's' reference number. This is in effect a portion of the SG number and is referred to as the stand, plot or erf number. The reason why this is significant is because the treasury department will most of the time try and keep an accurate record of this number. The SG number is 21 digits long and cumbersome to work with whereas the stand number is only 5 digits long. Together with the stand number there is also a sub division number that is used to identify farm portions. Because this number is not unique one also needs to specify the area in which the RCL is in order to locate it.
- Street reference system. This refers to the conventional street name and number system that will lead one to an RCL in formal areas. For central business districts it is necessary to include building name and unit number as well in order to get to a specific RCL.
- Coordinate reference system. In rural areas as well as informal developments, stand numbers and street addresses are frequently unavailable or differ from official records. In these areas it may be necessary to locate a RCL by its global coordinate and a global positioning system (GPS) is used to record and navigate to a RCL.
- The POD addressing system is an addition to that of the RCL. Consider a farm where the entrance to the farm is two kilometres away from the actual meter installation. The address reference for the farm or RCL is inadequate to locate the POD. In these cases a POD address note is added to the RCL address that may lead one "past the main house 2 km down to the pump at the river" where the POD is situated. It may also be a GPS coordinate that pinpoints the position of the POD.

From the above it is clear that the variety of addressing systems have to be catered for in the service delivery domain. Operators of billing systems are not equipped to capture such data at the point of application for a service and without proper work flow management the installation contractor will not pass the correct addressing data back to the billing system for capture – that is if the billing system is equipped to accept 'out of the ordinary' addressing references.

## The data elements required for a conceptual data model

It is also important to note that for this supply area there will normally be a one to one relationship between cadastre, RCL and POD of a certain type such as water or electricity. In other words if one would try to locate the electricity meter for example, it would be possible to only give the cadastre as reference and there would be no ambiguity as to where the RCL or the POD would be. Should there have been more that one RCL or house on a single cadastre, this would not be possible – one would then need to specify which RCL was being referenced.

Consider a typical informal housing development. In South Africa there are many of these housing developments and although every effort has been made to ensure that each house or RCL is situated on a single cadastre with proper street names and numbers in place, this has simply not happen as planned. The reality of these housing developments is that stand numbers are used as 'house numbers' and that street names are different to official records. If street names exist they are also not well signposted and hence the street reference system does not work for these developments. In these areas, it is more feasible to use the 'city planner's' reference system, i.e. stand number and area. In some informal housing developments, the procedure of subdividing the cadastre or land parcel on which the houses are situated has been skipped. In this case one would find that the relationship of cadastre to RCL is one to many. It is then also impossible to use the 'city planner's' reference system since all RCLs are situated on the same stand. It would be more feasible to use the GPS coordinate reference system in these areas.

Consider a typical business district supply area. In a business district one typically finds a single cadastre with one or more buildings build on it. In these buildings there are several RCLs each with their own POD in the case of electricity. For water the utilities normally take a more sane approach of having a single water POD for each cadastre. This is a policy decision that probably evolved out of practical supply considerations. The fact is that this policy saves the utilities from endless problems regarding the configuration data, meter reading, billing and revenue collection.

The business district has the tendency to change as businesses close down and new ones take their place – shops are divided and consolidated according to the need of the tenant and the electricity PODs normally change with them. A good policy would be to install a POD for the building and let the landlord sort out sub accounting in conjunction with rent. Although further discussion on this proposal falls beyond the scope of this paper it would also make an interesting research topic: to determine how much operational cost is being spent by utilities in order to accommodate these frequent changes as well as to indirectly administer the electricity accounts of buildings on behalf of landlords. In a business district one would also find a many to one relationship between cadastre and RCL. The fact that building names exist and that different units have numbers allows one to use the street addressing system as long as the building name and unit number are also specified. Consider a typical rural supply area where the RCL and POD are normally situated on a farm. There might be more than one RCL on a farm and thus a many to one relationship exists between cadastre and RCL. For a farm area it not always possible to specify the road name and there are no road (or street) numbers. Thus the street addressing system will not suffice for RCLs that are situated on farms. There are two options: either use the cadastre reference system or use the coordinate reference system.

If one looks at the size of the farm and cadastre then it makes sense to address the POD separately from the RCL in this case. Consider the POD that is situated at the dairy on the farm, but the house or RCL is quite some distance away from it. If one were to use the coordinate reference system for the RCL then the coordinate should indicate the point of entry to the RCL and a second coordinate should be used to indicate the POD. Let us now consider which data elements would be required to manage revenue as well as service delivery in these environments. As already mentioned in previous sections, one would require the following data elements:

- POD or point of delivery
- RCL or resource consuming location
- Cadastre or registered land parcel
- Legal entity
- Agreement
- Tariff

In addition to the above one would also need to be able to identify what happens to a metering device when it is not installed at an RCL. If these metering devices are merely removed and not managed they are bound to get lost. The concept of a location for a meter is necessary and the policy that accompanies it would require that a meter always has a location.

The meter arrives at the utility from the supplier and if faulty can be sent back and forth. From the utility store the meter is issued to an installation contractor who installs the meter at an RCL. Hopefully the meter stays at this location for most of its lifespan. However, if necessary, a maintenance contractor is authorized to remove it from its location and return it to the utility store. If the meter is found to be destroyed or broken beyond repair it should be legally disposed of and moved to the disposal location. The above basic data model allows for efficient meter life cycle tracking. Note that all locations can be specified as such in the data model and that each location will have an associated legal entity that is responsible for the meters. This also allows the engineer to effectively track the meter and ultimately constitutes the basis for service delivery.

## The proposed conceptual data model

The previous section explained what data elements should be present in the conceptual data model. It is now necessary to show the relationships that should exist between these.

Fig. 1 shows the proposed conceptual data model for integrated revenue management and service delivery. In the proposed conceptual data model there are a few new data elements that are secondary to the cadastre, RCL, POD, Meter, Agreement and Legal Entity (called the 'primary elements' and indicated in yellow). These are Tariff, Debt, Store Location, Utility and Area. The secondary elements are there to complete the model in terms of revenue management and service delivery.

The model can be applied to accommodate the reality of the South African metering systems. The model can live within a single metering system or can be the collection of data that is situated in various systems – as long as the relationships shown exist. At this point it is important to consider that the above model exists to some degree in most billing and vending systems. The problem however is that some of the data elements and their attributes are contained in a single table that requires some normalisation in order to have the relationships as indicated.

Take for instance the concepts of a meter, POD and RCL. It is very easy to house these elements within the same table. That will however imply that a one to one relationship only can exist between these elements. In the next section the concept of data normalisation will be touched on and the development of the data model will also be discussed in this context. The paper has a certain bias to prepayment metering systems.

The reason for being biased to the prepayment metering systems is simple: Prepayment metering devices entered the market more or less ten years ago and brought with them the segregation of vending systems from utility billing systems.

It is in this domain particularly where integration is considered a necessity rather than a luxury (Brand [9]).

## Applying the data model

The conceptual data model as depicted in Fig. 1 can be applied as a foundation for the integration of revenue management and service delivery. The model does not intend to be prescriptive in that all integrated systems should have the same data structure. It rather serves as an example of a model that will be able to cater for modelling the reality of the metering environment and enable decision makers to view information holistically.

The level of integration may vary. At a very basic level of integration a utility might decide to keep existing systems in place and only integrate at a data warehouse level. What would be important in this case is to consider the data captured on various systems and how this could be linked on a central data warehouse. The warehouse then serves to provide a holistic view of the metering environment modelled by the entire collection of systems. Decision-making will be based on the warehoused data.

On the other hand a utility might decide to procure or develop a metering system that caters for service delivery and revenue management on a single platform. ERP systems endeavour to achieve this. The advantage of this approach is that the operational data is situated on a single platform and data validation can take place at the time when operators enter such data.

If this type of system is developed properly the operational data can be very good and would probably require little 'cleaning' for warehousing. The disadvantage of this approach is that older systems are becoming redundant and people need to be trained according to the new system. This results into a costly exercise that many of the smaller utilities might not be able to afford. Between the above two extremes of integration there exists also an intermediate approach where existing systems are not replaced entirely, but rather integrated and adopted to fulfil the same objectives as the conceptual data model from Fig. 1. There are examples of such endeavours available in the South African market. The advantage of this approach is that existing systems are largely retained and little training is required.

The disadvantage of this approach is that the owners of different systems may not be willing to integrate and that the responsibility for the overall success does not reside with a single service provider. If one would consider this route for integration it would be to the utility's advantage to appoint one service provider to take responsibility for the integration process. This way one could reduce the burden of managing the integration process. The result of integration of service delivery and revenue management can hold many advantages for the utility. The most important aspect of integration however is to be able to make decisions that can positively influences the delivery of services to the community. In order to deliver a better service the utility needs to be able to fund new projects and maintenance to existing infrastructure.

It is difficult to say what is the most important ingredient for success - is it the quality of service delivery that motivates people to pay their bills on time or is it the revenue protection processes that ensure that the utility has a steady stream of income? This question leaves us with a 'chicken and egg' situation, however what is

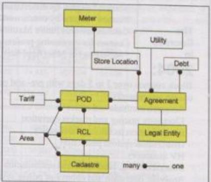


*Fig. 1: Conceptual data model for integrated revenue managment and service delivery*

sure is the fact that to measure is to know and if you know what is really going on you have a better chance of making the important decisions that can positively influence the overall health of the metering system.

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# Implications of economic and social objectives for electrification

by Prof. C T Gaunt, Department of Electrical Engineering, University of Cape Town

**Electrification is an electrical engineering activity. The electrification networks are planned, designed, built and operated by electrical engineers and electricity distribution utilities. Traditionally the utilities have conservative management, so it is reasonably expected that the investments in electrification have been carefully assessed.**

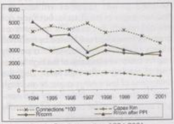


*Fig. 1: Cost/connection: 1994-2001*

However, other authorities, including national and local government and international development agencies, also have some responsibilities for electrification. All have their own goals and priorities for social and economic development, resulting in multiple objectives for implementing electrification. These multiple objectives often confuse the policies, perceptions and optimisation of electrification. This paper introduces a concept of electrification for purely social objectives. It shows the concept is not widely recognised. Instead, most decisions about electrification are based on models that assume electrification contributes to economic and socio-economic development. The novel model of social electrification leads to the adoption of decisions different from those taken in most conventional electrification.

The paper is based current research into electrification that includes technological, financial, institutional and ethical aspects.

## Historical electrification in South Africa

"Electricity-for-All" started in 1990, but electrification in South Africa started a hundred years earlier. Electrification started for economic reasons, to reduce the costs of mining, related industries and the railways. The convenience of electricity for lighting induced the municipalities to adopt it for public and private supplies, and the government recognised the importance of controlling and owning this economic function. For 80 years, economics drove electrification. Socio-economic electrification developed in South Africa during the 1970s and 1980s when, spurred by political pressures, Escom (which became Eskom in 1987) extended subsidised supplies to rural areas. Even so, many farms were too far from the grid to be able to afford supplies at the high costs associated with the technologies and tariffs then in use.

Several new townships near the cities, built during the 1980s to house the influx of people from rural areas, emphasised the issue of whether electricity should and could be supplied to poor families. In many cases where electricity was available, expensive technical standards, uneconomic tariffs and bad debt made distribution unviable.

A business strategy process in the late 1980s identified the possibility of deriving significant socio-economic benefit from a national electrification programme. The "Electricity-for-All" programme commenced at the same time that South Africa started going through political change from apartheid to a broadly democratic government. Targets defined by the National Electrification Forum were adopted by the new government as the National Electrification Programme in 1994.

The achievements of the "Electricity-for-All" and National Electrification Programmes are shown in Tables 1 and 2. The urban areas served by the municipalities were already substantially electrified, with approximately 1,8-million domestic customers, before the programmes started. However, Eskom had fewer than 112 000 domestic customers in 1990 [1], so was responsible for the greater share of new electrification. The overall extent of electrification was increased from about 36 % of households in 1990 to 67 % in 2000. The new connections planned and implemented by utilities have reduced since the electrification targets were reached at the end of 1999. As a result, with growing population, urbanisation and the construction of new houses, the percentage electrification nationally and in some regions has fallen since the highest figure reached in 1999.

Some have envisaged complete electrification by 2012: "Government committed itself to funding both grid and non-grid connections at the average rate of R3000 per connection for 300 000 connections per year from 2001 to 2005, and 250 000 connections per year from 2006 to 2010. However, recent budgetary allocations indicate that these targets will not be met" [3]. Even when given access to electricity, it became evident that many people were too poor to benefit substantially from it, and the voter appeal of promising free services was recognised. Proposals for "poverty" tariffs and promises of free electricity indicate another reason for electrification, neither economic nor socio-economic, but the social objectives of poverty alleviation and political support.

Three different objectives can be identified then for the electrification in South Africa: initially economic, later socio-economic and recently social. Usually, different "solutions" are needed to reach different objectives.

## The (un)viability of electrification

The viability of economically driven electrification is a simple business case, typically based on financial models of net present value or internal rate of return.

The analysis of electrification for socio-economic development is widely researched and reported. Despite differences in details, it is generally assumed that electrification supports development by contributing to improved education and health and the services that bring customers into the formal economy through improved production. Extensive literature shows that organisation structures, tariffs and technology have been developed on the basis that they should support the identified socio-economic objectives. However, the projects do not always meet all the objectives expected of electrification because, possibly, those various objectives are not differentiated.

| | 1991 | 1992 | 1993 | 1994 |
|---|---|---|---|---|
| Eskom | 31 035 | 145 522 | 208 801 | 254 383 |
| Local government and other | 51 435 | 74 335 | 107 034 | 164 635 |
| Total | 82 470 | 219 857 | 315 835 | 418 918 |

*Table 1: Yearly domestic connections of Electricity-for-All programme [2]*

| | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | Total |
|---|---|---|---|---|---|---|---|
| Eskom | 250 000 | 300 000 | 300 000 | 300 000 | 300 000 | 300 000 | 1 750 000 |
| Other | 100 000 | 100 000 | 150 000 | 150 000 | 150 000 | 150 000 | 800 000 |
| Total target | 350 000 | 400 000 | 450 000 | 450 000 | 450 000 | 450 000 | 2 550 000 |
| Achieved | 418 918 | 478 767 | 453 995 | 499 391 | 427 426 | 443 290 | 2 669 345 |
| [Derived from Eskom Annual Report, 1995, and NER reports, 1996-2001] | | | | | | | |

*Table 2: Household connection targets of the NEP in 1994, and achievements*

There is little published evidence of electrification undertaken for purely social reasons, that is, with the primary objective of poverty alleviation. However, the concept that social development or poverty alleviation can be a driver for electrification is demonstrated by the electrification progress and decision-making in Southern Africa. The cost of electrification has been high. South Africa has spent over R10-billion on new connections in the past ten years. The capital investment in distribution exceeded the investment in power stations and transmission in the same period. Completing universal access to electricity in South Africa (in accordance with government policy) will cost another R7-billion. Energy generation and systems operations and maintenance after construction are also costly, such that building and operating distribution networks typically represents about a third of the cost of energy supply in most electricity distribution tariffs. By these measures, the electrification investment plus the future commitment in South Africa may be valued at about R60-billion over 20 years. How viable is this investment?

An evaluation of the NEP [4] found electrification in low-income areas was not financially viable. Economic analysis indicated the investment is marginal, but probably understates welfare and multiplier benefits.

The Deputy Minister of Minerals and Energy has stated: "It is evident that successful household electrification has largely happened in the urban areas and a few of the more densely populated rural areas where the cost per service point is comparatively low. Consequently most rural areas today still lag far behind, while experience shows that the economics of electricity supply to those customers become progressively more adverse as more remote areas are targeted" [5]. According to the National Electricity Regulator: "The new challenge in electrification for South Africa in the next couple of years is to address the effective electrification of rural areas in a sustainable manner" [6].

## Technology change to meet the challenge

A change from the early approach of simply meeting numerical targets for connections was largely driven by recognition of the high costs of the existing standards and methods, comparisons between the utilities and a growing realisation that costs might not be recovered. The remarkable achievements of the national electrification in South Africa from 1991 virtually doubled the number of domestic customers in 10 years. The electrification was characterised by a continuous and substantial change of technological standards. The changes included innovative research and development, including the greater application of single-phase instead of the traditional three-phase distribution, the adoption of new technologies in line design and feeder conductor selection, the broad application of prepayment metering, and revised industry standards and implementation procedures.

The development may be viewed as an engineering approach to problem solving. As the targets changed, so the staff of the electricity distribution industry responded with more suitable technology, bringing down the cost/connection as illustrated in Fig. 1.

The scale of the change was such that it challenges several conventional ideas of electrification. It was generally accepted that capital investment costs per customer in rural electrification are high, but the evidence indicates that appropriately planned rural systems may be no more expensive than urban systems. The national average costs per connection for urban and rural electrification in 1995 and 2001 are shown in Table 3. The average cost of urban electrification appears to have increased by about 15 % in current terms but decreased by 20 % after allowing for inflation (PPI). At the same time, the average cost of rural electrification decreased by 40 % in current terms and a massive 70 % after inflation. The savings were achieved by adopting designs that match the network technology and capacity to the needs of the customers. Designs are based on information about customers' needs derived from an extensive load research project in which several AMEU members participate.

| National average cost/connection (Rand current) | Year 1995 | Year 2001 |
|---|---|---|
| Urban | 2170 | 2674 |
| Rural | 3568 | 2622 |
| Derived from NER reports | | |

*Table 3: Average cost per connection, 1995 and 2001*

Technology improvement is not unique to South Africa. Its importance in the context of this electrification is that it was stimulated by an awareness of costs that was symptomatic of new needs in distribution and electrification, even if the nature of the change was not clearly understood. The technological achievements of the electrification programme also created opportunities to extend further the benefits of electrification.

The financial constraints and customer needs that forced down the costs of electrification also challenge the standards, technologies and approaches to non-grid electrification so widely supported by some development assistance agencies. The National Research Foundation reported recently: "Over a third of the population is still not connected to Eskom's power grid and the cost of doing so seems prohibitive. Renewable energies, particularly solar power, offer viable, sustainable solutions." [7]. However, the costs of PV solutions appear to still be much more expensive than grid-supplied energy, as shown in Table 4.

It appears that PV systems are only viable:

- where comparisons of the costs of renewable systems are made against high costs of grid electrification, distorted by high energy capacity and possibly inefficient procedures,
- with aid support and aid subsidies, or where conventional electricity utilities fail, and
- when the authority and financial power of government officials dominates individual choice by customers with limited means.

In Southern Africa, the large pit-head power stations using low grade coal, and the large hydro stations with the capacity to regulate the uneven seasonal water flow have economies of scale that are not yet matched by small electricity generating technologies. Technology might have the potential to develop future renewable energy and isolated power supplies without the disadvantages of small scale, but this is not yet achieved. Because PV systems as presently conceived are limited by the small energy available, they represent a poverty trap for customers because of the high further cost of moving to the next level. Until the limitations of low energy capacity and high costs change, renewable energy and non-grid supplies must be considered generally irrelevant to large scale electrification.

## An ethical basis

Analysis of the ethics supporting electrification has identified religious obligations to help the needy, a philosophical principle of giving equal consideration to the interests of all, and political or pragmatic reasons to help the poor. From all perspectives, electrification to alleviate poverty is justifiable and even desirable.

The world does not lack the resources for social development and poverty alleviation through electrification, but the mechanisms for using the resources are insufficient. African countries, particularly, do not have a good reputation for efficiency and integrity. Financiers need to be confident that the institutions can identify suitable objectives, and use funds and technology effectively, without resource waste and benefit leakage through corruption and inefficiency. There is still a need and a role for aid and subsidies for social electrification, but they must be assessed in terms of the objectives and management.

Economic and financial studies are inappropriate for assessing social development plans because of the long term of the development and the difficulty of expressing the benefits in economic values. Instead, a social model leads to a specification for a social tariff:

*A social tariff will be one in which a subsidy reduces the cost to customers of a fully cost-reflective tariff, including the profits of a*

| | International data | | South African data | |
|---|---|---|---|---|
| | PV | Light grid | PV | Grid |
| Investment cost | US$750 | Not given | R5900 each | R2541/customer + R2000 for capacity |
| Energy delivery (kWh/year) | 100 | 1000 | 100 | 1000 |
| Investment cost/kWh/year | US$7.5 | US$1.9 | R60 | R4.60 |

*Table 4: Investment costs of PV and grid related to energy capacity [8]*

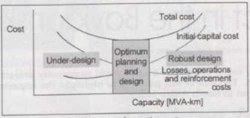


Fig. 2: Variation of cost with capacity

*privatised utility. The subsidy will not be so large as to damage the economy and will be derived from a source that can sustain it. Geographic uniformity will promote perceptions of fair pricing, but the subsidised tariff may be restricted in terms of the service provided. However, a social tariff should be substantial enough to make a difference in respect of the purpose for which it is intended, and must not put the beneficiaries into a poverty trap that restricts them to a limited benefit. Of course, the benefits should reach a clearly identified group of beneficiaries (the target group), with as little as possible leakage to those outside the group. A simple tariff structure will assist understanding and reduce the costs of implementing the tariff.*

Recent research into a subsidy of electricity consumption for poor customers in South Africa produced a novel self-targeted tariff consistent with the specification [8].

## Implications

Technological, financial, social and tariff subsidy analysis lead to conclusions that

- Social benefits cannot be delivered to households that have not been connected. Blanket electrification is appropriate to social electrification, rather than restricting supply to those customers that can best afford it. Also, a basic electricity support tariff cannot help the 30% of South African households not yet electrified. They comprise mostly poor households and consumption subsidies must be accompanied by continued expenditure on electrification.
- A specific institutional structure is relatively unimportant to success in electrification, as long as a few basic requirements are met, including having a clear understanding of objectives that are realistic, and a technological core that can meet the needs to develop and maintain networks at minimum cost. It also appears that efforts and expenditure on restructuring may not show much benefit in the long run, and in the short term could damage the efforts for electrification. Learning organisations are more effective than specific structures. Further, there may be significant value in having or retaining diversity of utility structures and sizes.
- Electricity utilities have been widely used for socio-economic and social interventions, and in developing countries this is not an unexpected role for them. However, social responsibilities complicate the utilities' more obvious goals of delivering electricity efficiently and profitably. Having established national policy, government must accept the utilities' objectives and activities. Similarly, utilities must understand that electricity supply cannot be separated from politics.
- In an electricity distribution system supplying economic customers, loss of supply arising from rationing or black-outs caused by under-design will be costly. An electrification system implemented for social objectives will have a lower penalty associated with under-design. Obviously, the optimum capacity is that which is just right, as illustrated in Fig. 2, but under-design will be preferred to over-design where the costs of under-performance are relatively low. Minimum cost solutions are needed for socially directed electrification.

## Conclusions

All the decision-makers in the process of electrification need to be aware of the differences between economic, socio-economic and social objectives. Their understanding of electrification shapes the objectives, plans, and evaluations of achievements.

Non-technical people need to understand the contributions that different technologies can make to meeting their objectives, and technical people need to be aware that different outcomes are required in different circumstances, and that the technologies must be correctly selected and applied.

The benefits initially expected of electrification investment in South Africa are unlikely to be achieved quickly, because they were expressed in terms of economic and socio-economic objectives.

However, substantial benefits are derived from the electrification programme through its contribution to social and poverty alleviation objectives.

Hindsight indicates that the confusion of objectives prevented the optimum systems being implemented at the start of the programme, but financial constraints and changes in development thinking have led to the adoption of more appropriate technologies and processes. In future, the planning, approval, implementation and post-project evaluation is more likely to be appropriate if the objectives are identified correctly.

Also, differentiating between economic and social objectives suggests an approach to defining subsidies needed from government to support non-profitable electrification, and instead of defining the boundaries of six regional distributors to obscure the differences between viable and non-viable electricity supply, an industry structure compatible with strategies of efficiency and effectiveness might be adopted.

Electricity in Africa will continue to have both economic and social impacts. Understanding the differences, and applying them to electrification, electricity tariffs and the electricity distribution industry, should contribute to better decision-making and greater effectiveness.

Research to inform these processes and improve electricity distribution will continue.

## Acknowledgements

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# Inspiration project in the Baviaanskloof

by A van der Walt, technical director, Kwezi V3 Engineers

**This paper highlights some of the technical and social aspects of a small rural community project completed during 2002 in the Baviaanskloof (Eastern Cape). The aim of this paper is to highlight the importance of rural electrification in South Africa today.**

The missionary settlement of Zaaimanshoek originally developed around a missionary church and school. It is approximately 70 km from the nearest small town namely Willowmore where the Baviaans Municipality is situated. The Baviaans Municipality incorporated the Zaaimanshoek area into their municipal area after the 2000 restructuring of local government boundaries and is now responsible for providing basic services to the community.

There are approximately 40 informal houses built around the formal church and school building. The houses are mostly constructed of a reed and clay combination with only a few brick and zinc units. No formal roads are laid out in the area but distinctive vehicle tracks have been established over the years. Only recently have pit latrines been installed through a provincially funded project and running water will be installed in the near future. Pumping of water is now made possible by the presence of electricity in the area.

## The Project - Technical

The project was awarded to the lowest tender, namely Adenco Construction, after an open tender process.

The scope of the project included electrification of the following:

- 1 school hall
- 1 office - principle
- 6 classrooms
- 42 house connections
- 10 street lights
- 1 pump station supply point

In addition to the above a vending machine had to be installed on site in order to facilitate the sale of electricity. This facility is managed by Baviaans Municipality and is serviced weekly.

*Design*

In terms of the design the following were applicable:

MV/Bulk:

- a new 5 km 11 kV spur line was built by Eskom
- single transformer 100 kVA located centrally
- bulk metering for the account of Baviaans Municipality

*LV/Reticulation*

- ADMD = 2 kVA
- Standard pre-payment metering and ready board on steel back plate
- Overhead bundle conductor
- Airdac overhead connections
- Connections limited to 20 A

*Buildings*

- Class rooms, office and hall equipped with single tube 5 foot fluorescent fittings
- Class rooms, office and hall equipped with single socket outlet
- Single central prepayment meter point for school

*Street lighting*

- 70 W HPS IP66 fittings - back entry on 250 mm long spigot clamped directly onto the pole
- Not separately metered
- Supplied from central control box at bulk supply point

The design is therefor very basic and robust in order to minimize operating and maintenance costs.

## The Project - Social Impact

In terms of the large number of electrification projects undertaken nation wide yearly this project is truly insignificant in terms of extent. The value of a project like this is however that it highlights the significance that projects like this have on the quality of life of people. From the start I realized that this was a very special project. The first day that I visited the site I was amazed at the genuine nature of the people living there. As I entered the first class room, where a teacher was busy teaching approximately 20 pupils, the whole class jumped up and said "Goeie môre Meneer!". The anticipation and anxiousness of the people to get access to electricity was tremendous. With each site visit one could see how people are gearing up for the day they will be 'empowered'. A very poor community that led fairly uncomplicated lives would no longer be the 'left behind' but they will become equals to the town people with appliances such as fridges, plug-in stoves and even TVs (courtesy of a sender maintained by Baviaans Municipality).

## Handing over concert

As one would expect from a respectable contractor (and consultant) at the end of a project there should be a braai or a social event of some sort - but not in Zaaimanshoek. Here a proper ceremony with a concert and singing is hosted by the entire community, including dignitaries such as the mayor, municipal manager, pastor, school principal, police captain, community leaders and yes the engineer and contractor. A show was hosted depicting the impact that electricity will have on the every day live of the community. The people sang and danced and praised God for the privilege that was bestowed onto them. The contractor made a remarked after the ceremony that this project was the most rewarding and extraordinary that he has ever done in his 20 years as a contractor. It is when one experience a project like this that the bigger picture of what we as the engineering fraternity can accomplish in lives of ordinary people truly stand out.

## Conclusion

The true essence of this project should be carried forward as an inspiration for all future projects that can make a difference to the lives of ordinary people. Yes, these small remote projects are very seldom profitable for the consulting engineer. Yes, these projects are difficult since one starts from scratch. Yes, these projects sometimes cause headaches due to unforeseen technical difficulties. However at the end of the day, we as the engineering fraternity should also realize our social responsibilities and take on these sometimes difficult projects. The contribution that we can have on the future of South Africa will surely be felt in years to come. Great leaders such as Nelson Mandela have risen from the rural parts of our country and we should not underestimate the value of small development projects such as this in these remote areas. Δ

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# Energy efficient lighting for social development

by Barry Bredenkamp, marketing manager, Bonesa

**In the run-up to the 2000 local government elections in South Africa, President Thabo Mbeki announced that all residential consumers would be entitled to 50 kWh of electricity and 6000 kilolitres of water "free of charge" on a monthly basis. The aim of this rebate was to assist in poverty relief, through the provision of free basic services.**

However, there has been a lot of media coverage relating to the implementation of these concessions, both negative and positive. The main problem and delay in implementing this initiative was the difficulty and costs relating to the systems required to be developed, in order to implement the EBSST[1] (commonly referred to as the "poverty tariff"), on a national scale, together with the fiscal implications on the service providers, both from an implementation and a "revenue loss" point-of-view.

A number of pilot programs were conducted in different parts of the country, to measure the impacts and to determine an optimum solution for implementing the EBSST in South Africa. Two of these sites, Zwelitsha and Dengwane in the Eastern Cape, were assigned to Bonesa, to determine the feasibility of opting for an efficient lighting - based solution to the problem, and to assess the social and developmental impacts associated with such a solution.

*Key objectives*

- Obtain feedback from residents as to whether or not the provision of energy-saving compact fluorescent lamps (CFLs) could serve as a suitable alternative (or partial implementation strategy), for "free electricity";
- Measure sustainability i.e. willingness of communities to participate, local pride in success, understanding of technology, long-term sustainability of technology including general maintenance, repair/replacement and manufacture of new products as a possible small business;
- Bonesa would need to test different solutions in at least two of the nodal areas i.e. integral vs. modular CFL options;
- Check on existing lighting technologies used ie. potential for additional retrofit opportunities through SMMEs;
- Identify, develop and train existing unemployed people within the villages for possible luminaire assembly, marketing and communications skills, and product distribution;
- Measure the impact of reduced demand on existing "overloaded" networks;
- Test the technical, economical and financial feasibility of "local assembly" of luminaires, by receiving the components in a kit form;
- Test the implementation of existing delivery mechanisms for this option, as well as the development of suitable control procedures required to maintain the system;
- Establish a protocol to possibly offset the $CO_2$ savings as part of a "carbon trading mechanism", with the appropriate stakeholders.

*Measurement*

- Measure load profiles with the present situation, including the peak coincidence factor of lighting on the overall load;
- Determine the demographics of the affected areas and develop algorithms to predict the load in similar areas;
- Both the above factors were tested before and after implementation.

### Bonesa and the Efficient Lighting Initiative (ELI)

The IFC/GEF Efficient Lighting Initiative (ELI) was a three year program supported by the International Finance Corporation (IFC) and funded by Eskom and the Global Environment Facility (GEF), to accelerate the penetration of energy-efficient lighting technologies into emerging markets in developing countries. South Africa was one of seven[2] developing countries taking part in the Efficient Lighting Initiative (ELI). The aim of the ELI was and still is to increase awareness of the features and benefits associated with efficient lighting, as well the impacts of global warming, the need for demand-side management interventions and the creation of jobs through this new-found opportunity in South Africa. The main thrust of the ELI however, is to promote access to, and the use of modern and quality efficient lighting technologies, such as the compact fluorescent lamp (CFL).

The potential exists in South Africa to replace some 31,5-million old-fashioned incandescent light bulbs with CFLs. This would cut the peak load on the national grid by 820 MW, which is almost equivalent to the peak load of a city the size of Cape Town. The ELI will thus not only reduce greenhouse gas emissions, but could also save[3] the country approximately R100-million in new generating plant. In essence, the ELI program is an electricity efficiency initiative, which is providing the economic thrust, drive and foresight to find solutions to link household energy initiatives with other development objectives. Bonesa, as local implementing agency in South Africa, was positioned to support the international vision, through implementing local educational, marketing and awareness and limited retrofit programs.

The key objectives of the overall ELI project are as follows:

- The lowering of household energy costs, thereby making more disposable income available, particularly to South Africa's previously disadvantaged population;
- The creation of employment and economic benefits arising from a robust, energy efficient lighting market; and
- The conservation and preservation of the environment, through the reduced demand for electricity during the peak consumption period, ie. between 18h00 and 22h00.

### Technology issues

The incandescent light bulb (the ordinary globe), is a remarkable device that has served us well for over 100 years. But it has three main drawbacks: it is inefficient; it doesn't last very long; and it is environmentally unfriendly.

Almost all the electricity a GLS globe uses is converted into heat rather than light, but a compact fluorescent lamp (CFL) gives out the same amount of light, using only 20% as much electricity, so that you can replace a 100 W globe with a 20 W CFL.

The filament in a globe melts and evaporates as it burns, and a globe burning three hours a night normally lasts about a year, whereas most CFLs are designed to last between six and fifteen years.

As its name implies, a CFL is a compact form of the common fluorescent tube. But it uses a sophisticated control circuit to give it the advantages of the fluorescent tube (efficiency and long life), without the conventional tube's two major drawbacks - the CFL does not flicker, and it produces an attractively coloured light, either cool white or a warm yellowish colour similar to a normal globe.

[1] EBSST refers to the Electricity Basic Support Services Tariff.
[2] The other participating contries are Argentina, Peru, the Czech Republic, Latvia, Hungary and the Phillipines.
[3] This figure was calculated as part of Eskom's overall Integrated Strategic Electricity Plan (ISEP).

A CFL initially costs more than a GLS globe, but increasing demand for CFLs is bringing the price down rapidly. A 100 W globe generally costs about R3, and over its one-year life (burning three hours a night), it uses in the region of R30 worth of electricity.

An equivalent 20 W CFL would retail at about R30, but while burning three hours a night, it uses only about R6 worth of electricity a year. The CFL thus generally pays for itself in just over a year. Over the next five or more years of its life, it saves hundreds of Rands in lamp replacement and electricity costs, not to mention the costs to the environment.

Even though CFLs are widely recognized as the major solution for reducing energy consumption for domestic lighting, most programs focus on easy to replace screw-based CFLs. Pin-based CFLs however, have the potential to offer a more sustainable solution - with less electronic waste, lower costs, and no risk of being replaced by incandescent lamps after lamp failure. Perhaps the most important advantage lies in the luminaire design - the typical characteristics of pin-based CFLs - form and light distribution - offer new possibilities in this respect.

*Why pin-based?*

Pin-based CFLs perform like the others in terms of energy saving, but have a separate ballast (the electronic part needed to produce light); this is no longer part of the light bulb, but incorporated into the fixture. This reduces the price of the lamp when the bulb must be discarded and replaced, since the ballast (which generally lasts three times as long), can be retained. In addition, pin-based fixtures will help to make the switch to fluorescent lamps irreversible.

Why are similar lighting initiatives worldwide and Eskom directly involved in fostering this new product? The explanation is quite simple: Eskom wants to set off a revolution that would lead to dramatically reduced residential electricity consumption in South Africa, over a 20-year planning horizon.

Lighting uses a large amount of electricity in low-income homes, and CFLs can reduce this by a factor of four. According to the European Commission Delight report "the switch from incandescent lights to CFLs is as revolutionary as was the switch from gas to electricity in domestic lighting 70 years ago. The role of suitable fixtures is of similar importance".

*A new South African standard?*

The creation of an innovative new product for this program could become a South African (or even international), standard. This is a big challenge that needs a joint commitment by manufacturers of luminaires and lamp components, designers, retailers and community members alike.

As we were introducing technology which might be relatively unknown to newly electrified consumers, various issues needed to be addressed before actual implementation, e.g. a comprehensive awareness and training campaign amongst the community-identified assemblers of the appropriate technologies needed to be launched.

It was therefore important that Bonesa held hands with the community during the pre-implementation stage, to give energy saving concepts additional credibility. Free hand-outs of CFLs and/or fixtures also score political points, from a poverty alleviation perspective. It was also stressed that CFLs are not an "inferior" light source but in fact, in many residential and commercial areas, they are regarded as being far superior to conventionally known and commonly used products ie. lamps and luminaires. CFLs are presently amongst the most advanced technologies available for domestic lighting worldwide, and the amount of light output emitted from an 11 W PL-lamp is equal to a 60 W incandescent lamp.

It was also important for a program of this nature, that the complete luminaire should be sourced locally and assembled at a community level

**Basic assumptions and international experiences**

After the commitments of the 1997 Kyoto climate change convention for the reduction of $CO_2$ emissions, the European Union estimated that in many countries a significant result could be obtained just by reducing the peak electricity demand caused by domestic lighting.

According to the EU Delight report (1998) on efficient domestic lighting in European countries, the total domestic lighting consumption currently accounts for 17% of all residential electricity use, and is expected to increase by the year 2020. However, several studies sponsored by the European Commission have shown that 43% of Europe's electricity consumption for residential lighting can be saved by the year 2020, simply by promoting technologies already on the market, such as CFLs.

The average number of light bulbs is 24 per household across the EU. Around 70% of these are incandescent, with the remaining 30% being fluorescent or halogen bulbs. Only 30% of European households currently have at least one CFL. By implementing this proposal, South Africa could become the trend setter in the use of this economical and efficient lighting technology.

However, barriers such as the high initial price and the consumers' lack of confidence in the long-term availability of this technology is still a problem. In South Africa, the fluctuating exhange rate is also a problem, since all the lamps are presently imported into the country.

According to the Delight research, only the promotion of well-designed fixtures that meet public tastes and overcome behavioural barriers can change the lighting market, favouring the introduction into the residential sector of pin-based CFLs, already largely used in the commercial market.

Although South Africa's greenhouse gas emissions are small compared to those of the major industrialised countries, perhaps we do also have a responsibility to lead by example in encouraging clean environmental practices on our continent, as this would not only cut greenhouse gas emissions, but would also save the country billions of rands in new generating plant. It would also send out a clear message to encourage foreign assistance in NEPAD[4].

**Pilot site implementation strategy**

*Background information*

The two villages Dengwane and Zwelitsha were electrified in 1997, as part of the Khoapa electrification project. The Khoapa electrification project consists of 1220 - 20 A prepayment connections. In order to avoid upsetting customers in the areas that may not reside specifically within Dengwane and Zwelitsha it was agreed that we would implement the pilot program in the total Khoapa electrification project, which is primarily constituted by these two villages, and which are supplied with electricity from the same network. Dengwane and Zwelitsha are situated in the Magadla Tribal Authority in the Eastern Cape, approximately 8 km from Matatiele on the main road, to Mt. Fletcher.

The communities of these villages are largely farmers, who apply a combination of traditional and commercial methods of farming. Land is often tilled year after year, with no period of rest allowed in between. Residents in these villages are engaging in primitive production activities of vegetable, poultry and pig production.

Through the environmental upgrading of schools by SEED[5], the youth in the area have already been brought on board regarding the importance of issues such as resource use and environmental concerns. This was further expanded by implementing the Bonesa/ELI Schools Curriculum at the five schools in the area.

This is a totally rural area, which has one major town in Matatiele. The people in this area are traditionally dependent on migratory labour ie. the men worked on the mines around Johannesburg, to send home money for their families. Some of the women also went to larger cities like Durban and Pietermaritzburg, in order to earn funds for the family. Now that the mines have begun to retrench their workers, we find that up to 65 % of the population are unemployed. This is one of the main contributing factors towards the poverty situation in this area.

*Existing infrastructure*

The villages are situated about 9 km from the nearest two Eskom vending stations, for purchasing prepayment electricity coupons. Residents have to use taxis and pay 2 x R3,50 =R7,00 to get to their vendor, i.e. return trip. A dirt road of about 7 km connects the villages with each other and telephones, electricity and other services are generally

[4] NEPAD is the New Partnership for Africa's Development, which is being spearheaded by South African President Thabo Mbeki.

[5] SEED is the Sustainable Energy and Evironment Development program, which is funded internationally.

available in the area. Running water is presently being addressed.

Firewood is very scarce and residents need to travel long distances, if they want to purchase this fuel source. Therefore, most households supplement grid electricity with paraffin and gas, for cooking and heating purposes. Eco-tourism is regarded as an area that could explicitly be developed in the area to facilitate job creation.

The natural surroundings in the area offer a panaromic view of the Maluti and Drakensberg mountain ranges and the high density snow experienced in the winters, often attracts tourists to the area.

*Job creation opportunities*

In an area with limited avenues for self-empowerment, the implementation of an efficient lighting-based solution to the EBSST, combined with the development of a marketing/communications, assembly and distribution infrastructure within the communities concerned, has contributed to a substantial and sustainable improvement in the existing economic activity in the area. With time, this could even be extended to provide an even more comprehensive lighting/ maintenance business, through the provision of a broader range of locally designed and produced luminaires that are representative of the culture of that particular community.

These could then be sold to local hardware stores, guest houses and tourists, to generate additional revenues. Households with more than two light points will also be able to purchase additional luminaires and lamps from these SMMEs.

*Training requirements*

It was important that the community leaders in the respective villages, identify potential unemployed candidates that could be trained to assemble, distribute and supervise the activities within those communities.

It was estimated that an initial quota of six people per village would be required to attend the official training for this purpose, i.e. 1 supervisor, 3 assemblers and 2 distributors.

We also identified one individual with some basic computer and communication skills, to facilitate the development of the marketing-activities in the area, as part of the Potlako franchise pilot study. An overall local project co-ordinator was also appointed to facilitate the project interaction between Bonesa and the community.

*Research requirements*

Lighting, primarily with incandescent bulbs and candles, are the major end users of energy in the poverty stricken rural areas of South Africa. The introduction of CFLs as a possible alternative to providing free basic electricity (50 kWh per month), could significantly reduce electricity consumption in these households and contribute to the objective of poverty alleviation.

Likewise, South Africa is facing increasing residential electricity demand, due to the intensive electrification drive over the last decade. In this market, lighting is considered to be the largest end-use of residential electricity, and this demand for electricity is virtually 100% co-incident with South Africa's peak demand ie. between 18h00 and 20h00.

Residential electricity consumption contributes significantly to the current demand patterns in South Africa and its share is increasing with the continuing electrification program in the country.

Future growth in residential electricity consumption will be due to the continued electrification program, construction of new RDP homes, and increased ownership of electrical appliances, such as televisions, kettles, irons, etc. At this stage (2002), about 60% of the South African population has been electrified, but that still leaves approximately 2 million homes and 100-million people without access to grid and off-grid electricity.

Since most of these connections are presently using standard inefficient incandescent (GLS) globes, this presents a unique opportunity for conversion to more efficient CFLs, which only use approximately 20% of the electricity needed to provide the same amount and increased quality of light.

Estimates of the savings possible from the current Efficient Lighting Initiative (ELI), are 820 MW of peak demand reduction, by the year 2019. This would involve the introduction of approximately 31,5-million CFLs into the South African residential market within the planning period.

The objective of the survey was therefore to verify the above assumptions and to estimate the electricity savings potential for both the consumer and the local authority/distributor/Eskom, in relation to the "free 50 kWh" promised by government, to all residential users of electricity. It was therefore imperative that the research contractor was successful in:

- Determining the consumption and demand savings for all parties;
- Wattage preferences for lighting and lighting fixtures (shades) used;
- Colour preferences for lighting, (cool or warm white);
- Type and hours of use of existing light sources, (candles, paraffin, electricity), etc.;
- Determine the existing number of light points per household and the potential lamps that possibly could be replaced with CFLs i.e. to determine the quantities of product that would need to be procured, to implement this pilot program;
- Current electricity tariffs, metering (prepayment and conventional), and non payment/illegal connections in the area;
- Appropriate methods of media/ product information dissemination in the area, eg. local radio, etc.

Using students for this exercise, assisted in reducing the costs and at the same time, provided them with much needed practical experience ie. capacity building.

The research methodology decided upon, provided results that covered the following six critical areas:

- General customer information ie. income, unemployment levels, average age and total population in the affected areas, etc.;
- A table showing current lighting equipment and useage patterns;
- A section on customer knowledge, attitudes (and understanding), of the Electricity Basic Support Services (EBSST), i.e. free basic services, as well as their knowledge and attitudes towards CFLs in general, as a possible alternative to EBSST;
- A table that covers other appliances that are used in the houses and their usage patterns, including other areas where disposable income is used e.g. Lotto tickets, cellphone cards, etc.;
- Use of dry-cell batteries for radio useage and the associated monthly costs;
- Present consumption levels and frequency, value and venue for purchasing prepayment electricity coupons/vouchers.

*Barriers*

The critical areas of the ELI-proposal that posed a potential threat to the full-scale successful implementation of the pilot programs, are as follows:

- Limited timing required to fast-track the entire program i.e. "rushing" the implementation of the pilot programs, resulting in insufficient timing necessary for detailled planning, stakeholder involvement, monitoring and verification activities;
- The timing for implementation of the program in these particular two areas, commenced immediately prior to the festive season holidays, which traditionally, is not a good time to introduce new technologies, etc;
- Community resistance, due to the limited number of people that can be accommodated in the "job-creation" component of the pilot program, whereas the unemployment levels are estimated to be far higher than the number of people that can be accommodated i.e. not all of the needy were able to benefit from this particular job-creation activity. The local councillors agreed to address this issue with the communities involved.

**Conclusions/ recommendations**

The plight of low-income households around the world displays some similar characteristics that transcend culture and geography. Among them are:

- a struggle to make hard choices between basic needs for services such as healthcare and food;

- decisions of which bills to pay when scarce unpredictable income materializes;
- a desperate need for someone to recognize that all of the individual problems of such households can often prove overwhelming, when experienced as a whole.

Most importantly, however, families in poverty share a common desire for self-sufficiency and empowerment, as full participants in the marketplace of choices.

Although we often presume to provide solutions to such problems, it does suggest that there is no single source of knowledge that exists regarding successful efforts to address low-income energy problems.

Developing countries have a chance to avoid serious mistakes that have been made in addressing such issues in the West, and they have the added opportunity to employ advanced technologies toward the seeking of solutions.

Simultaneously, the wealth of experience and lessons learned from countries with longer histories of attempts at addressing low-income energy issues, might reveal some ideas that can be equally valuable to emerging issues in developing nations.

Above all, the interchange of ideas must continue and expand.

Finally, there will always be a need for a safety net, as it is impossible to imagine a community where everyone has been permanently lifted into economic self-sufficiency.

-We are confident that the message of "energy efficiency" will be an exciting one in these market segments where services such as hot water and refrigeration are considered as luxuries.

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# Appliance energy efficiency labelling for electrical distributors

by Robert Henderson and Isak van Goss, TSI, Eskom Enterprises, and Andries Gildenhuys, DSM, Eskom

**Energy efficiency labelling is an internationally well known and tested tool to reduce the national energy consumption through making customers aware of the energy consumption of items like household appliances, cars and buildings. Energy efficiency labelling is part of the demand side management toolbox for an electricity distributor.**

Eskom's Demand Side Manager requested and supported the submission of an appliance-labelling programme. The key to this proposal is that it should lead to practical results and that it should support Eskom's DSM role-out plan. Several studies on appliance energy efficiency labelling have been funded in South Africa. The National Electrification Forum funded a task team on appliance labelling in 1991. DME has also funded studies in this respect.

There have been various "start-stop" initiatives on appliance labelling. In brief theses can be summarized as follows:

- National Electrification Forum (1991) recommended an appliance labelling programme.
- October 1993 "Energy efficiency labelling of domestic appliances" by Dr. Ernst Uken DUEE Proceedings
- September 1995 - DME initiated the "Development and negotiation of an energy efficiency (EE) labelling programme and awareness campaign for appropriate domestic energy appliances"
- January 1996 - TSI drafted "Objectives and work plan for appliance labelling" for Eskom residential demand-side management (RDSM)
- March 1996 - TSI submitted a summary to Eskom RDSM on "Appliance labelling for the market legend"
- June 1996 - a draft report on "Appliance energy labelling programme" was submitted to the DME and Eskom RDSM by Marbek Resource Consultants in association with the Energy and Development Research Centre (EDRC)
- June 2000 - Eskom RDSM and TSI approached the DTI in South Africa regarding appliance labelling in SA in order to obtain government support
- June 2000 - SABS called a working group meeting.
- July 2000 - Eskom RDSM and TSI approached the DME in South Africa regarding "appliance labelling in SA" in order to obtain government support
- September 2000 - TSI approached the Collaborative Labeling and Appliance Standards Program (CLASP) in order to assist in developing a "development and implementation programme for appliance labeling in South Africa"
- February 2002 Eskom DSM requests TSI to undertake a study on appliance labeling
- Year 2002 Eskom DSM request TSI to provide a status report on appliance labeling in South Africa.

In 1994 the topic of appliance labelling was raised in the residential demand side management (RDSM) section of Eskom and Electrotek (now Energy Efficiency Services EES) was contracted to make some proposals and test selected appliances. Some of this work is included in the MARBEK report (final report April 1997) commissioned by the Department of Mineral and Energy where the late Mike Smoog of EES was acknowledged. The situation has not changed and the findings show that the energy efficiency label will reduce energy used by these household appliances. The standards used for the performance of many appliances are the same as when this study was carried out. However, many standards have been split into a compulsory safety standard and a voluntary performance standard. There is generally a lack of enforcing the performance standard as most purchasers are buying on initial price. The safety standards are based on the IEC document and have been over printed by the SABS. The SABS have a safety mark that is similar to the CE mark of safety. The performance of the appliances is not required to be tested and only informed consumers will call for this mark when purchasing appliances.

The research up to date has been academic to a major extent and has not been results orientated. It would appear that there is a need to review appliance labelling research and the implementation thereof in South Africa. A workable appliance energy efficiency-labelling programme is required.

Contact was also made with the American Council for an energy efficiency economy (ACEEE) and CLASP (Collaborative Labelling an Appliance Standards Programme). CLASP requested further information about the work plan in South Africa and we will keep them informed of the progress. Contact was also made to the European Community Energy Efficient Economy (ECEEE) and the New South Wales energy labelling system in Australia.

## The international experience

The review of international experience reveals, that labelling programmes need to be in place for the long term, in order to affect long term changes required in the market, particularly with regard to:

- having consumers move from a general programme awareness to an understanding of the information being provided on the labels, and
- ensuring ongoing commitment and participation from appliance manufacturers and distributors.

Two key factors were found to be necessary to ensure sustainable and effective labelling initiatives:

- legislative support to mandate labelling, and
- stakeholder consultation.

Appliance labelling programmes were initially designed to facilitate a comparison by consumers of the energy performance of products. Today appliance-labelling programmes have two goals: product comparison, and product endorsement. Product endorsement is determined on the basis of fixed energy performance criteria that typically exceed the Minimum Energy Performance Standards (MEPS) and has been influenced by:

- utility demand-side management (DSM) programmes and
- "green" product assessment and endorsement.

The content of the energy labels can be grouped into three categories. On the basis of the information provided namely;

- energy consumption of the appliance on an annual or monthly basis or its rated efficiency. Including comparisons with the "most" and "least" efficient models (e.g., EU, Canada's EnerGuide label),
- "typical" annual energy cost (e.g. as shown on the US Energyguide label) and
- whether the product meets a prescribed performance level (e.g. US Energy Star programme for computers, EU system).

The scope and implementation of appliance energy performance labelling initiatives have grown significantly within the past ten years. At present, there are labelling programmes in at least fifteen countries as well as an initiative that is being administered by the European Union (EU) as a whole. Approximately 25 products are included in these programmes; refrigerators and freezers are the products with the most frequent coverage.

The participation of appliance manufacturers in energy labelling programmes can be either voluntary or mandatory. Although there continues to be a mixture of both, the trend is towards a greater reliance on mandatory participation in order to enhance programme impact. All of the current "integrated market" labelling programmes (i.e. North America, EU and Australia) are mandatory. An acceptable means of determining the energy ratings to be shown on these labels provided much of the initial impetus for developing many of the energy consumption test methods used in MEPS programmes.

The participation of the appliance manufacturers in energy labelling programmes can either be mandatory or voluntary. In the United Kingdom, for example, the labelling programme is voluntary, while in Australia and New Zealand on the other hand have a mandatory labelling scheme. Major appliance labelling initiatives e.g. Canada's Energuide programme, have evolved to become integrated with the development and enforcement of mandatory minimum Energy Performance Standards (MEPS).

### Constraints in South Africa

Some of the reasons why South Africa does not have an appliance energy labelling programme, can be attributed to the following factors:

- Lack of available information and its dissemination
- Other priorities and needs of government
- Structural changes in government departments and re-organisation
- Lack of a legislative framework
- Limited SABS capacity to do appropriate testing
- Limited capacity to police standards
- Lack of consumer awareness on the benefits of appliance energy labelling
- Low price of electrical energy in SA and the high cost of imported goods

*Costs and affordability*

This issue can be characterised in the form of two fundamental questions:

- to what extent will the appliance industry in South Africa be able to bear the incremental costs associated with the programme?, and
- to what extent can these costs be passed on to consumers?

There was a consensus among several of the manufacturers and retailers that the appliance market in South Africa is very price sensitive and, hence, the industry would find it difficult to pass on to consumers any incremental costs associated with energy efficient appliances.

It is clear that, as a basis for programme development and negotiation, it will be necessary to clearly estimate the incremental costs to the industry (retailers, importers and the manufacturers) associated with the programme. If the estimated incremental costs were indeed as small as expected, then there would be a need to communicate this very carefully to the industry. However, there might also be a need to offset possible incremental costs to the manufacturers as well as to the consumers. In either case, the labelling programme must "sell" affordability not only in terms of "first costs" but also in regard to the operating cost savings during the useful life of the product.

Compliance enforcement may employ four elements:

- self-monitoring by dealers,
- following up on tips and complaints,
- systematic spot checks by inspectors, and
- more rigorous compliance reviews.

The implementation of the General Agreement on Trade and Tariffs (GATT) has had a significant impact on the SA appliance industry. As a result of GATT, South Africa is now part of the global economy which means, that the performance criteria of appliances should meet international standards

*Consumer awareness*

The advantaged consumer households have a high degree of awareness of the cost of electricity and about 30 % consider the energy used by an appliance when purchasing these products. Limited information is provided on the awareness level of low-income groups. One can conclude that the level of awareness must be low, although further research may be required. Energy efficient and label appliances are generally more expensive to the end user. A large part of our population is not able to afford more expensive appliances.

Eskom's experience with the Retailers Programme is that retailers and sales staff have limited knowledge of energy efficiency and the energy performance power rating of appliances

Standards South Africa (STANSA) has published several standards pertaining to white goods appliances. The standards for these products are summarized in Annexure A.

*Legislative framework*

The international experience has shown that appliance-labelling programmes are to a large extent dependent on a legislative framework. There is no legislation in South Africa, which promotes appliance labeling.

Cabinet approved the White Paper on the Energy Policy of South Africa on 2 December 1998.

The White Paper says: "Public awareness of the operating cost of appliances is low, partly due to a lack of awareness around energy efficiency generally and partly because of a lack of information on appliance operating costs".

The Government will promote the introduction of a domestic appliance-labelling programme. Appliance labeling forms a major component of household consumer education and assists people in their choice of appliance. Not only are consumers informed about appliance energy consumption but also manufacturers tend to compete to produce more efficient appliances.

The White Paper on the Energy Policy of the Republic of South Africa 1998, includes a section 8.3 on Energy Efficiency (page 75) where it states that "energy efficiency is a measure of saving of energy...", "Government will promote an energy efficiency awareness in households and will facilitate the establishment of relevant standards and codes of practice for the thermal performance of dwellings ..." and "The Government will promote the introduction of a domestic appliance labelling programme." The DME have initiated a baseline study and energy audits of buildings and this appliance labelling study amongst its many programmes.

Publicity campaigns will be undertaken to ensure that appliance purchasers are aware of the purpose of appliance labels.

To date there has been limited progress with implementation of the White Paper in respect of appliance labelling. It may take several years for a legislative framework to be developed on appliance labelling.

*Cost benefit analysis*

A cost benefit analysis for energy efficient lighting has been done however there is a need to include other energy efficient appliances in the modeling.

A typical cost / benefit analysis for electric water heaters and refrigerators is given in Annexure B.

Similar cost benefits studies can be carried out for all appliances. The work group recommended that the eight largest users of electricity in the domestic market be focussed on and the energy efficiency label promoted for them. The energy label is not income related because the benefits are calculated for the user. The cost of financing the purchasing of major electrical appliances is different and this should be investigated in the implementation of the energy label.

From these tables one can see that the benefits are relatively small, however they are additive. If all appliances are made more energy efficient through the introduction of an energy efficiency label there will be large savings to the user, the electricity distributor and the electricity generator.

The cost to improve the efficiency of the product does not require that the cost of the product increases but can be achieved by use of new materials for insulation, better seals and redesign. The tooling cost can be amortised in the normal costing of the product.

### DME commissioned research on appliance labelling

As a result of a dialogue between the DME and DANCED over the years 1999 to 2001 the project "Capacity Building" in DME in energy efficiency (EE) and renewable energy (RE) has been formulated.

The project aims at enhancing DME's capacity and performance by assisting in developing programmatic approaches through strategies and action plans for energy efficiency and renewable energy in transparent co-operation with relevant stakeholders. These include for instance the National Electricity Regulator (NER), Eskom, other governmental departments, provincial departments, non governmental organisations, community based organisations, other organisations and industry.

The immediate objective of the labelling study is to form part of the basis for drawing up a strategy and action plan for energy efficiency. The labelling study was to the formation of a programme and proposed legislative regulatory text on the issue of labelling of household appliances as applicable.

## The present appliance labelling working group

The DME, NER and Eskom are the major players in electrical energy efficiency. Eskom DSM should support the minister and the energy white paper that calls for energy efficiency to be introduced in South Africa and the NERs draft energy efficiency and demand side management policy. Energy efficiency labelling is specifically called for in the white paper. The Department of Trade and Industry (DTI), SABS and the Department of Water Affairs and Forestry (DWAF) are supportive of energy labels and could be potential funders. Legislation may be included in the draft Energy Bill but this has not been released for comment.

Stakeholders are:

- Department of Minerals and Energy (DME)
- Department of Trade and Industry (DTI)
- Department of Environmental Affairs and Tourism (DEAT)
- Department of Water Affairs and Forestry (DWAF)
- Minerals and Energy Policy Centre
- Eskom DSM
- Manufacturers, importers, distributors and their associations
- Collaborative Labelling and Appliance Standards Program (CLASP)
- American Council for an Energy Efficient Economy (ACEEE)
- Global Environmental Facility (GEF)
- Eskom TSI
- Eskom Enterprises
- South African Chamber of Business (SACOB)
- The South African Bureau of Standards (SABS)
- National Electricity Regulator (NER)
- Consumer associations

In the DME Energy Label Study, TSI - EES and the work group which included the SABS, DTI, DANCED and DME, revisited the appliance selection criteria as this group focussed on energy and not only electricity. The selection criteria expanded the appliances to include:

- Water heaters - electric, gas, paraffin, coal and solar
- Refrigerators and freezers
- Washing machines
- Tumble driers - electric
- Stoves - fixed electric
- Dish washers
- Space heating - thermostats in particular
- Lamps - incandescent and fluorescent lamps

*Interaction in the working group*

The WG reviewed the methods of implementing energy labels used overseas and found that the schemes used a combination of energy labels and standards that were voluntary and mandatory depending on the country and appliance.

The WG recommended that where existing standards for performance of an appliance existed then these should be given a high priority than where no standards existed. In addition where there was a mandatory requirement via a compulsory legislation these would be given a high priority.

The appliance standards for performance are controlled by STANSA and any amendment would have to go through their process of approval. If no performance standard existed then this would have to be prepared and the test method accepted by the testing authority and the manufacturer. The latter would take longer than amending an existing standard. The appliances selected for the first phase of energy labels was narrowed down to the following:

- Water heaters - electric fixed,
- Stoves - fixed electric
- Refrigerators and freezers
- Washing machines
- Lamps - incandescent and fluorescent lamps

STANSA representatives assisted in guiding the WG as to which process was the fastest method of implementation. The time taken from initiating a standard to the date of publication can be from 12 to 18 months depending on the speed that the technical work group accepts the draft standard. The performance standard is required before the energy label can be implemented, as this is the method of testing and the criteria of the energy efficiency levels required. The fixed water heaters standard has a working committee and hence this was the first targeted appliance. TSI - EES wrote to the SABS Technical Committee requesting an amendment of the standard to include the energy label. The fixed electric stove was the second appliance selected as this is controlled by the code of practice, SANS 10142, for the wiring of premises. Both these appliances have the higher electricity use and have the higher penetration in the domestic market by numbers and energy used.

## Conclusion and recommendations

The marketing plan should focus on at most three appliances

One of the appliances should definitely be a refrigerator. Refrigerators are used in all segments of the market. Refrigeration is not a large contributor to peak demand but does consume a significant proportion of household electrical energy typically 10 to 15%. The penetration of refrigeration appliances is also quite high. Therefore refrigeration could be a first target of labeling, if Eskom is satisfied that there is enough peak impact.

The targeted appliances should have labels based on EU standards. Marketing cannot start without this being done.

There is sufficient research material available on appliance labeling programmes in South Africa. There is no need for further detailed research on the subject. However, there may be a need to do a research on the environmental benefits of such a programme.

At present there is an appliance energy labelling working group to drive the process further. It would be unwise to establish another working group without a formal commitment by Eskom and stakeholders such as the NER and DME.

There have been several workshops and conferences dealing with the subject of appliance labelling. To date there has been limited progress with the implementation of such a programme however with the continued commitment of the stakeholders it is planned to introduce the performance standards on at least three appliances this year and to introduce legislation as soon as possible.

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## Annexure A: South African domestic appliance standards

| Product | Standard number / year | Title |
|---|---|---|
| 1 | SABS 153 - 1981<br>SABS 154 - 1999 | Electric stoves, cooking tops, ovens, grills, and similar appliances |
| 2 | SABS 1422-1987 | Domestic electric laundry treatment machines |
| 3 | | Refrigerators and Freezers |
| 4 | SABS IEC 60335-2-24 -2000 | Safety of household and similar electrical appliances part 2-24 particular requirements for refrigerating appliances, ice-cream appliances and ice-makers |
| 5 | SABS ISO 7371 - 1995 | Household refrigerating appliances – Refrigerators with or without low-temperature compartment – characteristics and test methods |
| 6 | SABS ISO 8561 - 1995 | Household frost-free refrigerating appliances – Refrigerators refrigerator- freezers, frozen food storage cabinets and food freezers cooled by internal forced air circulation – characteristics and test methods |
| 7 | SABS IEC 60335-1 2001 | Household and similar electrical appliances – safety Part 1: general requirements |
| 8 | SABS 1125 - 2001 | Room air conditioners and heat pumps |
| 9 | SABS ISO 8187- 1991 | Household refrigerating appliances – refrigerator – freezers – Characteristics and test methods |
| 10 | SABS IEC 60335 series | Safety specifications for appliances complete range |
| 11 | SANS 10142 part 1 | Code of practice for the wiring of premises |
| 12 | SABS 0254 | Code of practice for the installation of water heaters |
| 13 | SABS ISO 14020 | Environmental labels and declaration – general principles |
| 14 | SABS 1356 | Instantaneous water heaters fixed |
| 15 | SABS 1307 | Solar collectors domestic water heaters |
| 16 | SABS 1808 – 24 | Gas powered domestic water heaters |
| 17 | SABS 1111 | Coal water heaters |
| 18 | SABS 1403 | Wood water heaters |
| 19 | SABS 151 | Electric fixed Storage water heaters |
| 20 | SABS ISO 7371 | Refrigerator test method |
| 21 | SABS ISO 8187 | Test method |
| 22 | SABS ISO 8561 | Test method |
| 23 | EN 60456 | Washing performance specification |
| 24 | SABS 181 | Thermostats for electric storage water heaters |

## Annexure B: Cost and Benefits

| Voluntary implementation | 20 % improvement | | | | |
|---|---|---|---|---|---|
| Year | 1 | 2 | 3 | 4 | 5 |
| Percentage changed to improved model | 5 | 10 | 15 | 20 | 25 |
| Number of units with improvement | 24 189 | 48 378 | 72 568 | 96 757 | 120 946 |
| Annual losses reduction kWh | 4 573 452 | 9 146 904 | 13 720 356 | 18 293 808 | 22 867 260 |
| Annual consumer saving at R0.30 /kWh | R 1 372 036 | R 2 744 071 | R 4 116 107 | R 5 488 142 | R 6 860 178 |

| Mandatory implementation | | | | | |
|---|---|---|---|---|---|
| Year | 1 | 2 | 3 | 4 | 5 |
| Percentage changed to improved model | 5 | 20 | 50 | 80 | 90 |
| Number of units with improvement | 24 189 | 96 757 | 241 892 | 387 027 | 435 406 |
| Annual losses reduction kWh | 4 573 452 | 18 293 808 | 45 734 520 | 73 175 233 | 82 322 137 |
| Annual consumer saving at R0,30 /kWh | R 1 372 036 | R 5 488 142 | R 13 720 356 | R 21 952 570 | R 24 696 641 |

*Energy efficiency labelling*

| | |
|---|---|
| Assumed average losses kWh/24h | 2,59 |
| Estimated number in service | 2 418 920 |
| Estimated replacement period yrs | 10 |
| Estimated number replaced | 241 892 |
| Estimated number new installations | 241 892 |
| Total estimated market size | 483 784 |
| Annual losses to system kWh | 457 345 204 |

*Fixed electric water heaters*

| | |
|---|---|
| Average est kWh reduction/unit/year | 189 |
| Ave Consumer cost R reduction/unit/year | R 57 |
| Life 10 years | R 567 |
| Added cost R | R100 |
| Return on investment | 5,67 % |

*For individual consumer*

### For electricity distributors

| Voluntary implementation | | | | | |
|---|---|---|---|---|---|
| Year | 1 | 2 | 3 | 4 | 5 |
| Percentage changed to improved model | 5 | 10 | 15 | 20 | 25 |
| Number of units with improvement | 500 | 1 000 | 1 500 | 2 000 | 2 500 |
| Annual losses reduction kWh | 94 535 | 189 070 | 283 605 | 378 140 | 472 675 |
| Annual consumer saving at R0,30 /kWh | R 28 361 | R 56 721 | R 85 082 | R 113 442 | R 141 803 |

| Mandatory implementation | | | | | |
|---|---|---|---|---|---|
| Year | 1 | 2 | 3 | 4 | 5 |
| Percentage changed to improved model | 5 | 20 | 50 | 80 | 90 |
| Number of units with improvement | 500 | 2,000 | 5,000 | 8,000 | 9,000 |
| Annual losses reduction kWh | 94 535 | 378 140 | 945 350 | 1 512 560 | 1 701 630 |
| Annual consumer saving at R0,30 /kWh | R 28 361 | R 113 442 | R 283 605 | R 453 768 | R 510 489 |

*Based on 10 000 units installed in region*

| | |
|---|---|
| Assumed average losses kWh/24h | 0,80 |
| Estimated number in service | 5 960 910 |
| Estimated replacement period yrs | 10 |
| Estimated number replaced | 596 091 |
| Estimated number new installations | 397 394 |
| Total estimated market size | 993 485 |
| Annual losses to system kWh | 290 097 620 |

*Electric refrigerators all types*

| Voluntary implementation | 20 % improvement | | | | |
|---|---|---|---|---|---|
| Year | 1 | 2 | 3 | 4 | 5 |
| Percentage changed to improved model | 5 | 10 | 15 | 20 | 25 |
| Number of units with improvement | 49 674 | 99 349 | 149 023 | 198 697 | 248 371 |
| Annual losses reduction kWh | 2 900 976 | 5 801 952 | 8 702 929 | 11 603 905 | 14 504 881 |
| Annual consumer saving at R0,30 /kWh | R 870 293 | R 1 740 586 | R 2 610 879 | R 3 481 171 | R 4 351 464 |

| Mandatory implementation | | | | | |
|---|---|---|---|---|---|
| Year | 1 | 2 | 3 | 4 | 5 |
| Percentage changed to improved model | 5 | 20 | 50 | 80 | 90 |
| Number of units with improvement | 49 674 | 198 697 | 496 743 | 794 788 | 894 137 |
| Annual losses reduction kWh | 2 900 976 | 11 603 905 | 29 009 762 | 46 415 619 | 52 217 572 |
| Annual consumer saving at R0,30 /kWh | R 870 293 | R 3 481 171 | R 8 702 929 | R 13 924 686 | R 15 665 271 |

*Energy efficiency labelling*

**For electricity distributors**

Based on 10 000 units installed in region

| Voluntary implementation | | | | | |
|---|---|---|---|---|---|
| Year | 1 | 2 | 3 | 4 | 5 |
| Percentage changed to improved model | 5 | 10 | 15 | 20 | 25 |
| Number of units with improvement | 500 | 1 000 | 1 500 | 2 000 | 2 500 |
| Annual losses reduction kWh | 29 200 | 58 400 | 87 600 | 116 800 | 146 000 |
| Annual consumer saving at R0,30 /kWh | R 8 760 | R 17 520 | R 26 280 | R 35 040 | R 43 800 |

| Mandatory implementation | | | | | |
|---|---|---|---|---|---|
| Year | 1 | 2 | 3 | 4 | 5 |
| Percentage changed to improved model | 5 | 20 | 50 | 80 | 90 |
| Number of units with improvement | 500 | 2 000 | 5 000 | 8 000 | 9 000 |
| Annual losses reduction kWh | 29 200 | 116 800 | 292 000 | 467 200 | 525 600 |
| Annual consumer saving at R0,30 /kWh | R 8 760 | R 35 040 | R 87 600 | R 140 160 | R 157 680 |

**For electricity distributors**

| | |
|---|---|
| Average est. kWh reduction/unit/year | 58 |
| Ave Consumer cost reduction/unit/year | R 18 |
| Life 10 years | R 175 |
| Added cost | R 100 |
| Return on investment | 1,75 |

*For individual consumer*

# Revenue security management

by WJC Botes, regional pricing manager, Eskom Eastern Region

**Revenue security management, within the context of Eskom Distribution, can be most simply defined as the assessment of customer's credit worthiness and evaluation of the financial risk as a result of non-payment of their accounts.**

Effective security management is to manage the factors that maintain and protect the Distributor's revenue flow and minimise financial losses. Against this background a revenue security strategy was developed which clearly categorises customers into various segments and addresses the various risks and dictates the various processes to be adopted. Various options are made available dictating security requirements dependant on risk and payment timing and mechanism.

## International debt practices

Much research was done via the internet some international utilities were visited, namely

- AES ElectroPaulo - Sau Paulo, Brazil
- CEMIG - Belo Horizonte and Rio de Janeiro
- CERJ - Sao Paulo, Belo Horizonte and Rio de Janeiro
- Rio Light - Rio de Janeiro
- Lus y Fuerza Del Centro (LFC) - Mexico City
- Comision Federal de Electricidad - Mexico
- Comision Federal de Electricidad - Mexico - Acapulco
- ESB - Republic of Ireland
- NIE - Northern Ireland
- Natonal Power - London

The following learning points were noted:

- Most utilities in America, Europe and Asia use the "good paying principle" to some degree
- Deposits for SPU and LPU customers ranges from 1 - 3 months and some utilities return deposits after 12 months if a customer honours his payments. If he then defaults in the future, a deposit is raised again
- If a customer is on a life support machine and cannot pay his account, the circuit breaker of the supply will be downgraded to match the machine's requirement, and responsibilities are clearly defined in the agreement
- In Canada and the USA customers are not disconnected in the winter
- AES EectroPaulo do credit checks on new customers but are also forced by law to supply anyone that applies for electricity
- Penalty charges and interest for overdue customers are applied by most utilities in Brazil and Mexico
- Large power user customers are on remote metering. Disconnections take place 4 days after customers receive their bills if no payment is made. Due to this vigorous disconnection policy, deposits are not called for in most cases.
- Focus on making it easier for customers to pay accounts is applied by most utilities visited
- Very good payment encouragement options. Suppliers sponsor total program, with all sorts of prizes including cars. Limited cost to utility as program partners carry the cost
- No deposits are required by UK utilities - abolished in 1998. They believe that this has contributed to their increasing debt levels
- Customers are forced to convert to prepayment if their payment record deteriorates. The outstanding debt is recovered when the customer buys prepayment tokens
- If a Large Power User is disconnected, it is forced onto direct debit / ACB. If customers convert to direct debit they receive a 5 - 7 % discount on their monthly bills

With this research completed, a revenue security strategy for Eskom was developed. Much of the best practices observed during the international visit will be implemented within Eskom.

## Revenue security strategy

The following aspects of the new revenue security strategy will be discussed, namely:

- Treatment of different supplies
- Security options
- Acceptable forms of security
- Provision of a credit rating in lieu or addition to security

*Treatment of Supplies*

- New supplies - All new customers are required to provide security. In the case of additional PODs to customers with existing supplies, the customer must provide security for the new supplies.
- Existing supplies - When a customer gets into arrears with payments of his electricity accounts and Eskom holds zero security or inadequate security, there will be an immediate review of his electricity supply agreement and the required security will be raised on his account.
- Take over supplies - If an area of supply is taken over from another distributor, the appropriate securities will be raised as per this policy.

*Security Options*

In the case of Small Power Users (SPU), see Table 1. In the case of Large Power Users (LPU), see Table 2.

*Acceptable forms of security*

- Cash deposit - When increased deposits

| Option | Security to cover a period of consumption | Requirements and conditions |
|---|---|---|
| 1 | 90 days | • Customer has 30 days, from the bill date, in which to pay the monthly account<br>• 14 days notice, from final payment date, is given in cases of default before termination of supply |
| 2 | 60 days | • Customer has acceptable payment record and signed Direct Debit payment mechanism. Monies will be drawn out of the account on day 15.<br>• Customer has 15 days, after the bill date, in which to pay the monthly account<br>• 14 days notice, from final payment date, is given in cases of default before termination of supply |

Table 1

| Short-term ratings | Rating agencies | | | Level of security | Days to pay |
|---|---|---|---|---|---|
| | Fitch | Moody's | S&P/CA | | |
| Exceptionally strong credit feature/Extremely strong capacity/Superior ability | F1+ | | A-1+ | 0 or 30 days | 5 days |
| Highest credit quality/ Strong capacity | F1 | Prime-1 | A-1 | | |
| Good credit quality/ Satisfactory/Strong ability | F2 | Prime-2 | A-2 | 30 or 60 days | 7 days |
| Fair credit quality/Adequate/ Acceptable ability | F3 | Prime-3 | A-3 | | |
| Speculative/Vulnerable | B | Not prime | B | 90 days | 15 days |
| High default risk/More vulnerable | C | - | C | | |
| Default | D | - | - | | |

*Table 3: Short term national ratings of rating agencies*

| Option | Security to cover a period of consumption | Requirements and conditions |
|---|---|---|
| 1 | 90 days | • Customer has 15 days, from bill date, in which to pay monthly account<br>• 14 days notice, from final payment date, is given in cases of default before termination of supply |
| 2 | 60 days | • Customer has acceptable payment record and signed Direct Debit form<br>• Customer has 7 days, from bill date, in which to pay monthly account<br>• 14 days notice, from final payment date, is given in cases of default before termination of supply |
| 3 | 30 days | *This option applies to Key Customers and Large Customers equal or greater than 5 MVA*<br>• Customer has acceptable payment record and pays by Direct debit or electronic banking<br>• Customer has 7 days, from bill date, in which to pay monthly account<br>• 14 days notice, from final payment date, is given in cases of default before termination of supply |
| 4 | 0 - 90 days | *This option applies to only Key Customers*<br>• Customer has acceptable payment record<br>• Acceptable credit rating by the approved Eskom rating agency.<br>• Customer has 5 days, from bill date, in which to pay monthly account<br>• 14 days notice, from final payment date, is given in cases of default before termination of supply |

Table 2



are required, customers should be given the option to pay their cash deposit off over an extended period if they cannot afford a lump sum payment.

- Guarantee - Financial Institution - Customers are allowed to furnish a guarantee instead of a cash deposit as security for payment of his account. Only certain financial and insurance institutions are acceptable to Eskom as guarantors.
- Guarantee - Holding Companies - Holding companies can provide a guarantee on behalf of its subsidiaries through a Letter of Undertaking providing that the Holding Company has a National Short Term A1 Standard and Poor credit rating or equivalent.
- Pledging of Eskom or Government Stock - The customer should complete a deed of pledge, together with securities transfer form in favor of Eskom.
- Fixed-period deposit pledges - A deed of pledge in Eskom's standard form should be completed by the financial institution and endorsed to the effect that a lien has been registered and that there is no previous lien against that particular investment.
- Letter of Undertaking for Government Departments - In certain cases a letter of undertaking by a Government Department accepting liability for the contractual obligations of another Government department with which the Government is associated, may be accepted instead of the usual guarantees.

*Provision of a credit rating in lieu of or in addition to security*

- Certain conditions apply for qualification and credit rating requirements, namely - existing customers should not have made any late payments to Eskom in the last twelve months. New customers will be required to provide a minimum of 30 days security for the first 12 months where after the amount of security required will be reviewed. The credit rating shall be provided by Moody's, Standard and Poors or Fitch.
- The customer bears the onus of ensuring a credit rating is performed.
- The customer bears all the costs related to the performance of the credit rating.
- The customer will be allowed to provide a credit rating instead of or in addition to its security to meet Eskom's minimum requirements (Table 3).

## Conclusion

- It can be said that the risk created by ill discipline regarding the management of credit cannot be countered by increased levels of deposits/securities paid by customers. All elements of the revenue management chain have to be managed properly.
- Deposits cannot and should not be viewed in isolation and will never solve all debt management problems
- There is a direct correlation between good quality of supply, customer service, disciplined credit management and outstanding debt. If the utility performs well there should be no need for a customer not to pay his bill Δ

# HR and labour relations issues when transferring a business

by Tamera Campbell and Michelle Moonsammy, Resolve Workplace Solutions

**The current restructuring processes that are underway within the electricity industry, will result in municipalities undertaking detailed investigations and cost-benefit analyses to create appropriate structures to perform the functions currently being performed by the municipality. In some instances, it may not be viable to create municipal entities, however, it will be necessary to prepare for the establishment of Regional Electricity Distributors, where electricity functions will be removed from the ambit of the municipality.**

## Introduction and background

Where Electricity currently forms an internal department within the municipality, the establishment of a municipal entity or the RED will mean that a separate, independent corporate entity will be created to perform the current functions of municipality's electricity department.

The restructuring process outlined above could have vast ramifications for employees. It is widely recognised that employees will contribute largely to the successful operation of the RED or municipal entities. In order to achieve greater efficiencies, effectiveness, enhanced quality and greater accessibility, it is imperative to consider a strategic comprehensive approach to human resources in the transition and following establishment.

## Objectives of this paper

The following paper will provide an overview of the human resources and labour relations considerations when transferring a business as a going concern, as will be the case in municipal entity and / or RED establishment. Specifically, the paper will address:

- The legal framework that enables the establishment of municipal entities
- The legal framework informing the general transfer process when transferring a business as a going concern
- The practical process of transferring employees from the municipality to a new entity
- The key people drivers for enhancing the overall success of the operation

## The meaning of "Transfer"

Transfer entails a change of employer by operation of statute. In other words the process by which the municipal entity / RED is substituted in the place of the municipality under section 197 of the Labour Relations Act, the Municipal Systems Act, and any other relevant industry legislation.

## Legislative framework

*The Labour Relations Act*

On the establishment of the municipal entity or the RED, "Municipal electricity employees" i.e. those employees performing the majority of their functions on a daily basis within the Electricity Department, will be transferred to the municipal entity in terms of Section 197 of the Labour Relations Act 66 of 1996, as amended ["LRA"]. This transfer comes with various legal consequences for both the municipality as well as the new entity. More specifically, section 197 established four major legal implications on MLM and the MBE:

- The transfer of employees is automatic and occurs by operation of law, unless agreement is reached to the contrary between municipality and the unions / new entity.
- The length of service of the transferring employees is transferred in tact to the municipal entity / RED and cannot be waived or altered even with the employees' agreement.
- Organisational rights, arbitration awards and collective agreements are transferred automatically to the municipal entity / RED, unless otherwise specifically agreed by the parties.
- All contractual and other rights as between the employees and municipality become enforceable as between the employees and the municipal entity / RED after transfer. This would include all claims and disputes between employer and employee that arose from the employment relationship.

In addition to the above obligations, the amended Section 197 also provides that the municipal entity / RED must agree a valuation with the MLM as at the date of transfer of the following employee liabilities:

- Accrued leave pay;
- Severance pay that would have been payable to the transferring employees in the event that they had been dismissed for operational requirements;
- Any other payments that have accrued to the transferring employees

The abovementioned agreement will also need to stipulate which employer would be liable for payment of any of the amounts mentioned above. More importantly, in terms of Section 197 both the municipal entity and the municipality will be jointly and severally liable for any employee liability, for a period of 12 months after transfer, in the event that an employee is retrenched or the new entity is liquidated or sequestrated and/or in respect of any claim concerning any term and conditions of employment that arose prior to the transfer.

*The Municipal Systems Act*

The Systems Act of 2000 directs municipalities towards the steps that must be carried out to achieve a successful municipal service partnerships or the establishment of municipal entities. This is essentially the enabling legislation which:

- Governs and regulates alternate service provision in the form of MSPs
- Stipulates the powers of the municipalities entering into such agreements
- Governs the procedural aspects of such agreements
- Governs the responsibilities and accountabilities of each party to the agreement

The Systems Act outlines the process of consultation with labour when local Government decides to utilize an internal or external service delivery mechanism.

## The steps that must be taken to consult with when deciding on an internal service delivery mechanism

*Step 1 - Assess the views of organized labour before taking a decision.*

- This could be achieved via the Local Labour Forum.
- Place the issue of reviewing and considering service delivery on the agenda 7 days before the monthly meeting takes place (or raise it as a new item at the meeting under adoption of agenda if it is urgent), in terms of an organisational rights agreement with labour.

or:

- Call a special meeting of the Local Labour Forum on 48 hours' notice if it is urgent.
- The Local Labour Forum may consider the establishment of a subcommittee (if one does not already exist) on workplace and services restructuring, for preparatory consultation.
- Information sharing and consultation with the unions must take place to ensure that unions are given the opportunity to make representations and ensure that the views of organized labour are considered in a proper and bona fide manner.

*Step 2 - Decision by the municipality*

- The municipality must then assess the views of organized labour.
- The municipality can then:
  - decide to explore the possibility of an external mechanism to provide the service (e.g. municipal entity), or

- make a decision on an appropriate internal mechanism (administrative unit, etc.).

*Step 3 - Deciding on an internal mechanism*

- The municipality must formally adopt the decision and thereafter implement that decision to provide the municipal service via an internal mechanism.

*Step 4 - Implementing the internal mechanism*

- Consult with labour on the structure and design of the internal mechanism.
- Develop a process for the fair and expeditious ring fencing of employees that will fall into the internal mechanism.
- Design a process for the fair migration (placement) of staff into the new structures of the internal mechanism.
- Consult with labour and attempt to obtain consensus where feasible.
- Communicate with staff - regarding the decision, process followed (Local Labour Forum, etc.), what the impact will be for them, the process that will be followed in implementing the internal mechanism, etc.
- An internal mechanism does not envisage a change of employer. Accordingly, it is 'internal restructuring' and there will be no transfer to another employer.
- Implement the ring fencing and placement of staff into the structures.
- Consult with staff throughout, and negotiate with employees who may experience a material change in their contracts of employment (position, status, responsibilities, etc.) in being placed into the structures of the internal mechanism.

**The steps must be taken to consult with labour when deciding on an external service delivery mechanism**

*Step 1 - Obtaining the views of organised labour*

- This could be achieved via the Local Labour Forum.
- Place the issue of reviewing and considering service delivery on the agenda 7 days before the monthly meeting takes place (or raise it as a new item at the meeting under adoption of agenda if it is urgent), in terms of an organisational rights agreement with labour.

or:

- Call a special meeting of the Local Labour Forum on 48 hours' notice if it is urgent.
- The Local Labour Forum may consider the establishment of a subcommittee (if one does not already exist) on workplace and services restructuring, for preparatory consultation.
- Information sharing and consultation with the unions must take place to ensure that unions are given the opportunity to make representations and ensure that the views of organized labour are considered in a proper and bona fide manner.

*Step 2 - Decision by the municipality*

- Consider the views of organised labour.
- Make a decision as to whether or not to opt for an external mechanism to provide the service, or to instead opt for an internal mechanism.
- Implement the decision.

*Step 3 - Implementing the external mechanism that will provide the municipal service via a SDA with a municipal entity*

- Information-sharing with labour regarding the proposed establishment of a municipal entity
- Consult with labour in terms of Section 197 of the LRA regarding the transfer of staff to the municipal entity as new employer.
- Disclose all relevant information to labour to ensure proper engagement on the transfer
- Consultation with labour on the terms and conditions of employment that will govern employees in the new entity (since their terms and conditions of employment are determined by collective agreement, they must be the same with the new employer as existed with the old employer), or
- An agreement can be concluded with labour governing the transfer to the new employer. Either the municipality can negotiate with labour to agree to varied terms and conditions of employment that will apply post-transfer, or the new employer can undertake such negotiations with labour; alternatively, it can take place between the old and new employers and labour.
- Provide to labour a generic copy of the agreement disclosed to each employee; i.e. of the agreement to be concluded between old and new employer regarding:
  - Which employer is liable for paying the accrued leave value, severance pay that may be payable after transfer, and any other payments that may have accrued to the employees with the old employer.
  - What provision has been made to make such payments if and when they become due and payable.

**Practical implications of the legislative framework**

It is imperative that a comprehensive human resources and labour relations audit is undertaken when considering the establishment of a municipal entity / RED. The purpose of the audit will be to:

- Outline a comprehensive list of human resources issues in order to gain a status report of HR issues within the organization;
- Understand the current status of HR / LR and to prioritise strategic initiatives that will promote the restructuring process.
- Provide a broad overview of the labour relations environment in which restructuring will take place and aims to identify any possible barriers or pitfalls that may hinder the process.
- Document the conditions of employment, salaries and benefits applicable to all employees in the organisation
- To identify employees to be ring fenced for transfer to the new organisation. This is the process used to group or draw an imaginary ring around 'like' employees or all employees whose core job it is to work in a particular department, division or sector for the purpose of transferring them into a new business entity e.g. the municipality decides to create a separate electricity entity. Section 197 provides that when the whole or part of a business is transferred as a going concern, the employment contracts of those employees who do 'electricity work' must be transferred to the new entity, unless otherwise agreed between the affected parties and employees.

**Success through people**

*People drivers of organisational success*

The restructuring of the electricity industry, through municipal entity and / or RED establishment demands that serious consideration is given to the manner in which organisational effectiveness can be heightened. More specifically, goals of enhanced accessibility, equitable service delivery and quality will need to be realised. Critical to the achievement of such strategic objectives is the organisation's human capital. Therefore, in considering organisational effectiveness, it will be imperative to design a human resources strategy that enables and supports the organisational objectives.

In recognising that employees are valuable assets requires an in-depth understanding what motivates, attracts and retains key individuals and groups within the organisation. Some of the critical issues that need to be addressed within the context of restructuring are:

- Job security
- Role clarity
- Training and development
- Conditions of service parity (internal and external to the market

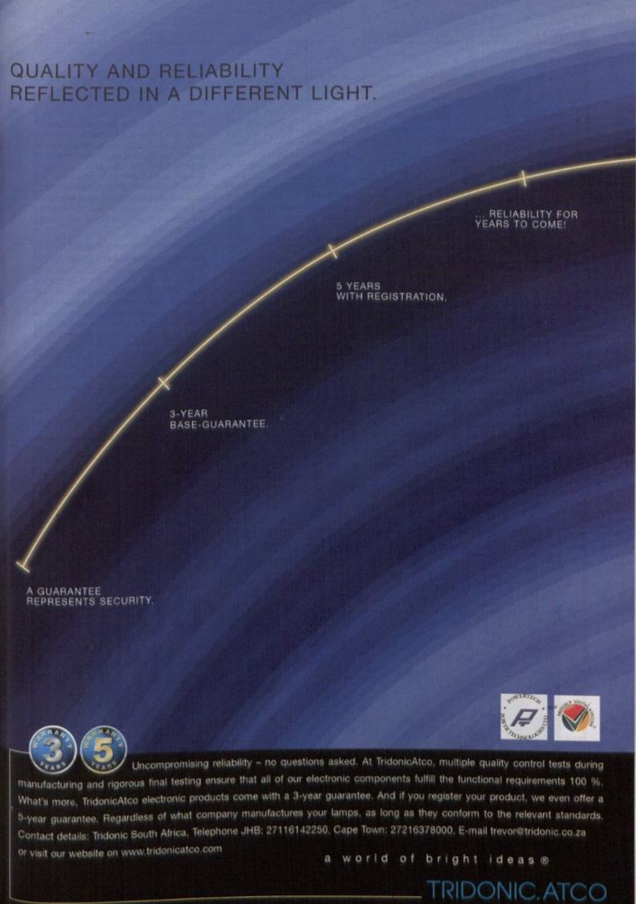
The restructuring process itself aims to create an organisation that is flexible, performance oriented, innovative and committed to quality and service excellence. In achieving these objectives through restructuring, a number of potential consequences exist for employees. Such consequences could include changes to:

- Reporting structures
- Position responsibilities
- Position titles
- Employer
- Way of working
- Location of work
- Filling of critical vacancies

In addition to the direct consequences of the transformation, municipalities would likely develop a strategy to move human resources and labour relations policies and practices into the realm of best practice. In this way, a number of consequences could be experienced:

- Redefinition of position responsibilities
- Performance management
- Consolidated terms and conditions of employment
- Salary and benefits parity strategy
- Collective bargaining structure realignment
- Career and succession planning
- Employment equity
- Skills development

It will be necessary to deal with a number of these issues in a coordinated fashion in order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to ensure a consistency in approach, as well as to implement the strategy of becoming a best practice employer.

**Process framework of HR and LR considerations in the transition**

The following framework represents the human resources and labour relations considerations when embarking on our during a transformation process. It is clear from the process framework that the organisational design forms the basis of the transformation process with respect to HR and LR. A number of other key processes should occur throughout the duration of the project - these processes including, an initial audit process, collective bargaining and general communication and change management. The "inside tiers" contain those issues that form part of the transformation at a substantive level.

*Organisational design*

Organisational design will involve the development of a high level organisational structure depicting the overall design of the new entity and its key functions. Arising from the high level design, it will be necessary to develop more detailed structures depicting all levels of the organisation. To date, this process has been completed for the top four levels of the organisation. In summary, it is best practice to utilise the skills and knowledge of employees throughout the organisation to develop new organisational structures. This is due to the expansive knowledge that employees have with respect to "how things work on the ground". In addition, employee involvement early in the process facilitates higher degrees of buy-in and less resistance to the newly designed structures.

*Role profiling, levels of work and salary scales*

Following the completion of the organisational design at both a high and detailed unit level, it is necessary to define the responsibilities of each of the positions within the organisational structure. This is performed by developing role profiles, highlighting knowledge, skills and experience that are required in the process. The role profile forms the foundation for the appropriate "level" (usually known as grade) to be determined and an appropriate salary to be assigned to the level of work. This is usually performed through an external and internal market survey.

*Ring fencing, transfer and migration*

Following the completion of the organisational design and the role profiling process, it is possible for the organisation to decide on "how to fill the organisational structure with people". This is commonly known as a migration or placement process. A number of rules or procedures should be established in order to ensure that employees are treated fairly and consistently and that key principles are applied in the process. Where a municipal entity and / or a RED is established, it will be necessary to transfer employees from the city to the new entity. This will need to take place with due cognisance to prevailing labour legislation, relevant industry legislation and collective agreements

continued on page 108

# Skills planning and capacity building in the EDI

by Naudé van Rensburg, training and development manager, Eskom Distribution, Northeast Region

**Both Eskom and municipalities have skills and competencies that are generic, but for the most different skills and competencies are required based on the different practices, systems and technologies in each environment.**

With the unfolding EDI and the establishment of REDs the employees from both Eskom Distribution and local government will be grouped into the new business. Different competencies will be required based on the organisational objectives and structures.

It is accepted that all employees in the REDs will require some form of development based on the above.

All training will have to be done within the framework and requirements of the legislation having a direct influence on skills development. The paper is structured to give some background on the different Acts and then provide an approach for the skills planning in the REDs or EDI

## Legislation

Since 1994, significant new legislation has been introduced to transform the National education and training system.

This transformation of the education and training system was necessary for the following reasons:

- It was not sufficiently responsive to changing needs.
- Unfair labour practices had to be eliminated, to ensure that all the people in South Africa have equitable access to proper, well-structured training and development.
- Investment in skills development by employers needed to be increased to ensure that the skills base of the entire labour market is uplifted.

The following Acts have been promulgated since 1994 that have an influence on the skills development environment:

- SA Qualifications Authority Act No. 58 of 1995
- Skills Development Act No. 97 of 1998
- Skills Development Levies Act No. 9 of 2000
- National Education Policy Act No. 27 of 1996
- Higher Education Act No. 101 of 1997
- Further Education and Training Act No. 98 of 1998
- ABET Act No. 52 of 2000

Other legislation impacting on education and training:

- Employment Equity Act No. 55 of 1998
- Labour Relations Act No. 66 of 1995
- Basic Conditions of Employment Act No. 75 of 1997

During the strategy development stages in preparation for transformation prior to 1994, all stakeholders agreed to the need for the Departments of Education and Labour to be integrated under a single ministry of Education and Training. This was not achieved. The two continue to be administered separately by the Departments of Education and Labour. In addition a third department has been introduced into the governance structure, namely the Department of Finance. This has resulted in a division of responsibilities that in turn pose a challenge to the integrated governance of the education and training system as a whole as illustrated in Fig. 1.

### SAQA Act No. 58 of 1995 and the (NQF)

An enabling Act to provide for the South African Qualification Authority (SAQA) to be established to oversee development of the National Qualification Framework (NQF).

### Skills Development Act (97 of 1998)

To establish a national framework for all skills development in SA with respect to governance, funding Learnerships and employment services.

- SETAs (Sector Education Training Authority) were established for each skills sector in SA and each enterprise must register with one.
- SETAs must compile sector skills plans, collect and reimburse payroll levy grants and function as ETQAs
- Each enterprise must have Workplace Skills Plans, annually audit their performance against them, and submit reports on their plans to the Department of Labour via their SETAs annually.
- Learnerships (whole occupational qualifications) will replace traditional apprenticeships and other fields of learning
- Skills programmes (non-learnerships and part or whole qualifications) aligned to the NQF will qualify for skills levy grants if within the scope of sector skills plan
- Employment services must be registered
- Governance structures (e.g. National Skills Authority) to advise the Minister and oversee implementation of the National Skills Development Strategy

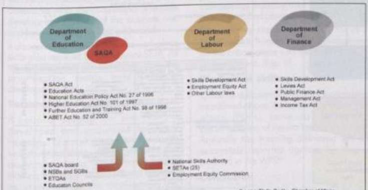
### Skills Levy Act (1999)

To ensure all enterprises in South Africa invest in skills development.

- Payroll levy to be collected from each enterprise (20 % will go into a National Skills Fund (NSF) and 80 % to be reimbursed - 10 % to the SETA and 70 % to the employer
- Reimbursement is based on acceptability of skills development plans and proven annual performance vs. these plans

### Higher Education Act (101 of 1997)

- All private and public providers must register and pay annual fees to the Department of Education
- Each provider must conduct an annual audit of its higher education (HE) and submit a report to the Dept. of Education.
- The Higher Education Qualification Quality Committee (HEQC) is responsible for the quality assurance of all higher education training (HET) institutes programmes in South Africa




Source: Stella Carthy, Chamber of Mines

Fig. 1

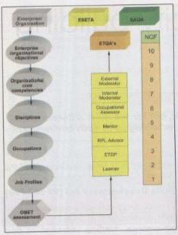



Fig. 2: Skills Development model

- The national governance structures for higher education (HE) in South Africa is the Council for Higher Education (CHE)
- Institutional governance structures include councils, alumni bodies and advisory committees.

### Further Education and Training Act (98 of 1998)

- All private and public providers must register and pay annual fees to the Department of Education
- Each provider must conduct an annual audit of its further education (FE) and submit a report to the Dept. of Education.
- Accreditation will be done by SETAs / ETQAs
- National, provincial and institutional governance structures for the schooling and college system

### ABET National Plan and Policy (1997) and Future Act (1999)

- National definition, vision and plans
- National (and future provincial) governance structures and technical committees

### Skills planning in the in EDI

With the merging of the different stakeholders to form REDS and the present situation as described above, it will be imperative to change the approach to strategic skills planning and human resource development to meet the needs of the REDS. It is proposed that staff from Eskom and the municipalities with different knowledge and expertise will be merged into single operating units.

It is imperative that, before any training and development initiatives can be embarked on, the organizational objectives, core job categories, and core job competencies of the new business must be defined using a framework such as that illustrated in Fig. 2.

Once the organisational objectives are defined, the following need to be identified:

- Key changes that will occur in the industry
- The impact of these changes on the company (RED)
- The opportunities for the organisation to become effective and sustainable in a newly competitive environment in respect of the competencies required by individuals
- The impact of the changes on jobs and job categories
- The attitudes and attributes that will be demanded of the employees

In the unfolding EDI, the REDS will require different, structures and competencies from the present Eskom regions and Municipalities that will be grouped within each RED boundary to form the new business units.

These newly established REDs will need to identify and define their organizational objectives and capability requirements The organisational core competencies for these new businesses will need to be defined based on the business roles and structures that will be designed.

These organisational core competencies then need to be structured into defined disciplines and occupations and Job Profiles need to be developed for each occupation or role required to successfully grow and sustain the business.

With the merging of the Eskom and municipality resources, staff will be grouped with different competencies based on unique technologies and systems. A mere grouping and resource leveling exercise cannot therefore be conducted due to these differing competencies and the competencies required by the new business.

Based on the job profiles which will be guided by both the organisational objectives and the organisation design, specific competencies will then need to be developed (per individual). The framework by which this may be achieved is given in Fig. 3.

### Job profile

Job profiles are developed for the different occupations, which are based on the core competencies and attributes required to achieve the organisation's core objectives.

### Competence profile

Competencies, knowledge, skills and attributes are defined for every activity, tasks and sub-tasks per activity on the Job Profile. (Fig. 4). The competencies are collected using questionnaires and or personal one-on-one interviews with the subject matter expert (SME), the line manager and an incumbent of the post. The competencies, knowledge and skills are categorized in:

- The frequency the task is performed
- The importance (criticality) of the task
- The training needs of the tasks
- Importance of training for the company's overall strategy

### Competence matrix

Each competence of a specific post is canptured on a competence matrix indicating the different competencies required (Fig. 5).

- Institutionalised qualification obtained at a formal training institution, i.e. degree, diploma, national certificate, learnership, or apprenticeship.
- Embedded knowledge: The competencies, knowledge the person will get by formal skills programmes or specific courses. These courses can be obtained by in-house or external providers.
- Behavioral skills are skills required to be able to successfully and effectively do the work, i.e. analytical skills, assertiveness, etc.

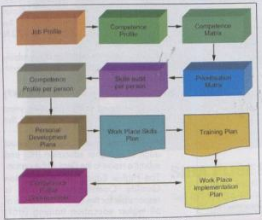



Fig. 3: Competence profile model

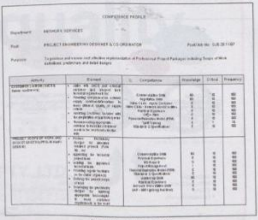


Fig. 4: Competency profile

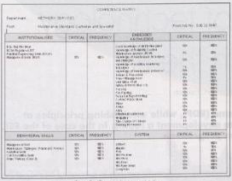


Fig. 5: Competence matrix

Fig. 7: Personal development plant

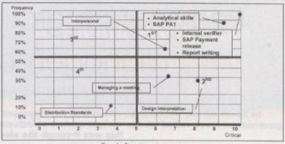



Fig. 6: Prioritisatoin matrix

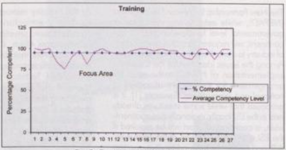



Fig. 8: Competence profile of the business

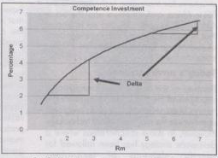



Fig. 9: Competency improvement on investment

- Systems: All the information management systems that are used for that specific role or post.

## Prioritisation matrix

All the competencies, skills, knowledge are plotted on a matrix in terms of the frequency applied and the importance of the skills (Fig. 6). The high frequency, high importance (criticality) will form the 1st quadrant, the Low frequency, high importance forms the 2nd quadrant, high frequency-low importance the 3rd quadrant, and low frequency-low importance (criticality) the 4th quadrant.

## Skills audit

The aim of the skills audit is to determine what skills and competencies exist in the business, and how the competencies compare with the organisational requirements. It further determines what the competency and skills development priorities of the business are, and how these may be best addressed.

It also serves as the source for the work place skills plan required by the relevant SETA. All the competencies are transferred from the prioritisation matrix onto personel development plan

## Personal development plan

A personal development plan (PDP) is developed and populated for every incumbent of a post. At present due to the lack of unit standards, assessment tools, and assessment criteria, recognition for prior learning is given on the face value of evidence as presented by the employee. The employee can however be assessed if suitable assessment tools and criteria are available. No credits will however be issued until such time such qualifications, unit standards are registered with the education quality training assurer of the relevant SETA.

The gaps in the competencies are identified and the manager contracts with the employee on the development for the next appraisal period (Fig. 7).

## Competency profile

The individual PDPs are consolidated at section, department, regional or business unit level. A competence profile is given to the manager to indicate the gaps on which to focus.

The focus shifts from mandays training per person to the average percentage competency improvement in the business over a specified contracted period (Fig. 8).

This allows the business to focus it investment in human capital development on the critical areas with the greatest return on investment. (Fig. 9)

## Workplace skills plan

Once the skills planning process is completed as outlined above, the personel development plans (PDPs) serve as the source documentation of the workplace skills plan. Annually the training delivered will be accurately reported against the targets outlined in the WPSP.

## Conclusion

To ensure that the EDI (REDS) will have the competencies and skills required to grow the new business and to sustain the effectiveness thereof will largely depend on the importance placed on the skills planning and capacity building processes and how they are linked to the organisational objectives and core competencies required.

A skills audit should be done to determine the competencies that are available in the organisation and to determine the skills gap. Training should be focused on the competency gaps and on the costs of such development.

It is imperative that resource leveling where staff is moved is not done by a blanket approach without prior assessment of required competencies in the new area, based on different technology, systems, etc.

## Acknowledgements

- Jeff Victor, Human Resource Manager, PBMR Project, Eskom Enteprises
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# Regional integration of technology management in the ESI

by Paul Johnson, Technology Standardization, Eskom

**In South Africa, the reconstruction and development programme (RDP), while establishing principles at government level, relied on the various sectors of industry to make development a reality. In the case of the ESI, this was through the electrification programme.**

The New Partnership for African Development (NEPAD), while establishing principles at governmental level for development of our continent, will require the active participation of industry to make the aims of NEPAD a reality. Among the issues identified for the successful implementation of NEPAD is the need for arrangements for the efficient allocation of national and international resources [1]. It is proposed that while some structures already exist in the ESI locally, regionally and continent-wide, a coordinated effort will be required if the ESI is to make best use of the resources, skills and experience in the industry in supporting implementation of NEPAD.

This paper examines some of the existing structures for managing technology in the ESI in Africa, and considers what the South African ESI in particular can do to ensure that its own structures for the management of technology in the restructured ESI are integrated with these, in support of NEPAD.

## Today's environment

Because of the autonomous management structures of the many electricity utilities, it has not been necessary to have an integrated approach to the management of technology. However, In some specific areas where a deliberate strategy has been followed for specific elements of technology management, such as the NRS project to establish common technical standards, benefits have been evident.

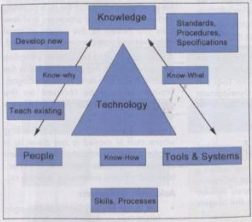


Fig. 1: Technology management triangle

As the industry restructures locally and as similar restructuring (unbundling, corporatization, privatization) is occurring in utilities across Africa, it becomes more and more apparent that deliberate strategies to ensure the efficient management of technology are needed. Technical skills are increasingly being stretched and the challenges of electrifying the continent will be present for decades to come. Access to electricity, with the provision of other services, is seen as a key enabler of economic, social and environmental development, but is unprofitable in the short to medium term. Meanwhile utilities are being pressured to privatize and unbundle in order to secure foreign investment in the industry.

Experience elsewhere in the world has shown that international participation of utilities in the areas of technology research and standardization (Cigré and IEC committees, for example) drops dramatically when restructuring occurs. These areas are too frequently seen as "unnecessary overheads" or those in a position to effectively contribute -trained experience engineers- are just too stretched with operational matters and restructuring to participate. Once participation lapses, the effort required to motivate getting involved often becomes too great. Furthermore, when competition is introduced, utilities that in the past may have shared technology freely find they are restricted as they may be "giving away" their competitive advantage, where such technology may be used to provide a better customer service than the competing utilities.

At the IERE Africa Forum (November 2001), a speaker from the World Bank notes that "System development seems to be more expensive in Africa than in other regions, .... US$ 500 to 1000 per connection. On that basis, the objective of most governments to double access to electricity by the end of the decade may cost as much as US$ 12 to 25 billion to connect 25 million new users... More cost effective technology will need to be developed" [2].

Specific projects in support of NEPAD at the level of establishing the Pan-African grid, are already being planned. These projects will lead to transmission interconnectors such as those planned for the western corridor, in conjunction with the integration of INGA power station. These projects while ambitious, are able to proceed through bilateral agreements and joint ventures using well-established technology. At the distribution level, even the modest objective of doubling access to electricity over 10 years mentioned above is an enormous challenge. Finding alternative, appropriate, optimized solutions for the application of grid and non-grid technologies to provide these potential customers in a geographic area greater than the combined area of the USA and India requires an integrated approach[1]. The industry is faced with a skills shortage, and technology is still largely imported from Europe and elsewhere outside Africa, and often designed for conditions very different from those in Africa. HIV/AIDS is expected to increasingly take its toll on staff availability, noting that in some countries in our region the average life expectancy is around 40 years and has decreased in recent years!

The local development, standardization and commercialization of prepayment metering technology, which now is applied in some 17 countries across Africa gives an indication of what can be achieved when technology is successfully managed. How best can the South African ESI contribute to managing the technology used in the African ESI? Herein lies the challenge and opportunity for utilities to make an active and practical contribution to the New Partnership for African Development.

## What activities comprise the management of technology?

The management of technology can be regarded as a cycle of inter-related processes:

- Fundamental and applied research,
- Design,
- Development,
- Production,
- Maintenance and operation, and
- Usage

which collectively are driven by the integrated application of knowledge, people, tools and systems (see Fig. 1) [3].

In practice it requires the interaction among researchers, planners, designers, standards

[1] The five largest countries in Africa (Sudan, D R Congo, Algeria, Libya and Chad, have a combined geographic area greater than that of the USA)

engineers, equipment suppliers, project engineers, commissioning and maintenance staff. Structures are required to enable such interaction to be coordinated and to happen effectively.

**What formal structures are already in place in Africa?**

*UPDEA*

The Union of Producers, Conveyors and Distributors of Electrical Energy in Africa (UPDEA) is an Association of electricity utilities with some 30 member utilities from some 26 countries throughout the continent. Its headquarters are in Abidjan. The presidency of UPDEA is rotated on a three-year term, and significantly the presidency for the current 2003 - 2005 term is held by Eskom, South Africa.

At the strategic level it provides a forum for chief executives from utilities to interact with each other and with external organizations. At this level its recognition by the AU is significant. The AU has established an African Energy Commission, which looks to UPDEA to provide direction for the application of technology.

*Scientific committee*

UPDEA's technical arm is the Scientific Committee. The president of this committee for the present three-year term is VRA, Ghana. Study Committees covering aspects of technology and operational management comprise representatives of the member utilities.

There are currently six study committees:

- Standardization
- Operations, maintenance and development
- Rural electrification
- Customer service (includes quality of supply)
- Human resources
- Restructuring and financing

UPDEA has the potential to significantly contribute to the aims of NEPAD and the African Renaissance, but challenges such as communicating effectively across the continent, language barriers and political rivalry are real and need managing. In terms of using the UPDEA structure to cooperate in the management of technology, finding the right people with appropriate experience and the time and willingness to participate effectively is probably one of the biggest challenges. South African participation is formally through Eskom's membership. It is proposed that whatever local structures are developed to manage technology, these should be integrated with, and provide input to influence the direction of the projects and activities of these UPDEA study committees.

*PIESA*

The Power Institute for East and Southern Africa (PIESA) has a specific focus on sharing technology among utilities in the East and Southern Africa - the current focus is distribution, and currently has eight national utility members namely Eskom (SA), Zesa (Zimbabwe), Zesco (Zambia), Escom (Malawi), SEB (Swaziland), LEC (Lesotho), SNEL (D R Congo), UEDC (Uganda), with the AMEU as an observer member.

PIESA is a relatively young association of utilities with a vision to be the catalyst for sustainable regional co-operation in expanding the electricity distribution industry in that region. Its prime objective is to stimulate the electrification of the region, which is to be achieved though:

- Encouraging membership participation from all regional electricity distributors and supporting industries
- Centralized integrated information on technology related to the distribution of electricity
- Continuous capture of experiences of members to improve efficiencies (feedback loop)
- Encouraging the use of local resources and the manufacture of equipment for use in the distribution industry
- Optimization of technical equipment specifications and codes of practice for the regional environment
- Promotion of applied research in areas that are relevant for the effective performance of the members
- Developing a culture of technology transfer and skills development among members
- Developing strategic alliances and partnerships in research, industry and manufacture and other similar organizations
- Compilation of standards and guidelines to minimize the impact on the natural environment
- Being flexible to respond to the needs of an evolving Electricity Distribution Industry
- Facilitating dialog relating to the Electricity Distribution Industry.

It currently functions through five working groups:

- Standardization
- Reduction of non-technical and revenue losses
- Low cost electrification
- Power systems analysis, and
- Environmental management.

Working groups comprise nominees from the participating utilities. AMEU is technically an observer member, and Eskom Distribution provides some support. The main driver is Eskom Corporate. The challenges are similar to those described for UPDEA and a consolidated approach is needed to ensure the South African industry supports the process.

**Structures in South Africa**

*SAPURAB*

Within SA there is the South African Power Utilities Research Advisory Board (SAPURAB), which comprises representatives of the wider stakeholders in technology relevant to ESI including academic institutions and other research bodies. It has the following objectives:

- To preview and review the broad based research direction proposed by Eskom.
- To identify research drivers.
- To identify research opportunities of relevance to the electricity producers, transmitters, distributors and end-users.
- To advise on the relative allocation of research funds.
- To advise on research priorities.
- To advise on research contractors.
- To promote the development of Electricity Industry research.
- To facilitate local, regional and international research co-operation.

*ESLC*

The Electricity Suppliers Liaison Committee (ESLC), comprising representatives of the AMEU, Eskom and the SABS established its own brief:

- to develop electricity supply industry standards, with the aim of
  - standardizing components
  - rationalizing the range of equipment and material used
  - optimizing the technical requirements for minimum life-cycle costs
  - assisting the development of the local market
- to provide a forum for discussing issues of common interest in respect of the electricity supply industry in South/Southern Africa, where no other appropriate forum exists
- to facilitate changes to regulations, codes of practice, etc., where appropriate, by making recommendations to Government Departments, and other statutory bodies

The ESLC recognizes the standardization activities of PIESA, and some integration of the PIESA and NRS standards is already underway. Such integration could be extended to the other elements in the technology management chain.

*AMEU*

Standing committees and functions of the AMEU provide fora in which technology management is facilitated. Specific examples are the training and engineering committees. It is understood integration with Eskom in these areas is already underway. Noting that the AMEU membership is not confined to South Africa, but covers Southern Africa, there is an opportunity to forge linkages with neighbouring utilities through the AMEU membership of PIESA. For example utilities in Namibia, which do not have membership of PIESA currently. Recognizing the ESI's support for NEPAD, as mentioned in the introduction, these wider southern African linkages should not be lost in migrating to a REDs environment.

*TESCOD*

Technology in the electricity distribution business in Eskom is managed through what is known as the TESCOD process [Technology Steering Committee of Distribution]. The structures to manage this process were established in the early 1990s, primarily to ensure best practices evolved in support of electrification.

Earlier this year a proposal was put to the AMEU representatives on the ESLC by Eskom Distribution to become involved in this process formally. This would be a significant step towards integrating technology management locally. The benefits of co-operation in the area of standardization, as one element of technology standardization has generally been regarded as positive, and by becoming involved in the whole technology management process further mutually benefits can be expected. Such an integrated approach within the SA EDI provides the basis for effective participation in regional activities, and is proposed as necessary step for an effective contribution of our industry to NEPAD, as well as to effectively pool resources for direct local benefit. Such an initiative could effectively form the basis for an Industry Association for the SA EDI.

TESCOD operates with a structure based on the Cigré model of study committees. A key aspect is that study committees provide for representation and active participation of operational staff in the process.

This ensures buy-in to implement changes in the application of technology and direct feedback into on-going research, design and development with a view to continual improvements in the application of technology.

Studies committees cover technology areas of both primary plant and secondary plant. For example, planning, maintenance management, lines and cables, substations, land development, protection, control, metering, telecommunications [4].

The ESI and specifically in the context of EDI restructuring, the future REDS could well find themselves without any structure to manage technology unless a conscious effort is made to put a structure in place. While this would lead to an unhealthy situation in the local industry, it would also leave the REDs without a framework within which to effectively participate in the regional activities (PIESA and UPDEA).

It is suggested that while the EDI is still in the "hurry up and wait" stage of restructuring, the proposal of Eskom distribution to involve the AMEU membership in the TESCOD process should be actively encouraged. While there has been good participation for many years in the area of standardization, through the NRS working groups and the ESLC, this only addresses one link in the chain of technology management.

Engineers and technicians both from technical support functions and the operational areas could then have the opportunity to be involved in and influence the research, design and development activities, as well as using TESCOD as a forum for coordinating the implementation of standards, maintenance and operation.

This would not only be mutually beneficial, but also provide the framework for efficient participation of the SA EDI in the regional structures such as PIESA and UPDEA. In considering such cooperation, it needs to be understood by the managers who direct staff to be involved that the mutual benefits only accrue if the technical staff can have such activities included in the job descriptions or job compacts, and budgets.

It is suggested that some formal agreements also need to be facilitated within the local industry stakeholders to ensure that staff in the local regulated ESI, whether they are local government employees, or employees of parastatals or corporations, are appropriately empowered to participate in these pan-African activities. Without such empowerment, participation will remain a low priority, un-coordinated, and only undertaken by specific self-motivated individuals.

## Conclusions

The management of technology in the ESI locally should not be overlooked in the restructuring process. The AMEU members participation in the Eskom distribution TESCOD process will provide vehicle for moving to a future consolidated technology management process.

Coordination of the management of technology locally with pan-African Associations, such as PIESA and UPDEA will enable the SA ESI to effectively contribute to NEPAD. Empowerment of the participating employees is essential for sustained and effective participation.

## Acknowledgements

Documents, presentation material and papers from the following sources were used in compiling this paper:

[1] Duncan Mbonyana, Managing Director, Office of the CEO, Eskom

[2] Mr. A Covindassamy, World Bank USA; Energy in Africa: What is its future? - Keynote address, IERE Africa Forum Sustainable development of Electricity in Africa, Cape Town, South Africa, November 2001

[3] A Bekker, Eskom Distribution Technology

[4] Ian Ferguson, Eskom Distribution Δ

Continued from page 100

*Recruitment, selection and developmental assessment*

Where positions cannot be filled internally - due to additional and new positions being created - it will be necessary to recruit individuals from the external market. It may arise that a decision be taken to recruit both internally and externally simultaneously. Once the selection process has been undertaken, it is advisable that developmental assessments be undertaken for those individuals in senior positions. This will assist in mapping the key areas of development that will be needed to optimally meet the requirements of the role profile.

*Conditions of service realignment*

The creation of a municipal entity / RED can enable differentiation of terms and conditions of employment depending on the industry context and strategic objectives. In efforts to treat employees consistently and fairly, it will be necessary to examine the terms and conditions of employment that employees enjoy and highlight the keys areas for potential change. Once the status quo is understood, it is will be necessary to develop a strategy for standardising and amending such policies, procedures and terms and conditions of employment. It should be noted that not all policies and procedures can be standardised and due consideration will need to be given to the collective agreements that are in place, as well as relevant provisions of the Labour Relations Act.

*Collective bargaining realignment*

In the event that municipal entities are established, the applicability of the current collective bargaining structures and arrangements will need to be investigated. Arising from this investigation, it may be necessary to establish processes for ensuring effective bargaining arrangements within the municipal entity itself. In addition, a comprehensive collective engagement plan should be developed in order to ensure that employee and union participation regarding issues of employee consequence are addressed.

*Performance Management*

In order to heighten levels of service delivery, it is imperative that employees throughout the entity understand the strategy of the new organisation at a practical level. Employees should appreciate the role that they play in optimising service delivery to the community. This can occur through performance contracts for senior levels of management, as well as a through the development of a broader performance management system for the new organisation.

*Skills Development*

A skills development strategy is imperative not only in terms of legislative compliance, but to assist the organisation in practically realising its vision for heightened and equitable service delivery, as well as becoming a best practice employer. The skills development strategy can be developed following the migration process and through the use of the new organisational strategy.

*Employment Equity*

It is obvious that employment equity is a critical consideration for the new entity in its transformation plan. An employment equity process should be developed with the objective not only of submitting a report to the Department of Labour, but to ensure that employment equity is evident in the human resources practices throughout the organisation.

Employment equity should be an important consideration in the migration process as well as in any recruitment and selection initiatives.

### Conclusion

The above paper has sought to outline the key human resources and labour relations issues when transferring a business as a going concern. The paper has sought to demonstrate that:

- The process of transfer is regulated by a number of statutes including, but not limited to the Labour Relations Act and the Municipal Systems Act;
- The process of transfer can be further regulated through the existence of collective agreements at an industry level;
- An integrated HR strategy should be developed at the outset. The purpose of such a strategy would be to position the new entity to leverage the value of its human capital;
- A detailed LR strategy is critical to manage the transition, the process of transfer, migration and broader HR strategic projects. Δ

# Distribution voltage regulation management and optimisation

by CG Carter-Brown, chief engineer, Network Planning, Eskom Distribution, and Prof. CT Gaunt, University of Cape Town

**In distribution networks the maximum allowable voltage variation is a major and, often, primary constraint in network planning and design. Any assumptions for allowable voltage regulation limits can have a major impact on both the capital and life cycle costs of distribution networks [1].**

The magnitudes of the voltage variations experienced by customers are a result of the combined effects of voltage drops in the HV, MV and LV networks [2]. The HV, MV and LV planning and designing functions within Eskom Distribution are not necessarily performed by the same individual, and in many cases responsibility for the different network levels is divided between the Network Planning and Project Engineering sections in the Network Services department.

Standardised voltage regulation and voltage drop limits are required in Eskom Distribution for the planning, design and operation of HV, MV and LV networks in order to:

- improve the quality of the voltage supplied to customers by optimising existing networks.
- ensure that voltages are within the limits specified by the NRS 048
- provide fit-for-purpose standardised limits, taking into account the characteristics of different networks and thereby ensuring compatibility between HV, MV and LV network designs
- reduce/minimise HV, MV and LV network strengthening and expansion costs

## Distribution voltage regulation apportionment

The Eskom Distribution voltage control strategy is to keep MV regulated busbar voltages within required limits with automatic on-load tap-changing HV/MV transformers, and limit the maximum voltage drop in MV and LV networks. The maximum voltage drop must be apportioned between the MV and LV networks.

There has been no historical standardisation of the maximum allowable MV and LV voltage drops in the planning, design and operation of distribution networks; there have been only experience-based figures. These figures vary significantly, and are largely derived from outdated practices and assumptions regarding LV service voltages, allowable voltage regulation limits and equipment specifications.

There are two possible approaches to future MV/LV voltage drop apportionment:

*Option 1: Customised apportionment:* The maximum MV and LV voltage drops are optimised for each application, using case-specific network data, load forecasts and expectations of future changes. Detailed network studies are performed for each network expansion and strengthening project. The results and recommendations are influenced by a wide range of variables, and can be very sensitive to errors in the input data. The detailed assumptions and limits must be captured for future reference.

*Option 2: Standardised apportionment:* The maximum MV and LV voltage drops are standardised to provide a limited set of options that will cater adequately for most applications. Customisation is performed to the extent that the most suitable of the standardised limits is selected for a particular network, or section of network. This results in a reduced and manageable set of options and, consequently, extensive databases are not required to record the assumptions and voltage apportionment limits.

Option 2, standardised apportionment, is preferred for the following reasons:

- basic databases requirements
- reduced network analysis and reduced data dependency
- standardised limits take into account a wide range of factors, and comparatively basic staff training is required

## Eskom standard

A new Eskom Distribution voltage regulation apportionment standard has been developed, based on the following [3]:

- The Network Planning section classifies each MV network, or section of network, as one of four Network Classes. The Network Class describes the voltage drop apportionment as illustrated in Fig. 1. The classification process takes into consideration the networks, customers, equipment and load forecasts.
- The MV and LV voltage drops for each network must be kept within the standardised limits associated with each Network Class.
- In addition to the Network Class, each MV network (or section of MV network) is assigned one of three Tap Zones. The Tap Zone dictates the required tap setting of the MV/LV distribution transformer. Using the specified Tap Zones, operational staff can correctly adjust distribution transformer tap settings so that the voltage performance of the network is maximised. For a given Tap Zone, the level of MV/LV transformer tap boosting is dependent on the transformer's nominal secondary voltage such that different transformers (380 V, 400 V, 420 V, etc.) provide similar LV voltages. For example, 380 V and 400 V transformers will have different tap settings to account for the fact that additional tap boosting should be performed with a 380 V transformer compared with a 400 V unit

The standardised limits provide the maximum voltage limits within which the network must be planned, designed and operated. In many cases, the nature of the network and the consideration of technical losses may result in networks that are planned/designed in such a way that the voltage drops are less than the maximum limits.

The standardised voltage control settings, MV/LV transformer tap settings and voltage drop limits result in acceptable service voltages, and are compatible with historical South African specifications, including 380/220 V equipment.

The four Network Classes cater for a wide range of network types, ranging from high-density urban areas (such as those in the

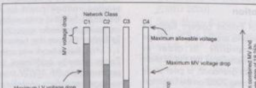


*Fig. 1: Voltage apportionment (four network classes)*

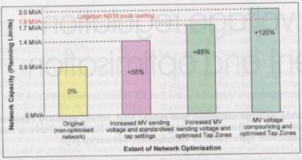


*Fig. 2: Lidgetton NB 16 capacity as a function of network optimisation activities*

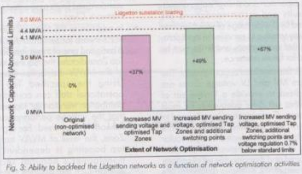


*Fig. 3: Ability to backfeed the Lidgetton networks as a function of network optimisation activities*

municipalities) to low density deep rural areas (such as those reticulated by Eskom).

An implication of this approach is that the same voltage drop apportionment may not apply to all installations, as is implied by some design guidelines. In some cases high variation of voltage will be permitted on the MV system, with close constraints on LV voltage variation, and in other cases a broad variation of LV system voltage will be preferred.

The voltage drop limits are dependent on equipment specifications and historical practices. In principle the Eskom strategy could be applied in a municipality. As municipalities generally reticulate urban areas, a reduced number of Network Classes would be required. In many cases a municipality could standardise on a single Network Class for all applications i.e. one voltage drop limit apportionment, one standardised MV voltage control setting and one set of MV/LV transformer tap settings (different settings for transformers with different nominal secondary voltages).

## Pilot application

The majority of Eskom Eastern Region's distribution networks are limited by voltage regulation constraints. In order to demonstrate the benefits of the application of the new Eskom Standard, a pilot study was performed during 2002 on the Lidgetton 11kV networks in the Kwa-Zulu Natal Midlands. The pilot had two key objectives:

- Establish the effectiveness and potential benefits of optimising the normal network such that the QOS to existing customers can be maximised and the capacity of the existing network increased.
- Analyse the present reticulation contingency (back-feeding) planning practices as these are directly effected by voltage regulation limits and optimisation activities (voltage control and transformer tap settings).

The pilot focused on voltage regulation related issues, and was undertaken by a team comprising the operational (Field Services and Electricity Delivery), network planning and design (Network Services) and Customer Services sections.

Increased loading had resulted in the installation of an 11 kV line voltage regulator on the Lidgetton NB16 feeder. The regulator had failed prior to the start of the pilot study, and was bypassed due to the lack of a suitable spare. This resulted in customer voltage complaints. Analysis of the network revealed that it was being operated in a sub-optimal fashion. Referring to Fig. 2, the sub-optimal network only had a capacity of 0,9 MVA, but was peaking at 1,8 MVA, hence the customer voltage complaints. Due to the historical practices regarding the tap settings of MV/LV transformers in the Lidgetton area, the MV sending voltage could be significantly increased (without over voltages) thereby increasing the feeder capacity to 1,4 MVA. To further improve the network capacity to 1,7 MVA, the network was split into two Tap Zones whereby additional boosting was performed on 86 MV/LV transformers. LV voltage recorders installed at various locations on the network measured a significant improvement in voltage regulation. There have been no customer voltage complaints since the application of the increased MV sending voltage and Tap Zones. Further studies indicate that the application of voltage compounding at Lidgetton will further increase NB16 capacity to 2,0 MVA.

The extent of network optimisation (normally open points, voltage control and transformer tap settings) also directly impacts the ability to backfed networks during contingencies. A single 5 MVA 88/11 kV transformer supplies the Lidgetton 11 kV networks. Studies were performed to assess the back-feeding capabilities in the event of the loss of the 11 kV Lidgetton source, and the results are illustrated in Fig. 3. Given the present loading levels, the original (non-optimised) network could only backfeed 3 MVA (65 %) of the Lidgetton load. By optimising the interconnecting networks (increasing MV sending voltages and the application of Tap Zones) 4,1 MVA (80 %) of the Lidgetton load can be backfed. Further increases in backfeeding capability are possible via the introduction of new switching points (or breaking jumpers) and accepting a small level of risk by allowing the voltages to drop slightly below standard limits.

Note that the feeder voltage performance is modeled as a probability based on a specified level of risk (network loading). The results are hence not absolute, and there will always be some uncertainty in the results.

The pilot project was a resounding success, with significant improvements in QOS and excellent buy-in and support by all involved. The conclusions are as follows:

- Standardising voltage control and MV/LV transformer tap settings could typically increase both normal and abnormal network capacities by 20% to 33% (predominately rural networks which are limited by voltage drop).
- In addition to standardised voltage control and MV/LV transformer tap settings, the use of multiple Tap Zones can increase normal rural network capacity by 45% to 85%, but operating the networks at these higher loading levels will result in a reduction in back-feeding capability.

## Implementation issues

The benefits of the new approach were demonstrated in the pilot application. Several issues are being addressed and project managed in order for it to become part of Eskom Distribution's normal business practices.

- Distribution Standard: A detailed technical standard is available on the Eskom Distribution Technology website detailing the approach, including examples, responsibilities and process flows.
- Suitable documentation: Certain parts of the business only need to apply specific aspects of the overall standard. Focused material is required and is being prepared to aid application and minimise training requirements. The focused documentation is aimed at improving the QOS voltage performance of networks, and educating both Eskom employees (and consultants) and customers on voltage issues:

- LV Network design: Aimed at the LV designer, including electrification designers.
- MV/LV transformer tap settings: Aimed at operational (Field Services) staff to standardise tap settings and assist with minimizing, and dealing with, customer voltage complaints.
- General information on voltage issues: Aimed at operational and customer services staff interacting with customers over issues including voltage complaints. Covers both the Eskom and customers' obligations, and some contributing factors such as appliances that are not strictly compatible with the South African Voltage Regulations.
- Customer information (on complaint): Provides further information describing both the Eskom and customer obligations. For sending to customers requesting it, or having voltage complaints.
- Customer information (newspaper and radio): Articles for the media describing how South Africa has changed from a 220 V to a 230 V standard and that voltages normally can and will vary. These articles are aimed at managing customer expectations. Similar articles on other QOS issues are also planned as part of a customer awareness campaign. Any potential conflict of interests with municipalities will need to be addressed as media campaigns will reach both Eskom and municipal customers.

- Staff training: Training is focused as follows:
  - Advanced: Aimed at engineers and technicians involved in the planning, design and operation of MV networks. Covers all the issues, including both MV and LV.
  - Intermediate: Aimed at LV planners and designers. Focuses on LV design issues.
  - Operations: Aimed at network operators, and focuses on MV/LV transformer tap settings and the handling of customer voltage complaints.
  - Customer services (non-technical): Targeted at call center and customer advisory staff. Focuses on the handling of customer voltage complaints, and provides a basic understanding of the issues. This information will assist customer service staff when advising customers for new supplies and installing new equipment, such that voltage related problems are minimised.
- Resources: Network optimisation engineers are required to ensure that the distribution network is operated within technical limits and is suitably optimised (transformer tap settings, voltage control settings, normally open points and load balancing). Network Planning is responsible for the strengthening and expansion of the network, but the day to day network operation is the responsibility of Network Optimisation. Traditionally there have been very few MV optimisation staff (the focus has been on the HV transmission and sub-transmission networks).
- Processes: Processes are required to manage Network Classes, transformer Tap Zones and voltage control settings.
- Systems and Databases: Need to support Tap Zones and Network Classes. By standardizing tap settings and voltage apportionment, the data storage requirement is minimised.
- Budget: The lack of standards and management has resulted in non-optimal MV/LV transformer tap settings. This needs to be addressed by a standardisation drive. Tap standardisation requires significant expenditure (each transformer needs to be checked) and must be integrated into the operational budget (as with maintenance records, load measurements etc).
- 380/220 V equipment: 380 V equipment needs to be actively phased out. Despite the fact that South Africa has a 400/230 V standard voltage [4], 380 V equipment can be purchased without any warning. Customers need to be aware that problems could arise with the operation of 380V equipment. As 380 V equipment fails so it should be replaced with 400 V equipment. This will take a long period of time (20 years plus), but needs to be actively managed. In the interim the proposed standard tap settings and voltage drops are compatible with historical specifications, but may result in isolated problems. In extreme cases, 380 V equipment may need to be de-rated or modified.
- Three phase motors: Have traditionally been designed for a continual voltage variation of $\pm$5% (IEC 60034) [5], but has recently been modified (SABS 1804-2) [6] for $\pm$10 % operation. South African LV<500 V service voltages are allowed to vary by 400/230 V $\pm$10 %. $\pm$10 % voltage variations can cause problems with older $\pm$5 % motors, and must be managed in order to minimise the number of related problems. Provided they are de-rated, $\pm$5 % motors can usually operate at larger voltage variations ($\pm$5 % motors typically need to be de-rated by 10 % to 20 % for $\pm$10 % operation [7]). The proposed standard approach should not require $\pm$5 % motors to be de-rated in urban supply areas, but limited de-rating (10 % to 20 %) may be required in rural networks.
- Culture change: There is presently the perception in Eskom Distribution that voltage and tap settings are not critical and don't need to be actively managed. Technical excellence is required for MV voltage regulation management and optimisation as voltage regulation is a primary constraint in many networks. Eskom Distribution staff need to understand that even though problems may not be evident (customers may not be complaining), the network may not be running optimally. In many cases the ability to backfeed networks is improved by standardising and optimizing network voltage regulation. Improved voltage regulation also increases energy consumption (and hence revenue) and customer satisfaction (improved appliance operation, efficiency and life span).
- Super users: A "super user" group has been established in each Eskom Distribution Region, with a representative from Network Planning, Network Optimisation (control), QOS and Field Services. The super users will drive the application of the new Eskom Standard.

## Conclusions

The application of a new standard will increase the capacity of existing and new Eskom distribution networks. The formal management of voltage drop limits, voltage control settings and MV/LV transformer tap settings will improve customer supply voltages and rural network capacity. The net cost savings are estimated at R25-million per annum due to cancelled and deferred network strengthening in rural areas as a result of increased capacity made available by the optimisation inherent in the new standard.

Application of the standard in urban networks, such as municipal areas, should minimise customer voltage complaints whilst ensuring that the network is planned, design and operated in an optimal manner.

## Acknowledgements

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# High stress design in the high voltage (42 kV-132 kV) cable range

by Mike Engelbrecht and Pravesh Haripersad, African Cables

**Improvements in cable insulating materials, the handling of these materials and production processes and facilities have now made it possible to produce XLPE insulated cables in the extra high voltage range (220 kV - 500 kV). Advantages for the high voltage (42 kV - 132 kV) cable range, due to these advancements, have included being able to push the electrical stress, traditionally associated with this range of cables, to higher limits.**

Particular attention is given to the cable design stress at the conductor/insulating interface and at the insulating/accessory interface. It goes without saying that the increased cable electric stress means that accessories also need to be capable of handling a higher electrical stress when compared to traditional designs.

African Cables has recently successfully type tested 132 kV, in-house produced, high stress design cables fitted with Pirelli terminations and joints. Cable stress has been increased some 25 % compared to the previous design while the accessory interface stress has been raised some 33 %.

One of the major advantages of the high stress design cable is its smaller diameter. Less material is used in manufacturing the cable and consequently the cost savings associated with the design are passed on to the end user.

## Introduction

African Cables has manufactured two high stress 132 kV XLPE cables, comprising a 300 mm² and a 1000 mm² copper conductor, in order to test a high stress design in terms of the IEC 60840 test specification.

Fig. 1 illustrates the individual components that constitute the 1000 mm² high stress cable.

The challenge for any manufacturer of a high stress design cable is to design a cable with stress levels that are acceptable, firstly from a material and process point of view, and secondly from an accessory interface point of view. With this taken into consideration, the maximum electric stress at the conductor/inner semi-conducting interface of the cable was designed to 8,0 kV/mm, as opposed to the existing design stress of 6,4 kV/mm. The stress at the accessory interface was designed to 4,0 kV/mm as opposed to 3,0 kV/mm.

The increase in stress was achieved by reducing the XLPE insulation thickness from 20 mm to 15 mm on the 300 mm² cable and 17 mm to 15 mm on the 1000 mm² cable. Cable stress at the conductor interface was increased by 25 %, and that at the accessory interface by 33 % when compared to the existing design stress levels.

## Background

*Electric stress theory*

The radial electric stress distribution of a single core circular cable is as illustrated in Fig. 2. The maximum stress occurs at the conductor surface, reducing in a hyperbolic curve, and becoming a minimum at the outer surface of the outer semi-conducting screen [1].

The maximum electric stress, Emax, which occurs at the conductor or inner semi-conducting interface is defined by equation 1. The minimum electric stress, Emin, which occurs at the outer semi-conducting screen or the inner surface of the sheath, is defined by equation 2 [1].

$$E_{max} = \frac{2U_0}{d.\ln\left(\frac{D}{d}\right)} \quad \text{kV/mm (Equation 1)}$$

and,

$$E_{min} = \frac{2U_0}{D.\ln\left(\frac{D}{d}\right)} \quad \text{kV/mm (Equation 2)}$$

where

$U_0$ = Phase voltage to earth (kV)

D = Diameter over XLPE insulation (mm)

d = Diameter over inner semi-conducting screen (mm)

*Manufacturing*

Work on the HV cables has shown that to raise the electric stress of XLPE cables it is essential that the extruded insulation is of high cleanliness, free of contamination and manufacturing defects, and that the screen interface is smooth [2]. In addition, an integrated extrusion plant employing a Vertical Continuous Vulcanising (VCV) process line is required. African Cables easily met these two criteria by carefully selecting imported insulating materials and by making use of their refurbished VCV extrusion line – the only one of its kind in South Africa.

The cable core is triple extruded and crosslinked in the fully enclosed process in which the inner semi-conducting screen, the XLPE insulation and the outer semi-conducting screen are applied simultaneously to the pre-heated cable conductor. Specialised in-line inspection techniques using X-rays are employed to monitor the dimensional accuracy of the

Fig. 1: Components of the 1000 mm² high stress cable manufactured by African Cables

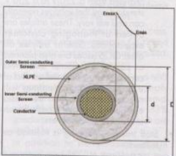


Fig. 2: Electric stress in a single core cable

Fig. 3: Routine microscopic examination of high voltage cable samples

Fig. 4: HV routine test lab - HV testing of high stress cable core

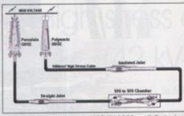

*Fig. 5: Type test loop on 132 kV 1000 mm² Cu high stress cable and accessories.*

extruded core, with the final cleanliness of the insulation being verified by careful microscopic examination of dissected cable samples from each drum length (Fig. 3). These examinations confirm the correct levels of insulation cleanliness, dimensional accuracy, crosslinking, moisture content, ageing performance and that degassing of the by-product has been achieved.

The VCV process is inherently the best method for the manufacture of cables with large insulation diameters and heavy conductors due to the vertical orientation of the conductor during the extrusion and crosslinking process. The force of gravity acts along the axis of the conductor, thereby assisting in the formation of a concentric and cylindrical insulation geometry, independent of the viscosity of the XLPE insulation.

The final stage of HV cable manufacture is the high voltage test, which comprises an HV withstand and a partial discharge detection test [3]. These tests take place in African Cables sophisticated HV Routine Test Lab (Fig. 4). The tests are of short duration, typically 30 minutes, and are capable of detecting the defects that initiate partial discharges, as small as one pico-coulomb. Such defects lead to gradual deterioration of the XLPE and eventually breakdown may occur.

*HV Accesories*

The manufacturing quality standards developed for high stress cables have also been applied to the design, manufacture and jointing of the accessories. In particular the accessories have to operate at the increased level of stress at the cable outer insulation screen, this being directly proportional to the value of cable design stress at the conductor screen. It follows that the outer insulation stress is highest on cables with larger conductor sizes. It is therefore essential that the accessories are designed to be completely compatible with the particular type and conductor size of high stress cable.

The jointing process is critical to the reliable operation of the accessories. In particular the cable screen has to be removed with precision and the exposed insulation carefully prepared to achieve the surface finish necessary to form the electrically stressed interface with the accessory insulation.

The following Pirelli HV terminations and joints were type tested with the locally manufactured high stress design cable: an Outdoor Sealing End; an Outdoor Polymeric Sealing End; two SF6 Immersed Dry-Type Sealing Ends; a Straight Joint; and an Insulated Joint (see Annex A).

### Type tests on high stress cable and accessories to IEC 60840

In order to prove the compatibility of HV cable and cable accessories, it is necessary to perform type tests in accordance with the IEC 60840 test specification. In terms of the IEC 60840 standard [3], type tests are defined as tests that are performed on a specific type of cable or a cable and its accessories, before they can be supplied on a general commercial basis.

During type testing the cable and its accessories must demonstrate their satisfactory performance for the intended application, and if successful the cable and its accessories may be offered as a fully approved type tested cable system. Once approved, type tests do not have to be repeated unless significant changes have been made to the cable or accessory materials, or to the design and manufacturing process.

When the type tests have been successfully performed on one type of cable with a specific value of rated voltage and on two samples with different cross-sectional areas of conductors, the type test approval is also valid for [3]:

- Cables with the same conductor cross-section, with slightly different rated voltage but belonging to the same voltage group as the tested cable.
- Cables of similar construction, in the same rated voltage group and with the same conductor cross-section.
- Cables in the same rated voltage group with all cross-sectional areas of conductors lying between the two on which the tests were made.

For the above reasons African Cables chose 132 kV, the highest voltage and subsequently the highest stress level in the HV group (42 kV - 132 kV) and two conductor cross-sections, a 300 mm² and a 1000 mm². Type test approval could then be claimed for the entire HV group with conductor cross-sections ranging between 300 mm² and a 1000 mm² copper and aluminium.

All type tests were conducted at SABS National Electrical Test Facility (NETFA). Fig. 5 illustrates the type test loop on the 132 kV 1000 mm² Cu high stress cable and accessories. The test loop constituted of the 1000 mm² high stress cable; one porcelain ODSE; one polymeric ODSE; one straight joint; two SF6 immersed sealing ends connected together in a chamber, and one insulated joint (Annex A).

The following tests were conducted on the cable samples to IEC 60840 requirements over a duration of about 7 weeks:

- Electrical Tests
  - The bend test followed by a partial discharge test
  - Heating cycle voltage test
  - Lightning impulse voltage test followed by an ac voltage test
  - Partial discharge tests
- Non-Electrical Tests
  - Dimension checks
  - Mechanical properties of thermo-plastic components
  - Compatibility of materials
  - Pressure tests at high temperature on cable sheaths
  - Hot set and shrinkage tests on XLPE

Type tests conducted at SABS NETFA were successful and African Cables was awarded type test certificates to confirm compliance of the high stress design cables and accessories to IEC 60840. The certificates of compliance are valid for high stress HV cables in the range 42 - 132 kV, and conductor sizes in the range of 300 mm² - 1000 mm² copper and aluminium. A complete cable system with high stress HV cables and accessories was thus approved and is now on offer to customers.

### Conclusion

Comparisons between the high stress cable and existing cable designs show that not only has the stress level increased, but a reduction in cable weight and cost savings have been achieved.

An increase in design stress has been achieved by the manufacture of clean and geometrically precise insulation from a plant integrated with African Cables VCV extrusion line, the only one of its kind in South Africa, which is essential to manufacture high stress HV cables.

Two high stress cables comprising of a 300 mm² and a 1000 mm² copper conductor with various Pirelli accessories were type tested at SABS NETFA. African Cables was awarded type test certification to confirm that the high stress system complied with the requirements of IEC 60840.

African Cables now offer a fully type tested high stress HV cable system to customers, ensuring reliability and cost effectiveness.

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## Annex A: Accessories utilised for the test

*132 kV outdoor terminations*

The 132 kV Outdoor Termination (ODSE), Fig. A-1 and A-2, is constructed from porcelain and polymeric material respectively, which serves as the main insulator.

The sealing ends are suitable for connection to single core polymeric cables up to system voltages of 145 kV.

The design will accept cable with conductor sizes up to 1000 mm², in either copper or aluminium.

The connection to the conductor is by means of a compression ferrule or CAD weld, depending on the conductor material. The electric field control is provided by means of a semi-conducting rubber electrode (stress cone). The surrounding medium is silicone fluid or polyisobutene [8].

*132 kV SF6 immersed dry-type sealing end*

The 132 kV SF6 Immersed Sealing End, Fig. A-3, is suitable for connection of a single core polymeric insulated cable to SF6 filled switchgear or oil filled transformer end boxes.

The sealing end is composed of a quartz filled epoxy resin insulator that can be mounted directly into the switchgear or transformer end box by means of a retaining ring.

The connection interface is in accordance to IEC 60859 [9].

*Straight and insulated joings*

Straight joints, Figure A-4, are suitable for the connection of single core polymeric cables with conductor sizes up to 1000 mm², either copper or aluminium.

The joint essentially consists of a one piece moulding with an integral semi-conducting outer screen and stress control components.

Stress control is so designed that the electric stress is reduced in the areas of contact between the joint and the cable.

The advantage of a premoulded joint lies in the fact that all parts produced are factory tested.

This avoids any manufacturing defect and means that once the joint is assembled, its reliability is comparable to that of the cable.

Fig. A-5, illustrates an insulated joint which is similar to the straight joint with the only exception being an additional concentric bonding cable lead and a non-continuous screen.

The concentric cable is essential for special bonding techniques, such as in cross-bonded or single point bonded systems. Δ

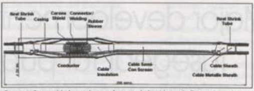

Fig. A-4: Premoulded straight joint for extruded cables with Cu or Al conductors

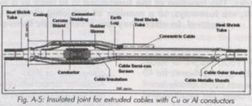

Fig. A-5: Insulated joint for extruded cables with Cu or Al conductors

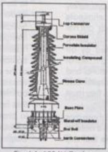

Fig. A-1: 132 kV Outdoor porcelain sealing end.

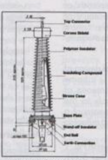

Fig. A-2: Outdoor polymer sealing end

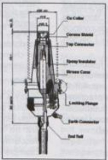
Fig. A-3: 132 kV SF6 Immersed dry-type sealing end

# Major developments in distribution fusegear for public networks

by TW Mennell, Public Distribution Products, Schneider Electric, Scarborough, UK

**Fuseboards, and their outdoor equivalent, feeder pillars, are the basis of low voltage distribution in most public networks. The function of the fuseboard is to take in a supply of electrical energy from a transformer and distribute it, via fuseways, to a number of outgoing circuits, providing each with a means of protection and control. In effect they are a very basic form of low-voltage (LV) switchboard.**

Prior to the mid 1980s, designs for feeder pillars had not changed significantly for 40 years. This paper sets out to identify recent pressures for change, the resulting and anticipated improvement to designs.

Today there are two major 'pressures' for change in LV electricity distribution; safety and, the desire to minimise or eliminate interruptions in supply. These 'needs' are not unique to one particular electricity utility, increasingly they are demanded by all electricity suppliers. As fuseboards are central to LV electricity distribution, the features and facilities they provide must accord with their changing environment, in addition, they must be cost effective for their application.

All utilities are cost conscious and those that are privatised, as is the trend, have a need to be profitable. It is highly desirable that any evolution is economically advantageous, but analysis should not be restricted to considering initial cost of individual pieces of equipment. 'Life time ownership costs' of the whole network taking full account of operational costs and likely future requirements is a more appropriate measure.

### Traditional designs

Fig. 1 shows a typical, traditional design of indoor fuseboard. Essentially it is a frame supporting: open busbars; a means of connecting the incoming supply to the busbars, either directly, or, by means of a simple disconnector (isolator); and outgoing fuseways.

The fuselinks used in the unit shown in Fig. 1 are in accordance with BS 88 Part 5 [1]. (These fuse links were very recently designated type gU with wedge tightening contacts in accordance with IEC 60269-2-1 Section VI [2].) Contemporary designs based around the use of fuselinks to DIN Standards (now known as fuse links with blade contacts in accordance with IEC 60269-2- 1 Section I) were similarly constructed.

Feeder pillars are essentially a fuseboard installed in a ground mounted weatherproof enclosure. They are suitable for installation outdoors without further protection. (Throughout this article the term 'fuseboard' will be used to include fuseboards and feeder pillars, unless otherwise indicated).

### Limitations

Traditional designs have their limitations:

- Personnel protection is not intentionally included; to IEC 60529 [3] they are categorised as IP00- "no protection"! Accidental contact with large areas of live and exposed conductors is only avoided by the care and diligence of the operator and, indeed, anyone else who happens to be in the vicinity of the fuseboard or feeder pillar with its doors open.
- Switching of circuits is carried out by the manual insertion and removal of the fuselinks. This potentially hazardous operation, relies on the skill and firmness of the operator to minimise arcing and ensure safe operation. When carrying out this operation, it is recommended that operators wear gloves and a visor to protect their hands and faces from burns, should arcing occur.
- Cabling of one circuit with those adjacent live and in service is extremely difficult with any degree of safety, due to the proximity of terminals to adjacent and unscreened conductors.
- Large supplies can only be accommodated by either, connecting two or three fuseways in parallel or, in some cases, taking the supply from the busbars via a disconnector (isolator).

With the latter arrangement the LV circuit relies on the MV switchgear on the primary side of the transformer for its protection, a significant limitation when earth faults across a delta star transformer are being considered.

### Pressures for change

Traditional designs of fuseboards have a good record and have served their application well.

Bearing in mind their obvious limitations, they have proved reliable in service and, due entirely to the skill and care with which they have been operated, safe in operation. However, times change, requirements, expectations and standards progress. Our two major pressures for change bring their often-conflicting requirements to bear in different ways.

### Safety

Today's society demands ever-greater inherent safety in all aspects of life and, the safety requirements for electrical switchgear are no exception. Improvements are frequently encouraged or obliged by law. Example of these are: The foreword of EN 50274 [4] summarises the pertinent requirements of applicable European Directives as follows:

'The Framework Directive (89/391/EEC) on Health and Safety sets out in article 6 - General Obligations on Employers:

(a) Remove the danger

*or if this is not possible*

(b) Separate the person from the danger by means of screens, barriers or obstacles.

*or if this is not possible*

(c) Provide personal protective equipment to ensure the health and safety of the person'

The statement *'Or if it is not possible'* linking the options does not allow a great deal of flexibility for new installations when, the technology and reasonable options are readily available to remove the danger. The UK's Electricity at Work Regulations [5] place similar obligations on employers and individuals. Specifically in respect of live conductors, Regulation 14 stipulates:

'No person shall be engaged in any work activity on or so near any live conductor (other than one suitably covered with insulating material so as to prevent danger) that danger may arise unless

- it is unreasonable in all the circumstances for it to be dead; and
- it is reasonable in all the circumstances for him to be at work on or near it while it is live; and
- suitable precautions (including where necessary the provision of suitable protective equipment) are taken to prevent injury.'

Fig. 1: Typical traditional indoor fuseboard.

Fig. 2: Shielded fuseboard

As with the European Directives the exposing of personnel to live conductors under any circumstances is effectively precluded within new installations.

South Africa also has stringent safety legislation and close links to UK requirements [10]. Work related obligations are set out in the RSA's Occupational Health and Safety Act (OHS Act) 1993 [6]. This imposes a wide range of duties on the employer. Those particularly pertinent to electrical applications and specifically fuseboards include:

'8:. General duties on employers and their employees:

- Every employer shall provide and maintain, as far as is reasonably practical, a working environment that is safe and without risk to the health of his employees.
- Without derogating from the generality of an employer's duties under subsection 1, the matters to which those duties refer include in particular
  - the provision and maintenance of systems of work, plant and machinery that, as far as reasonably practicable, are safe and without risk to health;
  - taking such steps as may be reasonably practicable to eliminate or mitigate any hazard or potential hazard to the safety or health of employees, before resorting to personal protective equipment.'

'10: General duties of manufacturers and others regarding articles an substances for use at work:

- Any person who designs, manufactures, imports, sells or supplies any article for use at work shall ensure, as far as is reasonably practicable, that the article is safe and without risks to health when properly used and that it complies with all the prescribed requirements'

'Electrical Machinery Regulations, 1988. 5: Switch and transformer premises:

- The user shall cause enclosed premises housing switchgear andtransformers to be of such a construction that persons cannot reach in and touch bare conductors or exposed live parts of electrical machinery.
- No person other than a person authorised thereto by the user shall enter, or be required or permitted by the user to enter, premises housing switchgear or transformers unless live conductors as insulated against inadvertent contact or are screened off, provided that the person so authorised may be accompanied by any person acting under his control.'

'Electrical Machinery Regulations, 1988. 6: Electrical control gear:

- The user shall, whenever reasonably practicable, provide switchgear with an interlocking device so arranged that the door or cover of a switch cannot be opened unless the switch is in the 'off' position and cannot be switched on unless the door or cover is locked.'

'Electrical Machinery Regulations, 1998. 7: Switchboards:

The user shall provide an unobstructed space for operating and maintenance staff at the back and front of all switchboards, and the space at the back shall be kept locked except for the purpose of inspection, alteration or repair: Provided that the requirements of this regulation with respect to the unobstructed space at the back of the switchboard shall not apply in the case of

- switchboards which have no uninsulated conductors accessible from the back;
- switchboards, the switchgear of which is a totally enclosed construction;
- switchboards, the back of which are only accessible through an opening in the wall or partition against which they are placed, such openings being kept closed and locked; and
- switchboards which can be safely and effectively maintained from the front and which have all parts accessible from the front.'

Again we see the exposing of personnel to live conductors is restricted and that the use of Personal Protective Equipment (PPE) must be a last resort.

This form of legislation leaves little room for manoeuvre. Strong requirements such as: 'Remove the danger, or if this is not possible', or, 'it is unreasonable in all the circumstances for it to be dead', or, 'taking such steps as are practicable to eliminate hazards before resorting to protective equipment', make it 'illegal' to install fuseboards that expose personnel in their vacinity to live conductors. LV assemblies, including fuseboards, that avoid exposing personnel to live conductors are readily available.

**Secure supply**

Increasingly, consumers are more demanding and less tolerant of interruptions in supply. Most are now computer dependent; to these a secure electricity supply is their 'life blood': dips and interruptions cause mayhem. In order to play its part in ensuring a secure supply the substation LV fuseboard must, as far as practical:

- Be capable of being, where necessary, maintained, repaired, or extended without the need for isolation of the assembly.
- Facilitate reconfiguration of the network with the maximum amount of the system live and in service.
- Offer alternative ratings of outgoing circuit up to and including the full capacity of the ransformer.
- Provide suitable overload and short circuit protection for each outgoing circuit, and, discrimination with up and down stream protection.
- Enable LV supplies to continue to be provided when the normal supply from the associated distribution transformer is not available.
- Minimise the number customers isolated when a fault occurs and when supplies are being restored. (Due to safety constraints some network operators isolate the MV supply in order to replace a single LV fuse link.)
- Minimise the skill, supervision and procedures necessary for safe operation. Enable the operation of fuseboards by personnel with widely differing skills and limited experience in fuseboard operation.

**The improvements**

Generally, change is an evolutionary process and fusegear improvements are no exception.

*Shielded Fusegear*

The first significant change has been the screening of all live conductors under normal service conditions (in the case of a feeder pillar with doors open). Whilst the approach may differ, depending upon the type of fuselink incorporated, the protection afforded is generally to the recognised level of IPXXB with all the fuselinks in place. This level of protection prevents accidental contact with live conductors. Anyone entering a substation to clean it or decorate it, or opening the doors of the feeder pillar to read the maximum demand indicators (MDIs), is safe from accidental contact with live parts. Fig. 2 shows a typical shielded fuseboard.

Switching of circuits with shielded fusegear is rarely proven by type test. It is, however, carried out in exactly the same manner as with the traditional design of equipment. As fuselinks have to be inserted and withdrawn manually, an operator requires the same level of skill, diligence and protection as previously. During this operation he may be exposed to live conductors and arcing associated with switching a load currents as with the earlier designs.

*Manually dependent switching*

Some designs of shielded fusegear based on the use of blade type fuse links now incorporate outgoing fuseways with a manually dependent switching capability. These arrangements offer some comfort but switching performance is still very dependent on the speed and firmness of the operator. The switching action of most designs incorporating fuse links with blade contacts is based on the fuse link being mounted inside a hinged cover that is pivoted at the bottom, a feature results in breaking at the top contact, essentially in the open and, in close proximity to the operators hand.

*Switched and insulated fusegear*

The logical progression from shielded fusegear is an arrangement whereby, the fuselinks are inserted and withdrawn in a manually independent manner. Fig. 3 shows such an arrangement, switched and insulated fusegear (SAIF) [7]. This offers the same level of protection against accidental contact with live parts as the shielded equipment, but the IPXXB protection is extended to the switching operation and the changing of fuselinks. In order to provide an assured switching capability, the fuseways within SAIF equipment include a switching capability independent of the skill and speed of the operator, effectively as for a conventional fuse switch with an independent manual mechanism. Technically it is feasible to provide single phase or 3 phase fuse switches for the application, but the costs are prohibitive. SAIF overcomes this difficulty by utilising a detachable, independent single phase spring mechanism.

This novel approach, enables the essential features of the fuse switch to be preserved, but at costs closer to those of the traditional fuseway. With SAIF, fuselinks are mounted in carriers and the carriers transferred between definite 'ON' and 'OFF' positions and vice versa with the detachable mechanism. The energy stored within the independent manual spring mechanism, is sufficient to insert the fuse safely onto a prospective fault of at least 50 kA, or break load currents in accordance with category AC22B of IEC 60947-3 [8]. As the operation is single phase, it has the advantage of fewer customers being disturbed in the event of a fuse link failure. SAIF is more suited to type 'gU' fuse links with wedge tightening contacts, however, an equivalent design for fuse links with blade contacts, as shown in Fig. 4, is now available.

*Safety interlocks*

Hitherto, fusegear relied solely on the skill and the diligence of the operators to ensure that it was operated correctly. There were no prompts or inherent safety features to ensure disconnectors were either fully open or fully closed; similarly, fuselinks could be partially inserted or, in the case of those with wedge tightening contacts, not fully tightened. With the SAIF type equipment, interlocks are provided to ensure that, disconnectors are either, closed and full contact pressure applied or, fully open, and locked open. Fuseways are operated with a detachable mechanism, which cannot be removed unless the fuse carrier is fully closed or, alternatively, it is in the definite 'off' position.

*Direct connection*

The close coupling of fuseboards and their associated transformers via a flange or similar, is tending to replace the traditional means of open overhead busbars, with it safety concerns, or cables. This can result in considerable cost savings, a reduction in the size of substation and shorter installation times. As the complete coupling system is provided by the transformer or fuseboard manufacturer, he is responsible for it, and the need for provision of cables or busbars on site is eliminated.

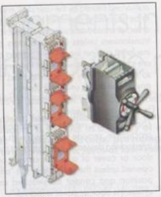

*Fig. 3: Switched and insulated fuseway*

*Fig. 4: Manually indepenent fuse switch-disconnector, blade type fuse lnks*

*Monitoring*

Conventionally, fuseboards have been provided with maximum demand indicators on the incoming transformer circuit. This crude means of monitoring gives an indication of the maximum transformer overload, following the last reset of the maximum demand indicators. It does not give any indication as to when the overload occurred, if it is repetitive, or which outgoing circuits are involved. This information is insufficient when looking at system utilisation and the need for reinforcement.

In order to improve management information substation monitoring systems capable of storing details of transformer loads and transmitting data via to GSM links, etc. to a host computer are now available. See Fig. 5. In the more dynamic cities and in particular financial capitals, some utilities see benefit in remotely monitoring all feeder circuits continuously and transmitting the loading details back to a central computer, which raises an alarm when a circuit passes into overload. Accurate on line loading data enables future problems to be predicted and solved in a controlled manner, and without the need for unplanned interruptions in supply.

*Incoming circuit breakers*

MV protection, generally in the form of fuses, has provided short circuit protection for the distribution transformer, the fuseboard incoming circuit and busbars. Usually, effective LV and transformer overload protection, has not been included. Transformers have been sized on the basis of assumed loads plus a margin. In some instances load changes have led to unidentified overloads and premature ageing of the transformers. Due to the number and rating of outgoing circuits, these situations can occur without a single outgoing circuit being overloaded.

To overcome this, some utilities are using a circuit breaker in place of the incoming disconnector to the fuseboard. In addition to providing the isolating facilities required, this affords effective overload protection for the transformer and, if so required, can provide back up earth fault protection and enable the full load of the transformer to be switched in a single operation.

If a circuit breaker is employed on the incoming circuit to a fuseboard, care is required to ensure that it can discriminate with the largest outgoing fuse. If there must be a compromise, this should take preference over discrimination between the ACB and the HV protection on the primary side of the transformer.

Where network loads frequently change, or, there is a history of overloading of transformers that has resulted in premature ageing and failure of transformers, or, where overload protection may provide the confidence to permit installation of a smaller transformer, incorporation of an incoming circuit breaker can be economically attractive.

*Standby generators*

Electricity Supply Utilities are seeking to improve and give a better service, usually measured in terms of the number of minutes lost and the number of customer interruptions. In order to keep customers on supply, many are using standby generators during the maintenance of HV switchgear or other equipment. The usual point of

*Fig. 5: Substation monitoring*

connection for a standby generator is the LV fuseboard. Initially, connections were bolted or clamped to the exposed LV busbars but, as fuseboards are now frequently fully shielded, this, apart from not being a very safe practice, is not an option. Fuseboards now often include a means of connecting the generator to the busbars, while they remain live from the normal supply but without exposure of the operator to live conductors.

The standby generator can then be synchronised to the normal supply, prior to its isolation and completion of the 'no break' changeover. Reversing the procedure enables the normal supply to be restored and the generator disconnected, again without an interruption in supplies to customers. For the majority of installations, disconnecting and re-connecting the normal supply requires the opening and closing of an incoming disconnector on the fuseboard. This device, as defined in IEC 60947-3, has no load making or breaking capability, but these limitations can be overcome.

Modern generator control systems are sufficiently sensitive and responsive so as to enable transfer of load to and from the standby generator while it is synchronised to the normal supply. This facilitates the isolation and reconnection of the normal supply, via the incoming disconnector on a fuseboard, without exceeding the defined capability of the disconnector. However, in addition to accurate speed and voltage control of the generator, care, skill and adherence to a strict procedure are required in order to ensure negligible current is interrupted and that minimal volts occur across the open contacts when the disconnector is opened.

Where preferred, the total reliance on care, skill and procedure can be reduced by replacing the incoming disconnector with a switch disconnector, as illustrated in Fig. 6. Switch disconnectors of the type illustrated have a certified manually dependent switching capability and their costs are not significantly higher than those of the disconnector generally incorporated as the incoming circuit to a fuseboard.

*Large supplies*

Where an LV supply with a capability in excess of 600 A is required from a fuseboard, practices are changing. Increasingly, moulded case circuit breakers (MCCBs) are being used for protection of these circuits in preference to reliance on MV switchgear, or LV fuses in parallel. Loads of this size are predominantly for 3 phase installations, reducing or even eliminating any advantage to be gained from single phase switching. MCCBs, and in particular those with a more sophisticated micro-processor based protection system, have advantage over the historical approach in this application. They provide:

- Effective overload and short circuit protection, and a proven means of isolation for the LV cables.
- The opportunity for earth fault protection with a setting to operate at much less than full load. This can permit the use of longer LV connections to the consumer, giving additional flexibility in system layout and the possibility of reduced cable and earth conductor sizes.
- Facilities for remote emergency tripping or tripping from the customers' installation.

### Note of caution

Many fuseboards presently in service are more than 50 years old. This long life has been achieved as a result of the fuseboards being; of an open and spacious design, based on generous section of conductor, and, the incorporation of the minimum amount of insulation to support the conductors.

As requirements progress, the combined pressures for operational flexibility, increased safety and economy have led to more compact assemblies, use of minimal section conductors, much wider use of insulating materials and an increased utilisation factor. Collectively these changes lead to a significant increase in operating temperatures, which, without adequate consideration at the design stage, leads to a high probability of premature ageing and early failure.

LV assemblies are thermally complex and their ageing mechanisms are not well understood. Plastics, and in particular thermo-plastics as now widely used, age rapidly with increased temperatures. Copper element fuse links, again as widely used for economic reasons, are much more prone to ageing and unexpected rupture at modest temperature than their predecessors with silver elements.

Such problems can be overcome with a good understanding of the application, careful selection of components and insulating materials and a limit on the temperature of fuse link elements under normal load conditions.

### Standards

The particular requirements for fuseboards for public networks have never been welladdressed in International or National Standards. In most instances they have been covered by utility specifications. Frequently these are of very prescriptive, of limited scope, and, very different for seemingly identical applications in other utilities. This has at last been recognised by the International Electromechanical (IEC). Work has commenced within IEC SC17D/MT11 to broaden the scope of IEC 60439-5 [9], to include fuseboards. In accordance with IEC requirements the standards should be performance based and an opportunity to detail and share 'best practise'.

### Choosing the most suitable option

Fig. 7 shows the typical modern fuseboard. This particular fuseboard provides personnel protection in accordance with IPXXB during all normal operations including changing fuselinks.

Fuseways are switched and the loading of all fuseways is continuously monitored in a central control room via CTs, transducers and a remote terminal unit. The fuseboard is close coupled to the transformer and transformer loading is continuously monitored by summating the fuseway loads in the central control room. Fuseways plug onto the busbars in order that additional units can be added with minimal disturbance, assuming busbar space is available.

Perhaps not all of the features of the fuseboard shown Fig. 7 will appeal to every utility. Each utility must evaluate and establish their own requirements considering the options outlined above and, their own particular obligations, needs, operational practises, future expectations and preferences. Economics will play a major part in the analysis, but, if the most viable solution is to be implemented it is vital this is not limited to the initial capital cost of the fuseboard. Analysis of the life-time ownership costs for the network is now a more usual approach, with areas considered including:

- Financial benefits of keeping customer on supply. Revenue lost due to supply interruptions often cannot be recovered. In a regulated network punitive penalties may be applied. Responding to dissatisfied customers consumes resources. More supply interruptions than expected leads to a damaged reputation.
- Current and likely future statutory safety obligations. The inconvenience and costs, should legal obligations be breached, may be significant.
- The benefits of equipment that is inherently 'safe' and simple to operate. When a useboard is suitable for operation by 'anyone' working on network, fewer people need to visit the substation. The costs associated with specialists skills, time waiting for the specialist, training, management and, operation of management safety systems may be reduced.
- The ability to re-configure the network without a substation outage. Being able to add future circuits and/or connect circuits with the remainder of the fuseboard live and in service can have considerable financial benefits in a

*Fig. 6: Manually dependent load break switch*

dynamic or developing network.

- Opportunities for increased operational flexibility and efficiency. The benefits of single phase switching in minimising the number of consumers involved in an interruption in supply are clear when considering a single-phase residential distribution systems. Being able to re-close a circuit in which the fuse link has previously operated, safely, and without the need to first connect a proving device can save time and cost. The ability to restore a faulted circuit without the need to interrupt other healthy supplies adds to the advantage.
- Reducing the need for PPE. In addition to its often being legally a last option; obtaining, regularly testing or replacing, maintaining and managing PPE incurs considerable cost. In addition, its use usually increases the time needed to carry out a task. Therefore, a small premium on the cost of a fuseboard for safety measures may be readily offset by reduced costs associated with PPE over the life of the fuseboard.
- Attendance at substations. The number and level of skill of personnel who visit a substation, for example to clean the substation or read the maximum demand indicators, may be reduced.
- The benefits of being able to connect reserve power. The ability to connect and disconnect a standby generator (or an interconnector to an adjacent substation) without interrupting supplies to customers can have significant benefits, particularly where customers are demanding a secure supply, or, in a regulated network.
- Alternative of an incoming circuit breaker. Providing effective overload protection for the transformer and fuseboard busbars has attraction when it prevents premature ageing of transformers, or, it enables smaller plant with a higher utilisation factor to be used with confidence.
- MCCBs for large outgoing circuits. Compared with fuses in parallel, MCCBs provide more sensitive protection for circuits and enable longer LV cables to be adequately protected, particularly in respect of earth faults. In addition, their single action to isolate a circuit is less prone to operator error than the alternative of removing six or nine fuse links.
- Substation configuration. Use of close coupled fuseboards and transformers (and ring main units) can reduce the overall size of a substation and eliminate the cable or busbar interconnections. This reduces civil and interconnection costs.
- Network utilisation. Remote monitoring of the incoming and/or outgoing circuits may be beneficial in assisting with asset management through, increased network utilisation, use of smaller plant, lower transformer losses and, prompt identification of a need to reinforce the network.
- Frequency and extent of maintenance. Maintenance is a disruptive and labour intensive process. With a suitable design, appropriate choice of materials and lubricants, use of 'non-deteriorating' contacts, etc. the amount of maintenance can be reduced and the interval between maintenance's extended. Subject to local legislation, suitable remote monitoring can further reduce the frequency of maintenance and attendance at substations.
- Reliability. The unexpected operation of an aged fuse link or the overheating of a connection results in considerable cost. Adding a little margin to the design, for example limiting temperatures, can considerably improve reliability.
- Life expectancy. For LV assemblies the most significant factor determining ageing is temperature. As a 'rule of thumb', the mechanical life of insulating materials is halved for every 10°C increase in working temperature. Hence, a small premium for the inclusion of conductors of sufficient section to ensure modest operating temperature and the selection of insulating materials with higher operating temperature capabilities may in the longer term be economic.

### What next?

The modern fuseboards is now "safe" and easy to operate with few concerns. In some cases they are intensely monitored, but this alone will not be sufficient to meet the ever-increasing demands for a guaranteed supply. A glance over the transformer may provide clues to the future. On the MV side the pressures are the same for a secure supply but, as the number of customers on each feeder is much greater, it is here that the initial effort has been concentrated.

On the MV side, the trend is towards automation and, in some instances, closed rings, in order to provide " no break supplies". The technology is available to automate the low voltage network.

Remotely operated circuit breakers can be used to control and protect LV supplies. When the balance of economics is such that this is attractive, the LV system will be automated.

### Conclusion

The requirements for feeder pillars have advanced considerably in the last 10 years, and will continue to do so. The need for much improved operator safety, fewer restrictions in operation and more flexibility in use has had, and continues to have, a considerable influence on fuseboard designs. The economy of the network as whole has and, will increasingly have in the future, a significant influence on fuseboard designs.

With the trend towards privatisation of public utilities, there is a need to deliver electricity profitably. This does not mean installing the cheapest equipment available, on the contrary it may mean the more expensive. The more enlightened supply operators are now making decisions on the basis of lifetime ownership costs. This takes into account, initial capital cost, cost of installation, anticipated life, maintenance costs, operating costs, lost revenue due to interruptions in supply, either planned or emergency, penalties if any for interruptions in supply, and so forth

*Fig. 7: Modern indoor fuseboard*

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# Telecomms opportunities for municipalities using distribution infrastructure

by Charles Kuun, Tshwane Electricity, City of Tshwane Metropolitan Municipality

**Since March 2003, four meetings were held during which municipal opportunities using the electricity distribution infrastructure for telecommunications were discussed and debated by the AMEU Telecommunications Workgroup. Presentations on the Metro Telco idea and blueprint business plans to members of the working group were arranged. This paper reports the findings of the AMEU Workgroup.**

## Introduction

It was found that within the present context and state of the telecommunications industry in South Africa, an ideal opportunity exists for the municipalities to participate in the activities of the Second Fixed Landline Network Operator.

It was concluded that this opportunity should be pursued because it could provide additional revenue generation possibilities for the electricity industry and accordingly for the municipalities willingly involved.

## Background

South Africa is in the process of liberalising the telecommunications service provisioning industry by establishing a Second Fixed Landline Network Operator, generally referred to as the Second Network Operator (SNO). After many iterative actions in the past, it seems that the 51% equity partner will be announced during August 2003 and the license from Government issued shortly afterwards.

The SNO will include Eskom Enterprises/Transtel (30 %), Black Economic Empowerment group Nexus (19 %) and a strategic equity partner (51 %). The real challenge is for the SNO to build a countrywide network within two years. Experience has taught that the classic SNO model worldwide has a limited penetration between 5 - 15 % and that only 6 SNOs are cash positive in the last ten years. They are mostly hampered by the obstacles of ability to get paying customers, long period to roll out national infrastructure and service delivery at local level.

SA Telkom has an annual income of some R33-billion from 6 million existing customers. The mobile phone subscribers totals 16 million. The SNO is seriously challenged by being a new entrant in the historically monopolised environment to have a core network installed by end November 2003.

Efficient roll out of new universal quality services to new paying customers need to be done in good time to ensure competitiveness. This has to be done within the ambits of acceptable return on investments made by overseas operator(s). The biggest challenge observed by the working group, is the absence of accessible last mile infrastructures.

## Metro Telco opportunity for local government (LG)

The electricity divisions of LGs, who own the electricity distribution grid, have already an installed base of contemporary power cables, optical fibre cables and wireless linkages to support their business. These could be deployed for telecommunication purposes, especially in the last mile, by applying the latest developments in powerline communication, wireless communication standards (IEEE 802.11, IEEE 802.16) and the latest telecommunication switching technologies. In using these facilities and available infrastructure for a Metro Telco, it was concluded that penetration rates would be much higher than with the traditional SNO and at a lower cost.

LG can also provide intellectual property rights and capital. By sharing in the total costs by means of joint ventures (JV) or public private partnerships (PPP) with the SNO, access to additional revenue generation can be accomplished.

It was noted that LGs already have an existing customers base and accompanying business processes and systems in place to provide the back office needed for provisioning of LG services. Additional telecommunication service delivery varying from low capacity digital communication to bandwidth on demand and broadband on available infrastructure can become a reality. By refreshing the digital infrastructure telecommunication services can be delivered on the core networks based on next generation network (NGN) technologies like asynchronous transfer mode (ATM), dense wave division multiplexing (DWDM), intelligent networks (IN), next generation network management systems (NMS) and state of the art customer relationship management (CRM) systems.

Applications can thus be run on multi-service internet protocol mediator platforms by applying multi protocol label switching (MPLS) technologies. It was observed that refreshing the infrastructure will not only bring about additional revenue generation possibilities, but will also benefit the electricity divisions of municipalities, and for that matter the electricity distribution industry in South Africa, as a whole.

It was observed that capacity and ability can be established to provide local services to the SNO by implementing either of two business models namely, equity participation in the SNO or a Metro Telco under the SNO license. These newly established Metro Telco's will bring tremendous socio-economic development potential along. It was concluded that Metro Telco's will by harnessing the Information and communication technology (ICT) revolution, contribute towards the quest of bridging the digital divide and thereby improve the lives of many people. From first iteration developed business plans on the Metro Telco idea, as particularly applied to the Tshwane case, it was observed that infrastructure refreshment can be applied and paid for in a short span of time, 4 - 6 years.

## Business structures

After many discussions and deliberations it was decided that in order to test the feasibility of a Metro Telco, either one or both of two models, described bellow, should be applied to the unique circumstances of individual municipalities. Favourable results thus obtained can be used as background knowledge during further negotiations with the SNO. They are very briefly:

- Equity participation in SNO
  - *Advantages*
    - SNO supplies infrastructure
    - No need for operator in LG
    - Get income from SNO
    - Less communication experience needed
    - Low Capex
  - *Disadvantages*
    - Low income potential
    - SNO controls infrastructure
    - Weak negotiating position
    - No control over income
    - SNO controls customers
    - License issue
- Metro Telco under SNO license
  - *Advantages*
    - High income potential
    - Control infrastructure
    - Control customers
    - Control income
    - Low exposure to SNO
    - License cover through SNO
  - *Disadvantages*
    - Must roll out own infrastructure
    - Need Telco experience?
    - Capital investment
    - Need operator providing billing and experience

The feasibility of a Metro Telco was at first tested by applying these models to the City of Tshwane's already partly developed infrastructure. The outcomes proved that a Metro Telco is feasible in Tshwane.

In an attempt to determine the feasibility of similar Metro Telcos in other munics, Gauteng Economic Development Agency (GEDA), has made a sponsorship available to assist any other Metros in South Africa with the initial audit on related telecommunications infrastructure. After the information from the audit has become available business modelling can proceed. The outcomes will reveal the viability and then a conceptual network design will be done in order to determine the costs involved to become fully functional and profitable.

**Action plan**

The workgroup decided to recommend the following steps to be taken in an attempt to make optimal use of the SNO opportunity:

- Create Metro Telco action (lobby) group
- Employ expert consultants to do the work
- Apply to put case of Metro Telco to the Department of Communication (DOC)
- Create Metro Telco business structure and final business plan
- Get other partners involved (Operator and Finance)
- Put political support plan in place
- Negotiate SNO participation with DOC
- Due diligence on partners

**Steps taken by the working group**

- Consensus still to be reached on whether each Metro should negotiate as an entity by itself or whether a collective group from all the Metros should enter into negotiations with the SNO.
- GEDA have offered a sponsorship to assist with the audit and business modelling. Separate quotes were also obtained from consultants that will be considered in due course.
- A letter was written to the Minister of Telecommunications on behalf of the AMEU telecommunications workgroup to explain the case of the Metro Telco. In response to this letter it was indicated that an official bid should be submitted via the laid down routes. A presentation was also made to representatives from the Department of Communication (DOC) in which the case of the Metro Telco was explained. The DOC was very impressed and suggested that the initiative should be pursued and further developed.
- A business structure, as explained above, and a financial modelling tool was developed and applied to Tshwane Metro. Information generated at Tshwane and the financial modelling tools were made available to all members of the working group to test, become familiar with and apply.
- Initial contacts were made with financiers to test the availability of funding. Seeing that the business model depends to a great extent on the licensing of the SNO, it was decided to wait a while.
- Workgroup members are attempting to put up meetings with the higher political structures. It is planned to make a presentation to them and try to get their buy-in.
- Negotiations with the SNO have not taken place except for on an ad hoc basis. From preliminary discussions it became very clear that both the short-listed bidders on the 51 % stake are very keen on the Metro Telco idea. Two Consortium have included the Metro Telco as a strategic equity partner in their business-plan and CommuniTel have indicated they will pursue the initiative very soon if they were to be the successful bidder on the 51% equity stake. Documentation is available to support this.
- Due diligence sponsorship has been arranged with GEDA as explained above.

**Case studies**

A number of case studies were cited, shared amongst the members and summarised below. It was noted that in each case, the electricity distribution infrastructure was used extensively to bring about the developments and bring about socio-economic development.

*Infocomm 21 - Singapore*

This initiative by the Singapore Government is aimed at developing Singapore into a vibrant and dynamic information and communication technology capital with a thriving and prosperous e-economy and a pervasive and Infocomm-savvy e-society.

The strategic thrusts of Infocomm 21 are:

- To position Singapore as premier infocomm hub

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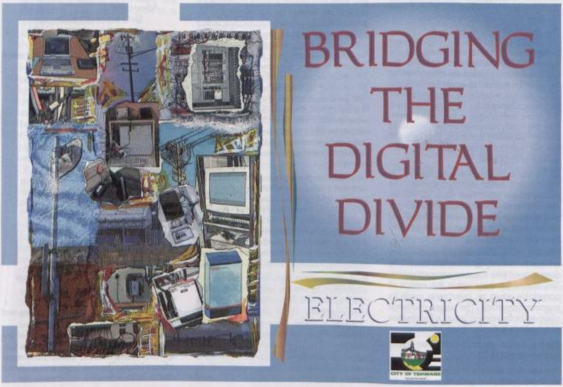


# Last mile telecommunications at Tshwane

by Maarten van Helden, City of Tshwane Metropolitan Municipality

**Last mile telecommunication is a concept quite new to the electricity industry. These services have been provided by Telkom over the last seventy odd years for which they have had the sole mandate to deliver these services. With the Second National Operator (SNO) coming into play soon, all of this will change. This paper reports on an investigation into last mile telecommunications at the city of Tshwane.**

## What is the Last Mile?

The last mile in telecommunication is the term used for the link/bridge between a telecommunication service provider like Telkom or the Second Network Operator (SNO) and the end user/subscriber. Currently these services or the last mile are being provided by Telkom by means of, mostly, telephone lines.

With the SNO coming into play, Telkom will no longer have sole mandate over the provision of last mile services. However in the case of the SNO, the problem of bridging the last mile arises.

It is just not viable for the SNO to roll out copper lines to each and every end user or subscriber in the same way that Telkom invested in their infrastructure over the last 70 odd years. It is for this reason that we here at the City of Tshwane have been investigating several last mile access alternatives.

Two of these alternatives are power line communication (PLC) and wireless access.

## Power line communication – PLC

Power line communication is not a new concept. It has been used by Eskom for telemetry purposes for a number of years already, at very low bandwidths/data rates. It is only recently that development in the field reached a level where broadband services such as telephony, high speed Internet access, video streaming, etc. can be supplied using the electricity network/ grid.

Power line communication works on the simple principle of providing voice and data services over the existing electricity infrastructure. Data and voice signals are injected into the network at a central point on the electricity network by means of some kind of PLC coupling device and the end user can retrieve these data or voice signals by means of a PLC modem.

| Manufacturer | Chipset | Country | Data Rate |
|---|---|---|---|
| ASCOM | ASCOM | Switzerland | 4.5 Mbps |
| Inovatech | DS2 | Australia | 45 Mbps |
| Main.Net | Itron | Israel | 2.5 Mbps |
| Sumitomo | DS2 | Japan | 45 Mbps |
| Ambient | DS2 | U.S.A. | > 10 Mbps |

*Table 1: The five PLC technologies*

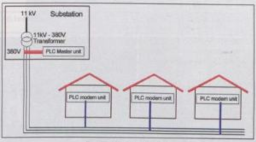



*Fig. 1. LV-PLC architecture*

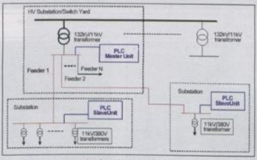



*Fig. 2. MV-PLC architecture*

Two divisions of PLC exist currently: medium voltage (MV-PLC) and low voltage (LV-PLC). With MV-PLC the 11 kV electricity network is used for primary data distribution, whereas with LV-PLC the 380 V consumer distribution network is used.

A typical LV-PLC system is shown in Fig. 1.

LV PLC is currently installed or being rolled out at various sites in Europe where electricity utility companies provide telecommunications services to their customers over the power lines using some or other kind of PLC technology.

At Tshwane we currently have four installations where the possibilities of providing telecommunication services under license of the SNO are currently being investigated.

MV PLC is still in the early stages of development and not much success has been reached in this field. The main reasons being that the general length of 11 kV cables is too great for the distance the injected signal can travel and some safety issues exists where the PLC equipment needs to be coupled onto 11 kV cables/switchgear/busbars.

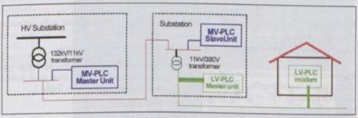
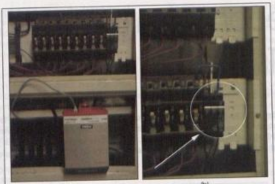



*Fig. 3. MV/LV-PLC architecture*



(a) (b)

*Fig. 4: Typical ASCOM PLC Master unit (a) and conductive coupling method (b).*

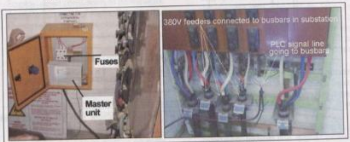
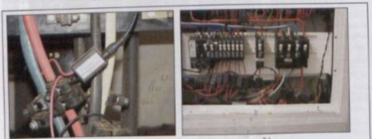



*Fig. 5: Main.Net equipment connected to the electricity infrastructure*

(a) (b)

*Fig. 7: MultiCat (a) and IPCat (b) of the Inovatech PLC system*



(a) (b)

*Fig. 8: Different coupling methods: (a) Capacitive and (b) inductive.*

The typical architecture of a MV-PLC system is illustrated is Fig. 2.

A typical system that combines both MV- and LV-PLC are shown in Fig. 3.

At Tshwane we have already rolled out four pilot projects regarding PLC. These include an office building, PLC in a laboratory, and two residential areas.

In all four cases it was be shown that it is possible to provide last mile access via power lines.

*PLC technologies available*

The five PLC technologies have been investigated at Tshwane and can be summarised as shown in Table 1.

### PLC pilots

A few PLC pilots have been rolled out in the last two years in South Africa by Tshwane and Eskom. The technologies tested up to date are ASCOM (Tshwane), Inovatech (Tshwane) and Main.Net (Eskom).

All three pilot systems have been rolled out successfully and future pilots with Sumitomo, Ambient and others will also be investigated. A short summary of these pilot systems are listed below.

*ASCOM power line communication*

The ASCOM PLC system has been successfully rolled out and tested by Tshwane during the course of 2002/2003 at various sites. The first pilot was at the Electronic Services offices in Tshwane. The Tshwane pilot was from a substation some 400 m away on overhead lines to the office building.

The second pilot is in a laboratory environment at the University of Pretoria (UP), where ten computers are connected via the electricity infrastructure and PLC. Data rates of up to 4,2 Mbps were measured in both the Tshwane and UP pilots.

Thirdly the ASCOM PLC system is being used for the roll out of PLC in a residential area. With this pilot, broadband services are provided to a few residential homes. Fig. 4 shows the ASCOM equipment as installed and coupled to the electricity grid.

*Main.Net*

The Main.Net PLC pilot was rolled out by Eskom TSI, their research division. The pilot successfully supplied Internet access via power lines to five residential users.

The minisub where the signal was injected was about 450 m from the furthest point in the PLC network. A constant data rate of 2 Mbps was shared amongst the five users. Fig. 5 shows the Main.Net PLC equipment as it is connected to the electricity infrastructure.

*Inovatech*

The Inovatech pilot was rolled by Tshwane and is currently still running. It is rolled in the same way as described for the ASCOM Tshwane pilot above. Data rates of up to 18 Mbps (11 Mbps downlink and 7 Mbps uplink) were measured.

This system also includes automatic meter reading whereby the meter data are also transferred via the power lines.

In Fig. 7 the MultiCat (Master unit) and IPCat (Slave unit) can be seen, while Fig. 8 shows how the system can be connected to the electricity grid.

### Wireless access

Another way of bridging the last mile is by going wireless. There are several wireless standards but the two of interest is IEEE 802.11 and IEEE 802.16.

The IEEE 802.16 wireless standard is a Wireless Metropolitan Area Network (W-MAN) standard that provides point to multipoint broadband primary data distribution. With this standard (approved and introduced in January 2003), data

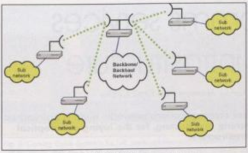



*Fig. 9: Typical IEEE 802.16 Wireless MAN network*

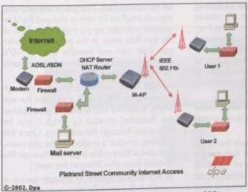



*Fig. 10: IEEE 802.11b Wireless application - courtesy of DPA*

transmission rates of up to 120 Mbps can be achieved. This wireless standard was designed to distribute high bandwidth data to multiple points throughout the network from one central point. Fig. 9 shows a typical Wireless MAN network application.

The IEEE 802.16 Wireless MAN standard is however operating in the licensed frequency band (6 GHz up to 50 GHz) for which an operating license is required. The advantage of the licensed frequency band is that one will be the sole user of that band with no other users in the same band.

The other drawback of this standard is that equipment is extremely expensive, partially because of the fact that technology is still brand new and equipment will be first generation equipment.

The IEEE 802.11 wireless standard is a wireless local area network (W-LAN) standard that provides point to point or point to multipoint data distribution. With this standard data rates of up to 22 Mbps can be achieve and is designed to provide data access to single users. Fig. 10 shows an application of IEEE 802.11 wireless standard.

The advantage of this standard is that it operates within the free/unlicensed frequency bands (2,3 GHz and 5,88 GHz) for which no license is required. The drawback of this is that any one can use this band and interference can quite easily occur.

Another advantage is that the technology has been around for about 11 to 15 years and the equipment comes at a relatively low cost.

These two wireless standards combined provides efficient and easy to roll out last mile solutions where the IEEE 802.16 standard can be used to distribute data from a central point to several distribution points (long distances), and the IEEE 802.11 standard can be used to distribute the data further to the end user (shorter distances).

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# Optical fibre telecomms services utilising municipal infrastructure

by Pieter Viljoen, manager: product and technical marketing, Aberdare Fibre Optic Cables

**Currently more than a third of the cost associated with an optical communications networks build is entrenched in the civils cost of providing an environment, normally trenching and ducting, for the laying of an optical communications cable infrastructure.**

Since civils practices for trenching and ducting is a matured technology it's difficult to decrease the cost and increase the provisioning of such projects. Furthermore, civils and construction presents an upfront cost and financing such projects can be difficult.

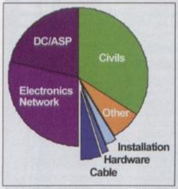


*Fig. 1: A typical breakdown of the cost involved in deploying an optical fibre cable network in an urban environment.*

These difficulties are further compounded in an urban environment, where disruption to traffic and basic services are normally the result of such civil works.

Clearly, for a network rollout unnecessary civils works i.e. trenching must be minimised at all cost. One of the more popular ways of reducing the civils scope in an optical fibre network infrastructure rollout is the use of alternative rights of way.

### Alternative rights of ways

One of the earliest pioneers of the implementation of an alternative right of way was in the power transport markets, where electricity transport utilities used their pylons as an alternative to trenching.

By using aerial cables, such as all-dielectric self supporting (ADSS) cables and composite optical groundwire (OPGW) cables, these utilities were able to roll-out optical communication infrastructures at a significantly lower cost compared to the traditional deployment through trenching.

Today, more utilities, such as gas, water and transport, are exploiting their own service infrastructures as an alternative right of way for the provisioning of optical communications networks. By exploiting these shared service infrastructures utilities have the added benefit over providing their communications needs, of having a second source of income through the leasing of communication services or infrastructure to the local incumbent telecommunications provider as well as any competitive telecommunications providers.

Using existing conduits (such as sewer, water or gas pipes) for multiple uses is not a new concept.

Early attempts were in Paris more than 100 years ago but poor results led to the abandonment of the concept of installing multiple utilities in the same underground tunnels. The first invention for using existing sewers for installing communications cables was developed by a group of engineers from the Water Research Centre in the UK, in 1984.

This invention was further refined by the development of the Nippon Hume robot, in Japan, and led to the installation of more than 990 km of optical fibre cables in the Tokyo Metro sewer system.

There are at least five robot companies, for the installation of optical fibre in existing fluid conduits for additional functions not originally intended: CableRunner; DTI-CableCat; Ka-te; Nippon Hume; and Robotic Cabling GmbH Kabelverlegung. In Fig. 2 an example of the BerliKomm robot is shown, as well as the attachment of the optical fibre cable to the roof of a sewer.

Sempra Fiber Links, Alcatel and Gastec are some of the companies that offer new technologies for installing optical fibre cables in natural gas pipes.

In Sempra's technology, special fittings are attached after tapping the gas main at two locations to form the entry and exit points for the optical fibre. The gas mains could be even as small as 25 mm in size and the fibre conduit will take up no more than 10% of the gas flow area. In the event a particular gas line can not handle even a 10% reduction in capacity, additional pipe capacity can be added.

A small HDPE conduit is threaded through the entrance fitting until it reaches the exit fitting. A special tool is used to grab hold of the threaded conduit by which it can be pulled out through the exit fitting. Once this housing conduit is in place in the gas main, the optical fibre cable is pushed through this conduit from one fitting to the next.

In the Alcatel system, a balloon device is used to pull a specially designed optical fibre cable through the inlet port clear through the outlet using a gas pressure differential. The cable itself has a special metallic barrier, to prevent hydrogen gas migration. Again, the seals and the ports are designed to meet various safety regulations.

Gastec offers a solution where a specifically designed shuttle pulls a cord from the inlet attached to the gas main all the way to the exit port using a gas pressure differential. This is done by creating an overpressure of about 150 mbar at the inlet side while a negative pressure is created by flaring off gas through the venting safety valve at the outlet side.

If for some reason, the shuttle gets stuck, the exact position will be known to the engineers from the transmitter signal built into the shuttle.

An added benefit of optical fibre in gas deployment is that an extra pair of fibre can be used as a leak detection system by collecting spatial resolution data. When an engineer applies Raman's law and the Joule-Thompson effect, the exact point along the

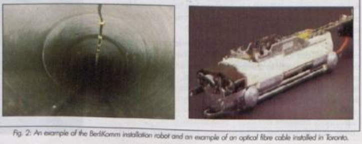

*Fig. 2: An example of the BerliKomm installation robot and an example of an optical fibre cable installed in Toronto.*

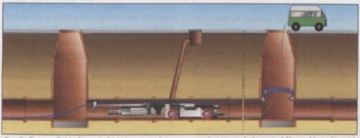

Fig. 3: Corning Cable System's S.L.I.M. sewer solution uses a robot to attach the optical fibre cable to the roof of the sewer. With the S.L.I.M. technique the robot is controlled remotely above ground and it is possible to install multiple cables in a particular sewer run.

pipe alignment where a leak appears can be detected within a short response time to take appropriate remedial action. Corning Cable Systems (CCS) offers two distinct solutions. The first solution is the SLIM cable technology where a robot attached and optical fibre cable to the roof of a sewer.

This installation method is similar to the previously discussed methods, and a schematic of the installation process is shown in Fig. 3.

CCS has further refined this process and up to four optical fibre cables can be installed in a particular sewer run. The second solution offered by CCS is the MCS drain technology, which offers a installation method whereby the integrity of the sewer duct system remains intact as the cable is not attached to the sewer wall.

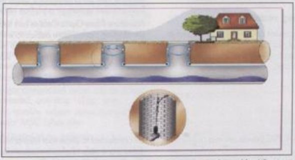

Fig. 4: The MCS Drain solution from Corning Cable Systems negates the need for drilling into the sewer wall, as the cable is tensioned between two manholes over guide pulleys which are attached into the manhole wall. Using this installation technique, the possibility of contaminating the groundwater is negated as the integrity of the sewer or drain walling remains intact.

In this case the cable is tensioned between two manholes over guiding pulleys attached to the wall of the manhole, as shown in Fig. 4.

The other advantage of the MCS installation technique is that no additional equipment is needed. The cable is carried between each manhole by a normal sewer cleaning head provided that the manholes are not spaced to far apart.

This technique is ideal for sewer diameters in the 250 to 500 mm ID range and has been deployed in sewers down to 160 mm ID. Using the MCS drain technology it is possible to install more than 1000 m of optical fibre a day.

### Possible business plans for optical fibre cable in shared fluid conduits

- The optical fibre infrastructure builder will either purchase or lease existing retired pipelines that are no longer in used in active service in exchange for either an upfront payment or an annuity type payment to the owner of this strategic asset. Pacific Gas and Electric, Key Span Energy, Con Edison, Atlanta Gas, Peco Energy, are all examples of this business model.
- Make the pipe owner a business partner. In this case reserve capacity in the existing pipe network could be used by the optical fibre infrastructure builder for installing last mile optical fibre in exchange for a negotiated percentage of the gross revenue. Cities of Albuquerque and Indianapolis are examples.
- The owner of the existing pipe network will take on network providers, content providers and vendors as partners to install optical fibre in their pipe network and operate this network. Other than a few optical fibres needed by the pipe network for self regulatory communications, the rest would be leased to any number of the above mentioned partners for additional revenue. In this instance the majority of the cost for rolling out the optical fibre network is borne by the pipe network owner. The city of Berlin uses this business model.
- The pipe network owner can further build and manage its own optical fibre network through its existing pipe network infrastructure. The cities of Tokyo, Hamburg, Vienna, Boston, New York and Los Angeles are examples of this.

### Concluding remarks

The development of optical fibre cables in existing piplines offers a win-win situation for all parties involved if proper standard of care is afforded.

However, working in sewers and natural gas pipelines requires sound pipline engineering input and anything less than that would be shortsighted.

For telecommunications carriers and service providers, these solutions represent a true end-to-end last mile optical fibre network which they could control. For the sewer, water or natural gas pipe infrastructure owners this technology enables an unique and powerful economic development tool, providing added revenue from an existing infrastructure.

Aberdare Fibre Optic Cables will be more than willing to assist with further information. The information provided only highlights the different ways in which an optical fibre cable network can be alternatively deployed in a fluid conduit system or a pipline network.

Aberdare Fibre Optic Cables has looked at developing optical fibre cables to with stand these unique environments as well as improving the economics of such an alternative rollout. Δ

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### Last mile access pilot projects

At Tshwane we have eight last mile access pilot projects. These projects are all aimed at testing the ability and feasibility of different last mile access methods. The eight projects are summarised as follows.

- Project 1: Power Line Communication (PLC) in a laboratory environment.
  This project investigates the use and implementation of low voltage power line communication (PLC) in a laboratory type environment, where traffic-capacity, HF interference, HF propagation, and network security is studied.
- Project 2: The use of electrical network infrastructure to support the learning process in schools.
  This project involves the evaluation of the electrical supporting network infrastructure to supplement the present distribution of learning material to schools by making available video streaming on demand. It also investigates the integration of the Gauteng on Line (GOL) programme of Internet to schools.
- Project 3: Internet connectivity to schools.
  This project investigates the ability of the electrical network supporting infrastructure to provide Internet connectivity to schools using PLC equipment. The project will integrate with the current GOL programme.
- Project 4: PLC power cell in a residential area.
  This project will evaluate the ability to provide high bandwidth last mile access to residential users by means of PLC equipment over the low voltage network.
- Project 5: Application of wireless standard IEEE802.11b in a community network.
  The project will evaluate the ability of the IEEE802.11b standard to provide Internet connectivity in a residential community.
- Project 6: Medium voltage PLC.
  The project will evaluate the feasibility to use the 11 kV electricity network to provide broadband data services.
- Project 7: IEEE802.16 Wireless MAN standard.
  This project will explore the deployment of the IEEE802.16 Wireless Metropolitan Area Network (MAN) standard for the purpose of telecommunication services.
- Project 8: PLC Pilot test Site.
  This project explores the deployment of PLC from a substation on overhead lines to the Electronic Services offices at the City of Tshwane.

These projects make use of a combination of PLC and wireless technologies amongst others to provide telecommunication services. This extensive range of projects are all conducted to show that Metro/Municipal Telco's are able to play an important role in the Second National Operator and to provide last mile telecommunication services to the end user.

### Conclusion

The investigation into last mile telecommunications proves that the available technologies can be used by an electricity utility to provide telecommunication services as an addition to the traditional supply of electricity. This can be a great solution to generate new and extra revenue an electricity utility.

The provision of telecommunications does not only include the generation of new or extra revenue, but it can be the carrier of other services required or provided by local Metro's or Municipalities.

Services that can piggy back on telecommunication infrastructure include remote metering (electricity and water), ripple control, SCADA, traffic light monitoring, streetlight control, etc.

The provision of last mile telecommunication is a new and very exiting field in the electricity supply industry and time to get a peace of the pie is running out fast!

### References

PLC: Demonstrating the convergence capability of the technology; Fernando Nogueira; June 2003.

http://www.platrand.co.za Δ

continued from page 122

- To develop Singapore business online
- To develop Singapore Government online
- To develop a Singapore society that is infocomm-savvy
- To develop Singapore as infocomm talent capital
- To enable economic growth and development

*Malaysia - The Multimedia Super Corridor (MSC)*

The MSC is a technology initiative by the Malaysian government to support developers and users seeking to deliver high-value multimedia services and products to customers across an economically vibrant Asia and the world. To reach this objective it aims to bring together all the elements needed to create an environment that engenders truly mutual enrichment for all kinds of IT/multimedia companies. The elements are:

- Leading-edge soft infrastructure;
- World-class IT networks;
- Major designated cyber city as a high-powered, one-stop shop; and
- Top-quality urban development in a major MSC cyber city.

*Dublin Digital Hub - Ireland*

The Irish believe the following for a digital hub.

"The Digital Hub will create an information infrastructure, which will be the foundation and generator of a new economic base for Irish and international digital media companies."

- The Dublin Digital Hub will be delivered through among others, the following: high-speed broadband infrastructure available in the immediate area
- Initiation of public private partnerships (PPP) tender process for the delivery of a mix of digital media, enterprise, learning, retail and residential development.
- Information/marketing centre as a general information point and digital media showcase
- Temporary accommodation for companies, on-site Enterprise Ireland support services, learning and training initiatives and short-term digital media related uses
- Commencement of refurbishment of Thomas Street properties for integrated mix of enterprise, learning and living over the shop development.
- Improvement to the environment in the core development with tree planting, signage, lighting and digital media installations.
- The Digital Hub will be a meeting place for enterprise, creativity and technology and will be enabled through collaborative projects between creative enterprises, the technology sector, artists, arts organizations and education providers."

*The Digital Network Infrastructure and Metropolitan Chicago*

The Metropolitan Planning Council's Telecommunications Working Group embarked upon the task of conducting an assessment of the then existing telecommunications infrastructure in the Chicago area. The working group also looked at the impacts, both economic and social, of information technology; and made firm recommendations for public and private actions.

*Borlänge - Sweden*

Borlänge used to be a municipality characterised by a few processing industries in the steel and paper sectors. These firms had undergone drastic rationalistion programs which resulted in thousands of lost jobs. Borlänge was slipping into becoming an economically depressed area. The interventions of Borlänge Municipality and the Swedish government with the support of the European Union, managed to put together action plans, executed them and saw changed fortunes for the area. The provision of the above services are depended on the core infrastructure and are a key to creating powerful social and economic networks by encouraging communication and the exchange of information.

**Conclusion**

The AMEU Telecommunications Workgroup has pursued its task with enthusiasm and diligence. Much work remains to be done. Most of the tasks were driven with huge time constraints because the window of opportunity was very limited and many initiatives had to be taken at short notice. The team have functioned very effectively and were always available to give assistance wherever needed.

**Recommendations**

- That a budget be made available for travelling and administrative purposes.
- That a further report be written on the choice of individual or collective negotiations with the SNO.
- That as many as possible munics participate in this initiative and that the political powers be informed and actively participate.
- That cognisance should be taken that this is the biggest local government revenue generation opportunity ever and should be pursued with eagerness and enthusiasm. Δ

*From left to right: Trevor van Niekerk, chairman AMEU Affiliates; Rev. Alan Wright; Peter Fowles, incoming AMEU president; Phindile Nzimande, CEO EDI Holdings; Clr. G H Zondi, Mayor of Pietermaritzburg (Msunduzi); John Erich, outgoing AMEU president and Jean Venter, Van der Walt & Co, AMEU general secretaries*

# Electrical accident safety briefings

## Ekurhuleni Metropolitan Municipality

*The Padstow street accident*

On 17 March 2003, an electrician and his handyman was working on a 33 kV outdoor isolator in the switchyard of the Padstow Street substation in the Alberton Service Delivery Centre. The foreman was also present on site. All procedures were followed and a permit was issued. The purpose of the exercise was to repair a hot connection where the blue phase busbar connects onto the stationary contact of the horizontal rotary action isolator. All that was needed was to remove, clean the contact surfaces and replace the U-clamp holding the connection. The triple pole isolator was mounted on its own structure and the busbars were isolated at the circuit breaker on the next structure. The other side of the isolator was left live, presumably because there was no intention to climb onto the structure or to work near the live parts, and switching it off would have entailed driving to another substation about 2 km away. There was no misunderstanding about the fact that the other end of the isolator was live, as more than one witness saw the electrician demonstrating to his handyman that this was the case by bringing a link stick close to the live parts. Both the electrician and the handyman had many years experience in this type of work.

After satisfying himself that the work was well under way, the foreman retired into his vehicle to fill in the logbook. The next moment there was a loud bang. When he looked up both the electrician and his handyman were lying on the ground in the vicinity of the isolator. He called for help and they were rushed off to hospital where they both later died. There were flash marks on all three phases of the "live" part of the isolator and the supply was tripped at the other substation. Indications are that the handyman had possibly climbed onto the isolator, structure causing the flash over. No reason for him or the electrician wanting to do so could be found.

The Department of Labour was informed and an inspector visited the site a few days later. He issued a "Prohibition Notice" in terms of General Machinery Regulation 5(1), prohibiting the Ekurhuleni Metropolitan Municipality *"to work on or near electrically live distribution networks where the voltage exceeds 6,6 kV, including a competent person"*. This has left the staff of the Electricity Division in a difficult position, as it is not entirely clear what the legal position is. How near is "near"? How do you operate and maintain an electrical reticulation system when not even your legally competent people are allowed to work near live equipment?

*The Langaville accident*

On 3 April 2002 an electrician and his handyman were busy replacing a blown 11 kV fuse in an outdoor ring main unit in Langaville in the Brakpan Service Delivery Centre. One or more of the fuses in this fuse switch had blown several times before, as the circuit it supplied was overloaded, inter alia, due to illegal connections made by members of the community, and the excessive consumption of the resultant free electricity. While they were removing one of the fuses an explosion occurred inside the fuse switch causing it to spew burning oil over both the electrician and his handyman. They were rushed to hospital where they both eventually died. It was later found that the explosion was caused by a loose piece of metal, possibly the end cap of a blown fuse, causing a short circuit between two of the busbars that was positioned underneath the fuse carriage. It was also established that fuses had, on several occasions, been found to have disintegrated inside the fuse carriage.

It seems that the accident was caused by the inappropriate application of the fuse protected ring main unit in a situation where overloads regularly occurred. The "back up" type fuses that were used are not suitable for protecting electrical loads against light overload conditions. Under such conditions this type of fuse will overheat and ultimately fall apart when the porcelain breaks. The fuse will, however, blow correctly under heavy overloads. Under medium overload conditions the fuse will start blowing in a reasonable time, thus setting off the striker pin mechanism. This will, in turn, trip the switch and thus protect the fuse from further damage due to overheating. The peculiar behaviour of a medium voltage fuse lies in the fact that such a fuse is, in effect, made up of a large number of series connected fuse elements that need to be blown simultaneously by a heavy overcurrent. If there is not enough current, the fuse may only melt in one place, and with the voltage available to sustain the resultant arc, the fuse will be turned into an arc furnace.

A contributing factor in this case was the design of the particular fuse switch. The placement of the busbars underneath the fuse carriage, combined with the fact that there was no physical barrier between the fuse compartment and the busbar section, was most unfortunate. Such a barrier could possibly have prevented the remains of the fuse from falling onto the busbars. It could also possibly have prevented the arc and burning oil from being expelled through the opened fuse compartment.

Japie de Villiers

Ekurhuleni Metropolitan Municipality

## Eskom Distribution, Central Region

An incident occurred on 20 March 2003 whereby a power transformer failed causing a PCB contaminated oil spill. A 20 MVA 88/33 kV transformer faulted in the region. This transformer (situated in the number two bay and one of three transformers at this substation) faulted, causing approximately 5000 litres to spill. A bundwall was in existence around the transformer, with a drainage system into an oil pit.

On arrival at the substation on the day of the failure, standard operating procedures were followed to isolate, earth and barricade the area. The operator inspected the faulted transformer, and discovered that a red warning label was affixed to the tank. The label showed that the transformer contained more than 500 ppm of PCB.

The operator didn't know what the label actually meant and what procedures were to be followed, although the procedure number and title was stipulated on the label. He contacted the supervisor who in turn contacted the risk department (environmental management) to clarify what actions they should follow regarding the warning label.

The approved contractor for oil spill clean-up and remediation was informed about the PCB contaminated oil spill. Safety clothing and other precautionary equipment was used to dismantle and remove the unit to an isolated storage area.

The crusher stone around the transformer was contaminated as well. This stone was sealed in a bin and send away for safe disposal. Disposal of all waste and clothes had to be done at an approved "Hazardous Waste Disposal" site. A similar process was followed to de-chlorinate or incinerate the PCB oil.

Upon inspection of the substation civil drawings, it was discovered that the areas around the transformers were connected through the underground pipes to a soak pit (French drain). This meant that all its contents and surrounding soil had to be removed and disposed of in the correct manner.

*Conclusions and solutions to prevent a re-occurrence*

- Identify all power transformers containing PCB
- Inform operating staff of such locations
- Label the substation area and fences with warning signboards regarding PCB contamination
- Do an environmental risk assessment on the substation and surrounds
- Label all power transformers to indicate their status
- Consider insurance premiums as at present most insurance policies do not cover PCB clean-up and incineration / de-chlorination of contaminated products.

Egmont Dennyschen

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| | KG Robson | East London |
| | *Clr RL de Lange | East London |
| | E de C Pretorius | Potchefstroom |
| | W Barnard | Johannesburg |
| **1987** | AP Burger | Pretoria |
| | JC Dawson | Uitenhage |
| | DH Fraser | Durban |
| | PC Palser | Cape Town |
| **1989** | PJ Botes | Roodepoort |
| **1989+1988** | MPP Clarke | Randburg |
| | EG Davies | Pietermaritzburg |
| | *JA Loubser | Benoni |
| **1991+1998** | AHL Fortmann | Boksburg |
| **1993** | FLU Daniel | Cape Town |
| | JE Heyderych | Middelburg |
| | B van der Walt | General Sec |
| **1995** | CE Adams | Port Elizabeth |
| | B Modeley | Iso-Tech Systems |
| **1997** | JD Algera | Rustenburg |
| | HR Whitehead | Durban |
| | F van der Velde | NER |
| **1999** | JG Malan | Kempton Park |
| **2001** | HD Beck | Buffalo City |
| | CE Burchell | ABB Powertech |
| **2003** | AJ Van der Merwe | Manguang |

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| **1917-1918** | *J Roberts | Durban |
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| **1920-1922** | *TWC Dodds | Pretoria |
| **1922-1924** | *GH Swingler | Cape Town |
| **1924-1926** | *Roberts | Durban |
| **1926-1927** | *B Sankey | Johannesburg |
| **1927-1929** | *JM Lambe | East London |
| **1929-1931** | *R MacCauley | Bloemfontein |
| **1931-1933** | *LL Horrel | Pretoria |
| **1933-1934** | *LF Bickell | Port Elizabeth |
| **1935-1936** | *GG Ewer | Pietermaritzburg |
| **1936-1937** | *A Rodwell | Johannesburg |
| **1937-1938** | *JH Gyles | Durban |
| **1938-1939** | *HA Eastman | Cape Town |
| **1940-1944** | *IJ Nicholas | Umtata |
| **1944-1945** | *A Rodwell | Durban |
| **1945-1946** | *JS Clinton | Harare |
| | *JW Phillips | Harare |
| **1946-1947** | *GJ Muller | Bloemfontein |
| **1947-1948** | *C Kinsman | Durban |
| **1948-1949** | *A Foden | East London |
| **1949-1950** | *DA Bradley | Port Elizabeth |
| **1950-1951** | *CR Hallé | Pietermaritzburg |
| **1951-1952** | *JC Downey | Springs |
| **1952-1953** | *AR Sibson | Bulawayo |
| **1953-1954** | *JC Fraser | Johannesburg |
| **1954-1955** | *GJ Muller | Bloemfontein |
| **1955-1956** | *DJ Hugo | Pretoria |
| **1956-1957** | *JE Mitchell | Bulawayo |
| **1957-1958** | *A van der Walt | Krugersdorp |
| **1958-1959** | *CG Downie | Cape Town |
| **1959-1960** | *RW Kane | Johannesburg |
| **1960-1961** | *RMO Simpson | Durban |
| **1961-1962** | *C Lombard | Germiston |
| **1962-1963** | *PA Giles | East London |
| **1963-1964** | *JC Downey | Springs |
| **1964-1965** | *RW Barton | Welkom |
| **1965-1967** | *D Murray-Nobbs | Port Elizabeth |
| **1967-1969** | *GC Theron | Vanderbijl Park |
| **1969-1971** | *HT Turner | Umtali |
| **1971-1973** | JK Von Ahlften | Springs |
| **1973-1975** | *JC Waddy | Pietermaritzburg |
| **1975-1977** | E de C Pretorius | Potchefstroom |
| **1977-1979** | KG Robson | East London |
| **1979-1981** | PJ Botes | Roodepoort |
| **1981-1983** | DH Fraser | Durban |
| **1983-1985** | W Barnard | Johannesburg |
| **1985-1987** | *JA Loubser | Benoni |
| **1987-1989** | AHL Fortmann | Boksburg |
| **1989-1991** | FLU Daniel | Cape Town |
| **1991-1993** | CE Adams | Port Elizabeth |
| **1993-1995** | HR Whitehead | Durban |
| **1995-1997** | JG Malan | Kempton Park |
| **1997-1999** | HD Beck | East London |
| **1999-2001** | AJ van der Merwe | Bloemfontein |
| **2001-2003** | J Ehrich | Pretoria |

## Past Recipients of AMEU Certificates of Merit

| | |
|---|---|
| **12th Technical Meeting - September 1998** | |
| Bokkie Boshoff | Vanderbijlpark |
| *Gerhard Gerber | Zwellweger |
| *Ian L Hobbs | Uitenhage |
| Nat Kirschner | Reyrolle |
| Prof. Ryno Kriel | Bloemfontein |
| *Ald Ben Steyn | Boksburg |
| *Theunis C Stoffberg | Eskom |
| **13th Technical Meeting - September 1990** | |
| *ACT Frantz | Cape Town |
| JAD Foubister | SABS |
| F Prins | Public Work |
| *WP Rattey | Strand |
| Prof. K Van Alphen | SABS |
| Jan Venter | Cape Town |
| **14th Technical Meeting - August 1992** | |
| William Loshley | GEC |
| Emil de Villiers | Rustenburg |
| **15th Technical Meeting - August 1994** | |
| * Ald Frikkie Kotze | Port Elizabeth |
| J van Soelen Lochner | Pietersburg |
| William Tindle | Reyrolle |
| **16th Technical Meeting - October 1996** | |
| KJ Murphy | Somerset West |
| PJ Muller | African Cables |
| AJ van den Berg | Krugersdorp |
| **17th Technical Meeting - September 1998** | |
| Clive Burchell | ABB Powertech |

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